Retrofitting Hard-to-Treat Social Housing across the English Midlands: Challenges, Strategies, and Opportunities

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Executive summary

Purpose and context

This report investigates the retrofitting of 'hard-to-treat' (HTT) social housing in the UK, focusing on properties across the English Midlands. HTT homes, characterized by their age, construction type, and architectural features, present unique challenges for energy efficiency improvements. This research aims to identify common barriers, effective strategies and innovations to retrofit these homes, reduce carbon emissions, and alleviate fuel poverty.

There is an urgent need to improve the energy efficiency of existing UK housing to meet net-zero targets and improve living conditions for residents. HTT homes, often older and not meeting modern standards, require specific retrofitting approaches. The research was prompted by regular meetings with our consortium members, who expressed challenges in retrofitting these type of properties.

This report addresses the key questions:

- What makes a home HTT?
- What percentage of the social housing stock is HTT?
- What strategies are being adopted for retrofitting?
- What support or innovations are needed?

By addressing these questions, the report aims to provide insights and considerations for various stakeholders to support the effective retrofitting of HTT social housing.

Methodology

Data was gathered via online focus groups conducted via Microsoft Teams and a survey of social housing providers who were funded by the Social Housing Decarbonisation Fund (SHDF) Wave 2.1, offering both quantitative and qualitative insights.

Key findings

Key finding 1: Characteristics of HTT homes

It was found that HTT homes face technical, locational, financial, and tenant-related challenges. Common issues include:

- Technical difficulties with insulation and other installations
- Design and structural challenges due to architectural features and space constraints
- Regulatory and planning hurdles, especially in conservation areas
- Impact on tenants
- Financial viability concerns

Key finding 2: Common barriers to retrofitting HTT homes include

The common barriers identified to retrofitting HTT homes include:

- Tenant resistance and engagement challenges

- Technical and structural issues like damp, mould, and exposure to extreme weather conditions
- Planning and regulatory complexities
- Contractor reluctance and high costs

Key finding 3: Percentage of social housing deemed HTT

Responses varied across our sample, with band 21-30% being the most common estimate, indicating diverse HTT levels across different social housing providers.

Key finding 4: Effective strategies to retrofit HTT homes

Key strategies to retrofit HTT homes include a fabric-first approach, innovative solutions for narrow spaces-such as alleyways, focussed tenant engagement, and addressing air source heat pump issues. Collaboration between housing associations and retrofit professionals, clear expectations created on the part of the tenant, and thorough project planning by housing providers are also deemed crucial.

Key finding 5: Support or innovations needed

We identified several areas where support and innovations are needed on the part of the social housing providers. These include sharing comparative cost data to aid in better financial planning, creating a detailed case study library for enhanced knowledge sharing, and increasing customer buy-in for low carbon heating technologies through education and engagement.

Recommendations for research and knowledge building

- Share comparative cost information: It would be beneficial to develop and disseminate cost data for various retrofitting measures, particularly for hard-to-treat (HTT) homes. This data could help housing providers and industry professionals better plan and execute retrofitting projects.
- Create a detailed case study library: Establish a comprehensive resource of successful retrofitting projects for HTT homes. These case studies could include specific strategies, methodologies, and best practices to enhance knowledge sharing and facilitate replication across the sector.

Recommendations for industry stakeholders

- Enhance customer buy-in for low carbon heating technologies: Industry stakeholders could focus on educational campaigns and engagement strategies to build public trust in technologies such as air source heat pumps (ASHP). Increasing awareness and acceptance among tenants and homeowners could significantly improve the success of retrofit programs.
- Collaborate with knowledge-sharing networks: Industry stakeholders should continue to work with academic institutions, technology providers, and local authorities to ensure the effective transfer of knowledge and innovation within the sector. This collaboration can support the continuous improvement of retrofit strategies and outcomes.
- Improving PAS 2035 compliance: More robust training and clearer guidance for contractors and housing providers regarding PAS 2035 could enhance compliance

and help overcome technical and operational challenges associated with retrofitting HTT homes.

