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# Resilience in Social Housing: An Investigation of Heating Practices in the UK

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**Abstract.** The social housing sector is crucial in reducing a nation's overall $CO_2$ emissions. While academic studies have examined housing energy performance during the design phase, they often overlook the dynamic changes in occupants' behaviours through resilience, where occupants learn from their experiences and adapt them to their daily lives, responding to changes adaptively. This paper employs a practice theory approach to explore how inhabitants react to extreme situations, such as pandemics and cost of living crises, and how energy usage in social housing reflects the practice of resilience.

## 1. Introduction

The National Statistics (1) reported that 17.0% of all carbon emissions in the UK in 2022 originated from the residential sector, highlighting its key role in reducing carbon emissions through improved building performance (2). Additionally, the English Housing Survey Report (3) revealed that 35% of households in UK social housing struggled with energy bill payments amid rising energy costs during 2021 and 2022. This underscores the need for improved energy efficiency in homes, addressing environmental and social needs.

The energy crisis and rising energy costs have made energy-efficient housing a pressing issue, particularly for low-income households in social housing. Consequently, this sector has become a key focus of this study in the context of the 2030 net-zero energy target (4). The growing urgency of climate change has intensified efforts to assess whether buildings and communities are resilient enough to cope with future uncertainties. Resilience is the capacity to resist or absorb social, economic, and environmental disruptions while maintaining stability and adapting to new conditions (5–7). The concept of resilience has evolved to highlight the need for flexibility, learning and adaptation across urban, ecological and socio-ecological systems (6,8). Biggs et al. (9) further stress the importance of knowledge exchange between communities, environments and governance for recovery after disturbances. Therefore, a better understanding of inhabitants' energy-related practices within social housing is essential to comprehend resilience in these households. The scale of social housing managed by housing associations, along with the specific opportunities and challenges of adequate heating systems in low-income households, makes this sector particularly suitable for research.

Conducting research and experiments on social housing sites can be a strategic approach to enhance the quality of urban housing, improve energy efficiency, establish new standards, and support recovery from crisis, such as the Covid-19 pandemic (10). The United Nations Human Rights report states that housing was 'the front-line defence against coronavirus', emphasising the vital role resilient housing plays in public health emergencies (11). The Covid-19 pandemic prompted significant transformations in the housing system as households adapted their living spaces into multifunctional areas that served as workplaces, study zones, and primary spaces for

cooking and dining (12). Webster and Bogunovich (13) argue that the planning, design and use of housing directly impact energy consumption and greenhouse gas emissions, highlighting the necessity for housing that is affordable and resilient to climate change. However, a critical challenge in achieving resilient and energy-efficient housing is 'energy invisibility', which refers to households being largely unaware of how energy is generated and used, resulting in unintended increases in energy consumption (14,15).

According to Palmer et al. (16), UK housing stock emits two or three times more carbon than design models suggest. This inconsistency reveals a significant gap between predicted and actual emissions, emphasising the necessity for improved housing performance. The updated UK Climate Change Act of 2019 requires a complete 100% reduction in $CO_2$ emissions by 2050 (17). In response, the Intergovernmental Panel on Climate Change Report (2) identified that enhancing housing performance is essential for reducing carbon emissions and adapting to climate change. While emission reduction targets are crucial, the implications of climate change, such as increasing temperatures, present further challenges for housing resilience. A post-occupancy evaluation (POE) conducted by Baborska-Narożny, Stevenson and Grudzińska (18) indicates a rise in overheating in newly constructed UK homes during summer. Although there are adaptation strategies for concerns related to ventilation, heating, and cooling, no POE studies have thoroughly explored how to future-proof homes against both physical and social changes, revealing a research gap in this field (19).

In 2022/2023, both Europe and the UK faced rising energy prices and threats of power cuts due to the ongoing energy crisis, significantly impacting households (20,21). This crisis underscores the need to examine its impact on households, particularly in terms of energy-related practices within the home. To better understand household energy use, Gram-Hanssen (22) highlights that energy consumption itself is not a 'practice'; rather, it is the activities that consume energy (e.g., cooking, washing, and showering) that constitute practices. Energy practices reveal how energy is embedded in daily routines to meet inhabitants' needs (23).