- Setting up a PAS 2035 Implementation Panel: An implementation panel could be established to address grey areas in PAS 2035 application and provide clear, actionable solutions for housing providers and contractors.

Considerations for Policymakers

As the Midlands Net Zero Hub, supported by the Department for Energy Security and Net Zero, we refrain from making direct policy recommendations. However, the findings from the research suggest areas of consideration for various stakeholders, including government bodies. These findings will be compiled and shared with the department to inform future planning and decision-making processes.

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List of Abbreviations

ASHP	Air Source Heat Pump
BEIS	Department for Business, Energy and Industrial Strategy
BRE	Building Research Establishment
CCC	Climate Change Committee
CERT	Carbon Emissions Reduction Target
CESP	Community Energy Saving Programme
CTD	Complex-To-Decarbonise
DCLG	Department for Communities and Local Government
DLUHC	Department for Levelling Up, Housing and Communities
DNO	Distribution Network Operator
ECO	Energy Company Obligation
EPC	Energy Performance Certificate
EPR	Energy Performance Retrofit
EWI	External Wall Insulation
HTT	Hard-To-Treat
IWI	Internal Wall Insulation
LAD1b	Local Authority Delivery 1b
MNZH	Midlands Net Zero Hub
PAS	Publicly Available Specification
PV	Photo-voltaic
SAP	Standard Assessment Procedure
SHDFd	Social Housing Decarbonisation Fund demonstrator
WHR	Whole House Retrofit

Introduction

The retrofitting of housing in the United Kingdom, particularly housing classified as 'hard-to-treat' (HTT), represents a significant challenge and opportunity in the pursuit of national energy efficiency and sustainability goals (CCC, 2019).

HTT homes are typically characterized by their age, construction type, and architectural features, which render conventional energy efficiency measures less effective or economically viable. These homes, often built before the implementation of modern building regulations, include solid wall properties, those of non-traditional construction, high-rise flats, and homes without access to mains gas, among other typologies (Dowson et al., 2012).

Retrofitting certain types of properties presents varying levels of difficulty and expense (DCLG, 2014). For example, masonry-walled dwellings with attached features like conservatories, porches, or bays require additional work and cost to properly insulate around these projections. Dwellings with a predominant rendered finish may incur extra costs as the render might need removal, repair, or treatment before insulation can be installed. Properties with non-masonry wall finishes, such as stone cladding, tile, timber, or

metal panels, pose significant challenges. These finishes can either increase costs or, in some cases, make external solid wall insulation impractical.

Flats present unique difficulties due to the need to secure agreement and financial contributions from multiple leaseholders. Additionally, the height of high-rise flats complicates the application of external solid wall insulation.

Other barriers include planning restrictions in conservation areas or for listed buildings, which can limit the feasibility of installing solid wall insulation. However, the English Housing Survey does not collect data on these specific restrictions.

Properties with fully boarded lofts across the joists also present challenges, requiring extra work and expense. Insulating rooms in the roof (and dropped eaves / sloping ceilings) involves extensive work and significant costs due to the need to add insulation between the rafters or to remove and replace the roof covering. Flat or shallow-pitched roofs are often not feasible for loft insulation because there is either no access to the loft or no loft space at all. Understanding these complexities is crucial for developing effective policies and strategies to improve energy efficiency in HTT properties.

Recent work on the topic has attempted to revise the definition of 'hard-to-treat' to 'Complex-to-Decarbonise' or CTD (HM Govt, 2023). The authors of that report argue that the phrase Complex-to-Decarbonise (CTD) better captures the multifaceted challenges associated with decarbonising certain homes using standard approaches. However, throughout our report we continue to use the term 'hard-to-treat' (HTT) due to its widespread use and understanding within the retrofit and housing sector, even if the term is flexible in its interpretation and usage.