Gram-Hanssen's (24) approach to practice theory provides a strong foundation for analysing everyday habits, embodied know-how, engagements, technologies and institutionalised rules. By bringing together resilience thinking and practice theory, it becomes possible to examine both the activities of inhabitants and how their routines endure or transform under changing conditions. This combined approach is particularly valuable for understanding household energy practices in dynamic environments, where external influences (e.g., technological advancements, policy changes, the energy crisis and Covid-19 pandemic) affect routine behaviours. Integrating resilience within practice theory deepens the understanding of energy practices as socially and materially embedded routines, while also highlighting their capacity for flexibility and change over time. This combined approach addresses a gap in practice-based research by introducing a resilience aspect often overlooked in practice theory and socio-technical studies.

The main research question for this paper is: How can new-build social housing be future-proofed through a better understanding of occupants' heating practices and their resilience over time? The overall aim of this research paper is to explore and understand resilience in relation to occupants' heating practices in the household.

## 2. Methods

This study is based on qualitative interviews conducted across multiple homes within a single social housing association, using a case study approach that examines both individual homes and cross-household patterns (25). The case study, located in Sheffield, UK, consists of 15 homes, with

a total of 17 semi-structured interviews conducted with inhabitants. To capture diverse social contexts, the study selected homes with varying household compositions, including singles, couples, and families, to reflect a broad spectrum of energy usage behaviours and practices. A single large housing development was chosen to ensure consistency in housing design, including similar heating systems and climate conditions. This approach helped minimise confounding variables while allowing socio-demographic factors to be examined in relation to heating practices.

The case study (Table 1) aligns with broader social housing trends in Sheffield, where the majority of the homes are either houses (46%) or flats (40%), typically ranging from one to three bedrooms (26). The selected housing typologies – one-bedroom and two-bedroom flats – were chosen because they are among the most common in Sheffield's social housing stock and serve a significant portion of low-income households (26). Each housing typology presents distinct challenges and opportunities regarding energy efficiency and heating systems, making them ideal for exploring the diversity of heating practices.

**Table 1.** Case study characteristics

| Tenure Type | Social Housing |
|---|---|
| Typology | One-bedroom flats<br>Two-bedroom flats |
| Project Completion Date | New-built in 2016 |
| Location | Sheffield / UK |
| Energy Level | Code for Sustainable Homes Level 3<br>EPC Rating Score ranging between 81-86 (Energy Rating B) |
| Heating System | Gas central heating with gas-combi boilers<br>Radiators with thermostatic valves<br>Room Thermostat<br>Digital Programmable Timer |

## 3. Results and discussion

### *3.1. Extreme Factors that Affect Heating Practices*

One of the extreme factors that influenced the data collection period of this study was the Covid-19 pandemic, which significantly increased household occupancy levels and, consequently, energy use. With lockdown measures in place, many inhabitants began working from home, increasing the occupancy level and daytime energy consumption:

*"Well, I used to go out to visit the clients that I supported before the pandemic. And after Covid, I do an awful lot of work from home." (Inhabitant 6, age 51-70, male, lives on the first floor)*

This shift highlights a broader social change in domestic routines. With higher occupancy, particularly among older inhabitants who tend to spend more time indoors, household energy use increased. Previous studies have also found that the Covid-19 pandemic led to substantial changes in inhabitants' lifestyles, such as prolonged home occupancy, directly affecting electricity consumption (27). The findings from this study reinforce this trend, showing that the inhabitants who previously did not work from home started doing so during the pandemic, leading to higher energy costs, as Inhabitant 6 noted:

*"So, uh, so certainly, you know, the electricity bills rate up a little bit from working from home, but then I spent an awful less on petrol. So overall, my energy expenditure is going down." (Inhabitant 6, age 51-70, male, lives on the first floor)*

Beyond changes in occupancy levels, some inhabitants over 50 who contracted Covid-19 experienced increased vulnerability to cold weather or required medical equipment – such as breathing machines – that consumed additional energy:

*"My breathing machine affected the energy-use, and we use the washing machine a lot more regularly. Other than that, no [any social or environmental changes that have affected their energy use]." (Inhabitant 1, age 51-70, female, lives on the ground floor)*