There are varying assessments of the number of homes that are HTT in the English and UK housing stock. This reflects to some degree the criteria used to define them. A report by BRE (2008) estimated that in England alone, 9.2 million dwellings (43% of total stock) can be considered HTT. The English Housing Survey Energy report (DLUHC, 2022) estimates the total number of homes with harder to treat walls or lofts in the housing stock rather than estimate the degree where multiple difficulties exist. The report estimates that 2.3 million uninsulated cavity walls, 7.4 million uninsulated solid walls, and 1.3 million lofts can be considered HTT. These figures are supported by Mohammadpourkarbasi et al. (2023) who contend that a majority of HTT dwellings will have solid walls and highlight that there were estimated to be 7.7 million dwellings with uninsulated solid walls in 2021. A significant number of homes within conservation areas could fall into the HTT category and it is estimated that there are 2 million such properties across the UK (Historic England, 2020). We can see from this short review that the numbers are a significant proportion of the existing housing stock, and effective strategies are urgently needed to retrofit these homes.

Our review of literature found far less evidence on successful strategies for retrofitting HTT homes. However, this evidence gap was addressed in recent work (HM Govt, 2023), which demonstrated, through case studies, some of the successful approaches to retrofit CTD homes. The report highlighted the importance of using both established and innovative technologies, scaling up methods to improve economies of scale, and implementing ongoing monitoring and evaluation to enhance outcomes and learning. Case studies emphasized the necessity of understanding each building's unique characteristics through detailed early surveys, and structural assessments, which are crucial for successful retrofits.

Furthermore, effective retrofitting involves clear project objectives, collaborative decision-making, resident-centric approaches, and dedicated retrofit coordinators to ensure smooth project execution.

In England there are 4 million households in the social rented sector-17% of all households. Social rented housing has higher energy efficiency ratings compared to other tenures. In 2021, the mean SAP rating for all homes across England was 66. Social renters had a higher average rating (70) than owner occupiers (66) and private renters (65) (DLUHC, 2023).

Good progress has been made on improving the energy efficiency of social rented homes, driven by the 'stick' of regulation compliance and the 'carrot' of government-funded schemes. There is, however, a concern that HTT homes are being 'left out' of retrofit programmes due to their complex needs, ultimately leading to households being left behind in the transition to net-zero. This places many millions of people at risk of being entrenched in poor quality homes and fuel poverty.

Given the urgent need to reduce carbon emissions and alleviate fuel poverty, the retrofitting of these HTT properties is essential. The scale of the challenge is, however, formidable, with Inside Housing[1] estimating that the cost of decarbonising all social homes in the UK to be £104bn. As reference for scale, WHR (Whole House Retrofit), SHDFd, SHDF wave 1, SHDF wave 2.1, SHDF wave 2.2, and SHDF wave 3[2] add up to approximately £2.3bn.

This report aims to investigate the various challenges and barriers together with strategies, technologies, and frameworks that can facilitate the effective retrofitting of HTT social housing in the UK. Data for this investigation was gathered using focus groups and an online survey, providing a mix of qualitative and quantitative insights.

The sample for this research includes social housing providers with stock across the English Midlands, encompassing both local authority and private registered providers. All organisations were participating, at the time, in the Social Housing Decarbonisation Fund wave 2.1 scheme that provides grant funding for the retrofit of social housing (BEIS, 2022). Although not necessarily representative of the entire country, this sample provides valuable insights into the emerging themes and challenges around retrofitting HTT social homes. The objectives of the research are to answer the following key questions:

1. What makes a home hard-to-treat?
2. What percentage of the social housing stock could be considered hard-to-treat?
3. What strategies are registered providers of social housing adopting to retrofit these properties?
4. What further support or innovation is needed to retrofit hard-to-treat homes?