Inhabitant 1 who is living with Inhabitant 2 mentioned above that using breathing machine affected their energy use. Similarly with Inhabitant 1, Inhabitant 11 also mentioned that they need to use the heating more after Covid-19 which increased their energy usage:

*"The only thing was my husband got Covid and he was on a ventilator. And since then, he feels the cold more. So, we have to have the heating on more. But now, obviously with the price, and we are thinking more about it. We are wearing more thick tops and things like that to keep warm." (Inhabitant 11, age 30-50, female, lives on the first floor)*

As Inhabitant 11 mentioned above, during the Covid-19 period, her husband was on a ventilator and felt cold more often than before. Consequently, Inhabitant 11's household adapted to this changing situation by keeping the heating on longer. Reflecting on these two households, the inhabitants over 50 who became more vulnerable to the temperature inside their homes due to contracting Covid-19 and this shaped their heating usage within the homes.

Another significant extreme factor happened during the data collection period was the energy crisis that commenced in the UK in 2021. The rising cost of energy compelled inhabitants to reconsider their heating and electricity use:

*"[…] I mean in summer, we do not use the central heating. Which most people do not. And at the moment I have been very careful because of the cost of living rises. I know it because like everybody, when you are a pensioner you have got to be really careful." (Inhabitant 9, age 51-70, female, lives on the first floor)*

Inhabitant 9 mentioned above that the pensioners living in this social housing need to be careful about using the central heating, as there is an increase in the energy bills due to the energy crisis. This response highlights how financial constraints influenced heating practices, particularly among pensioners. In this study, 8 out of 15 households relied on pensions, making them more cautious with their use of heating and electrical appliances that might impact on their energy use. Beyond pensioners, other inhabitants (see above for Inhabitant 11's quote) also try to reduce their use of heating controls by wearing thicker clothes to keep warm. As a result, the inhabitants adapted their heating practices when there is an extreme situation, such as an energy crisis, where they need to consider their financial situation.

In the UK, home energy use fell by 14% in 2022 and continued to decrease in 2023 due to the new energy efficiency measures and households reducing their 'non-essential' energy use (28). However, this study found that some households went beyond reducing non-essential energy use, cutting back on essential heating instead. This raises concerns about potential negative health and well-being impacts, particularly for older inhabitants and those with respiratory conditions.

Some of the households are aware of the potential impacts of energy crisis and how using their heating unnecessarily could increase their energy consumption. For example, Inhabitant 17 noted:

*"You know earlier we used the room thermostat when it was cold and whenever the temperature drops to a certain temperature, it just comes on. But now we do not do that anymore. We only use the heating certain times of the day. We make sure that the lights are turned off when we leave the room, even if we are going to come back to the room." (Inhabitant 17, age 30-50, female, lives on the ground floor)*

Inhabitant 17's statement above explains that, they changed their heating habits due to the energy crisis by using it on specific timeframes to reduce energy consumption. Reflecting on the statements of Inhabitant 9 and Inhabitant 17, both statements demonstrate how households adjust their heating practices in response to external pressures, particularly the energy crisis. This aligns with practice theory, which emphasizes how routines and habits are shaped by both material conditions (e.g. rising energy prices) and social norms (e.g. awareness of energy saving) (24). The shift from using the room thermostat automatically to scheduled heating as seen in Inhabitant 17's case, illustrates an adaptation of heating practices in response to financial concerns. Similarly, Inhabitant 9's awareness of energy costs reshapes their behaviour, demonstrating how financial considerations act as a structuring force in energy practices.

### *3.2. Alternative Options for the Heating System*

Particularly in terms of know-how and embodied habits, most inhabitants within this case study (9 out of 15) have personal alternatives rather than those provided by the housing association, if their heating system breaks down. For example, Inhabitant 3 noted:

*"Well, they [portable heater] are just there as a backup in case the heating broke down. […] for example, in the wintertime, we come in and it takes, say, 20 minutes for the heating to warm up. I would consider putting on the portable heater." (Inhabitant 3, age 51-70, female, lives on the ground floor)*