This report reviews current practices and stakeholder views to find common barriers and best practices for retrofitting HTT properties. It aims to suggest solutions that address both technical and social challenges. By looking at insulation strategies, low carbon heating systems, and renewable energy integration, the report provides a comprehensive view of the retrofitting landscape and its effects on tenants and communities.

[1] https://www.insidehousing.co.uk/insight/insight/the-cost-of-net-zero-social-landlords-decarbonisation-plans-revealed-68497 (accessed 30/5/24)
[2] From the forecasted amount prior to official launch of scheme

The goal is to offer clear insights and recommendations to improve the UK's social housing. By focusing on HTT properties, the report supports housing providers, and other stakeholders in meeting energy efficiency goals and improving residents' quality of life.

The report is structured as the following sections:

Section 2, Methodology, describes the data sample, collection, and analysis methods used in the research. It details the focus group discussions and online survey methodology, including participant selection and data handling procedures.

Section 3, Results, presents the key findings from the focus groups and online questionnaire. It highlights the main themes and insights that emerged from the data, offering a detailed analysis of the current challenges, strategies, and needs related to HTT homes identified by social housing providers.

Section 4, Discussion, draws together the key findings from the focus groups and questionnaire and discusses them with reference to the existing literature on the topic.

Section 5, Recommendations and considerations, uses the research findings to identify considerations for various stakeholders engaged in the retrofit of UK social housing.

Section 6, Conclusions, summarizes the main findings of the report.

Methodology

We adopted a pragmatic standpoint to best answer the research questions (Gray, 2014). To this end, we took a mixed methods approach by using quantitative data from a questionnaire and qualitative data from focus groups.

Appendix A provides a detailed explanation of our research methodology, which we summarise below.

Data collection

Focus groups: Conducted online via Microsoft Teams, these groups included 14 participants from nine registered providers. Discussions were facilitated in three breakout rooms, with approximately three to four participants in each, to encourage diverse perspectives. The sessions were designed to probe into specific issues, with moderators guiding the conversation and MNZH staff members taking detailed notes.

Questionnaire: Distributed to 23 members of the MNZH consortium, with an emphasis on both quantitative and qualitative questions. The questionnaire aimed to capture a broad range of experiences and challenges related to HTT retrofitting. A 40% response rate was achieved, providing data from various housing providers.

Data analysis

Focus groups: Thematic analysis was conducted on the qualitative data, identifying key themes and patterns. This involved organizing the data, coding for significant themes, and exploring relationships between themes.

Questionnaire: Quantitative data was analysed using Microsoft Excel, while qualitative responses were thematically analysed, linking the findings with those from the focus groups.

Ethical considerations

In line with GDPR practices, participant privacy was ensured, with data anonymized and used solely for research purposes. Participants were informed of their right to withdraw at any time.

Results

Focus groups

The data from the focus groups is presented below under each question and sorted into the key themes revealed during the analysis.

How do you define or describe a "hard-to-treat" home in terms of retrofitting?

What characteristics do you think makes a home hard to treat (HTT) or hard to decarbonise?

Design and structural challenges

- Design issues
    - Struggling with retrofit designs for these properties
    - Issues with achieving SAP points to meet funding scheme rules
    - Difficulties with internal wall insulation (IWI) in specific areas like kitchens and bathrooms
- Specific construction types
    - Properties with alleyways, reducing practicality for insulation
    - Roof lines and traditional terrace properties posing challenges
    - Problems doing properties with “Edwardian brick features”

Planning and regulatory issues

- Planning permission and regulations
    - Planning permission required for older properties (e.g., 1860s homes)
    - Conservation areas imposing additional restrictions
    - Local authority planning department requiring “expensive” architectural drawings
- Heritage considerations
    - Impact of retrofitting on the aesthetic and value of heritage buildings
    - Difficulties with Victorian facades, which may lower resale prices if EWI is used

Technical and installation issues

- Internal Wall Insulation (IWI)
    - IWI as a hard-to-treat measure is problematic due to its disruptive nature

    - Problems with IWI in functional areas like kitchens and bathrooms
    - Challenges with radiators and the layout of properties
- External Wall Insulation (EWI)
    - Problems with EWI affecting entrances and alleyways
    - Considerations for neighbouring private residences with limited storage space for materials and scaffolding
- Other technical challenges
    - Narrow cavities, system-built properties, and mansard roofs posing additional problems
    - Issues with solar PV installations on certain property types

Resident and tenant considerations

- Tenant disruption
    - General disruption to tenants lives due to retrofit
    - Specific challenges with supported housing for tenants with learning disabilities or other complex needs

Financial and strategic concerns

- Investment decisions
    - Questioning the worth of investing in certain properties based on their "let ability" and potential to reach energy efficiency standards (e.g., EPC band C)
    - Considering whether to invest in or dispose of hard-to-treat properties

What are the main challenges or barriers you face when considering retrofitting these homes?

Responses to this question are categorised in the following themes.

Tenant and resident issues

- Tenant mistrust and engagement
    - Tenants have mistrust, feeling solutions are "too good to be true"
    - Tenant resistance leading to access issues, particularly for loft insulation, with some cases involving solicitors

Technical and structural challenges

- Weather and wildlife
    - Adverse weather conditions exacerbating damp problems
    - Wildlife "interference" complicating retrofitting efforts
- Damp and mould issues

    - Continuous damp problems needing resolution before insulation. Timeframe issues with confirming damp problem resolution, usually requiring a year
    - Ensuring mould does not grow behind insulation by using 'breathable' materials like wool
- Conservation and heritage properties
    - Retrofitting difficulties in conservation areas and Grade 2 listed buildings, including alms-houses with small interiors
    - High costs of aesthetic solutions like brick slips, approximately £4,000 or more
- Logistics and access
    - Difficulties with properties on narrow streets and the logistics of eco requirements
    - Issues with gas pipes and replacing windows
    - Challenges in re-roofing programs with long gutters and forming new gullies

Planning and regulatory issues

- Planning authority challenges
    - Issues with planning authorities and understanding of SHDF measures
    - Need for planning and resident engagement for project mobilisation
- Policy and funding
    - Inconsistent application of policies on decarbonising social housing
    - Suggestion of the need for pre-project release of funds for better planning and execution

Contractor and cost issues

- Contractor behaviour
    - Contractors using project lists as a 'menu', choosing easier properties first and avoiding harder ones
    - Preference for tackling easier properties first to gain more experience
- Cost and incentives
    - Cost models used to determine if properties are worth investing in
    - High costs and limited incentives for retrofitting, such as a £30,000 cost for a heat pump with only £7,000 claimable, and £21,000 for external wall insulation (EWI)

Have you had any past attempts or experiences with retrofitting hard to treat homes? What worked well and what didn't?

Technology and retrofitting methods

- Heat pump installations
    - Difficulty with wall space in terraced homes, leading to challenges in installing air source heat pumps (ASHP)
    - Mixed experiences with ASHP, including issues with maintaining temperature and noise vibrations
    - ASHP used in new-build properties performing well, but waiting for "technology development" for retrofitting older properties
- Fabric first approach
    - Interest and adoption of fabric-first approach by some organizations, prioritizing energy efficiency measures like external wall insulation (EWI)
    - Challenges with budget constraints and convincing stakeholders of the efficacy of smaller budgets
    - Recognition of the potential for significant energy performance certificate (EPC) increases with smaller, less-costly retrofit measures
    - Finding ways to work around the narrowing effects of EWI in alleyways, such as using thinner materials lower down and increasing thickness higher up
    - Need to minimize disruption through a combination of IWI and EWI measures

Cost and budget concerns

- Budgetary constraints
    - Struggles with limited budget allocations, with 12k considered insufficient for effective retrofitting
    - Average cost per house estimated at approximately 26k, indicating significant investment required for comprehensive retrofits
- Planning and consistency
    - Inconsistencies with planning processes and requirements across different local authorities (LAs), impacting project planning and execution