In this situation, as Inhabitant 3 mentioned above, even if she changes her habit by using a different control (portable heater) for heating, her household has redundancy to continue heating their homes. This demonstrates how some inhabitants incorporate redundancy into their heating practices, ensuring they have backup solutions when needed. In contrast, when the inhabitants have problems with practical knowledge, the majority of them (13 out of 15 households) rely on maintenance services, especially when they have encountered a problem with the boiler. For example, Inhabitant 5 noted:

*"I don't touch the boiler at all because it was adjusted for everybody for when you moved in, and someone comes out regularly to check to maintain the boiler. So I prefer them to do that." (Inhabitant 5, age 51-70, female, lives on the first floor)*

This highlights the distinction between habitual, everyday heating adjustments and more technical interventions that require expert assistance. When the inhabitants lack confidence in using the controls, they are less likely to engage with them and instead prefer to wait for an expert to handle the problem.

Only 2 out of 15 households have developed an alternative method for heating water if the boiler stopped working, using a kettle as a substitute. Inhabitant 1 described the challenge of this workaround:

*"We are using the kettle, but it is really difficult. I have been here for 6 years now and it is still not fixed." (Inhabitant 1, age 51-70, female, lives on the ground floor)*

This emphasizes how the absence of effective backup systems can lead to prolonged discomfort and inconvenience, particularly when repair delays persist. Alternative heating controls and their connection with know-how and embodied habits are significant when considering the number of 'things' available for inhabitants' heating practices if the specific control fails. Beyond individual alternatives, the study found that broader external factors, such as power cuts, can exacerbate heating challenges. Inhabitant 10 expressed concern about the lack of backup systems during power failures:

*"[…] it would be nice to have a backup system for that [power cuts], especially because the older generation will be affected more. I also think they need the electricity for those certain things, with medical conditions, and then if we are having a power cut, it should be a concern. We need electricity for the things to work, you know what I mean." (Inhabitant 10, age 51-70, male, lives on the ground floor)*

This is particularly significant for elderly inhabitants living in social housing who rely on electricity for medical equipment, and it can be a big concern if there is no alternative for a power cut. With increasing extreme events such as the global energy crisis, pandemics and climate change, energy poverty has worsened, contributing to power cuts in the UK according to the International Energy Agency (29).

These findings underscore the importance of redundancy in heating systems to mitigate the impact of extreme events. The study by Stevenson, Baborska-Narozny and Chatterton (30) supports this view, emphasizing the need for resilience in home heating systems. Integrating alternative solutions and ensuring reliable backup systems can help reduce vulnerability, particularly for older inhabitants and those with medical conditions.

## 4. Conclusion

This study found that extreme events such as power cuts, significantly affect vulnerable inhabitants, particularly those who are susceptible to cold weather, have used ventilators during Covid-19, or rely on breathing machines, especially if their homes lack backup systems. By 2039, over 70% of social housing households will include a member aged 60 or older (31,32). Thus, it is crucial to implement alternative options for the heating system in the social housing sector to future-proof housing and its inhabitants.

Extreme events, such as Covid-19, also affected the inhabitants' heating practices, especially among vulnerable groups, such as those who had been on ventilators. Burlinson et al. (33) highlight that households rely on their financial resources (income, savings, etc.) to protect their health and well-being during unexpected energy price increases. This research analysis builds on this finding, showing that households with increased energy bills tend to adapt their heating practices by using less heating within their homes, not using the heating controls for extended periods, and wearing thicker clothes when they feel cold at home.

According to National Energy Action (34), supplementary heating equipment like fan heaters are among the highest electricity-consuming appliances in the homes. As a result, inhabitants using extra heating equipment are likely to have higher energy consumption than initially estimated. This highlights the importance of inhabitants' "know-how" – their understanding of

how heating controls work and how they can implement these systems efficiently. Proper knowledge of heating controls could reduce reliance on alternatives, but if issues arise due to maintenance or power failure from extreme events, the Housing Association should provide a backup option to mitigate these effects.

Inhabitants who are aware of changing conditions and their impacts are more open to adapting their heating practices than those unaware of these events. Therefore, collective know-how is necessary to increase awareness among inhabitants about knowledge on energy saving, the effects of energy crisis, and climate change. This collective know-how can be achieved through advice from household members, their neighbours, or the Social Housing Association.

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