Skill and knowledge partnerships

- Value of partnerships with universities for skills and knowledge exchange, including utilizing Masters and PhD students as valuable assets
- Working with a Midlands based University on digitalisation methods to improve property assessments

Operational and management challenges

- Importance of collaboration among contractors and stakeholders in project planning and execution
- Recognition of a learning curve among contractors, leading to challenges in bidding for projects and project execution
- Challenges in managing multifunctional teams and coordinating client management, contractor relations, and project delivery simultaneously
- Importance of expert customer liaison leading to improved tenant engagement

In your opinion, what support or resources would be most helpful in overcoming the challenges associated with retrofitting hard-to-treat homes?

It was unfortunate that there was somewhat limited time available to gather extensive responses to this question in the focus group session. However, some of the key points suggested are presented below.

Comparative cost information

- Cost analysis
  - Importance of sharing comparative cost information, including cost per meter, for retrofitting measures like external wall insulation (EWI)
  - Need for comprehensive cost data across larger geographic areas to understand differences between 'normal' and HTT homes

Knowledge sharing and resources

- Resource library
  - Proposal for a centralized resource library containing information on tackling difficult features in retrofitting projects
  - Importance of detailed examples and case studies to provide insights into successful approaches

Stakeholder engagement

- Customer buy-in
  - Challenges in gaining public buy-in, particularly for technologies like air source heat pumps (ASHP)
  - Need for strategies to improve customer awareness and acceptance of innovative retrofitting solutions

We continue in the next section with the results from the questionnaire.

Questionnaire

This section presents the quantitative and qualitative findings from the questionnaire data analysis.

Estimate the percentage of your housing stock with an EPC rating **below** band 'C'

The survey asked respondents to estimate the percentage of their housing stock with an EPC rating below band 'C' (Figure 1). The responses varied, with two respondents indicating the categories representing 21-30% and 41-50% of their housing stock, respectively, as the most common. One respondent estimated that only 0-10% of their housing stock falls below band 'C', while another estimated that over 51% of their housing stock has an EPC rating below band 'C'. Additionally, two respondents were unsure about the percentage of their housing stock with a low EPC rating.

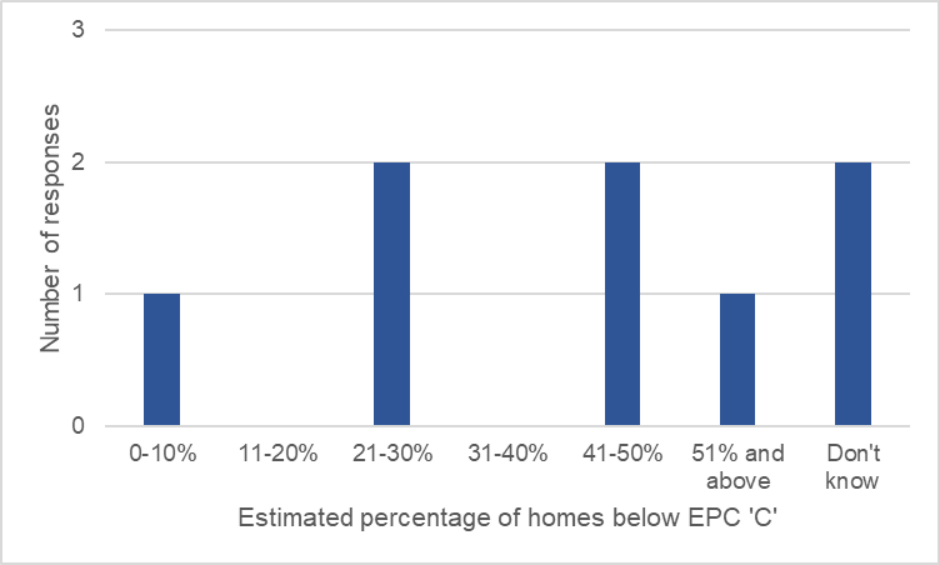

Figure 1 Estimated percentage of respondents housing stock below an EPC band C

What percentage of properties in your portfolio would you consider 'hard to treat' in terms of improving energy efficiency?

The survey asked about the percentage of housing stock that respondents consider 'hard-to-treat' (Figure 2).The most common response, indicated by three respondents, was that 21-30% of their housing stock falls into this category. Two respondents estimated that 0-5% of their housing stock is hard-to-treat, while one respondent each estimated 6-10% and 41-50%.

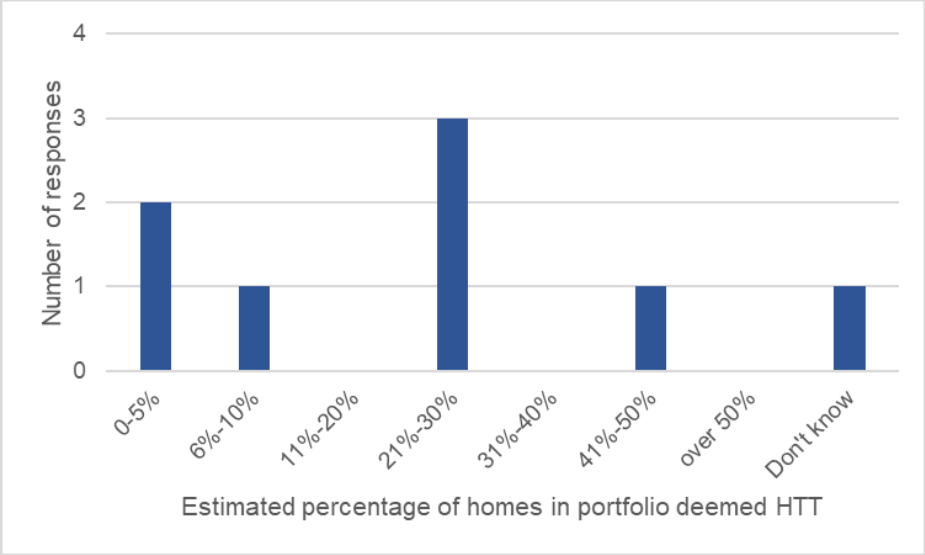

Figure 2 Estimated percentage of homes in portfolio deemed HTT

Can you briefly describe some of the characteristics of these 'hard to treat' properties?

The qualitative responses from the questionnaire were synthesised into the following key themes:

Construction types and materials

- **Solid wall properties:** Includes solid brick or stone, often found in older, traditional buildings and sheltered housing complexes.
- **Non-traditional construction:** Post-war dwellings such as steel frame, concrete sectional, and Wimpey No Fines, which are often problematic and may have "defective by design" status.
- **Cavity wall and system built:** Includes three-storey cavity wall blocks and system-built properties like cross-wall with tile cladding.
- **Unique architectural features:** Older traditional buildings with bespoke brick designs, unique elements like lintels, corbels, and plaques, which complicate EWI efforts.

Physical and structural challenges

- **End-of-life properties:** Some properties were intended as temporary housing post-WWII and are now approaching the end of their lifespan.
- **Encapsulated asbestos:** Cast iron properties with asbestos encapsulation present significant retrofit challenges.
- **Space constraints:** Issues with narrow cavities, access, and maintaining minimum room sizes when installing IWI

Location and design issues

- **Urban constraints:** Difficulty installing external equipment on inner-city terrace housing and properties with narrow alleyways.

- **Mixed archetypes:** A varied stock including traditional terraced houses, semi-detached, detached, and high-rise buildings, each presenting unique challenges.
- **Off-gas properties:** Properties not connected to the gas grid, often reliant on older electrical or oil heating systems.

Regulatory and planning barriers

- **Planning permission:** Significant issues with planning constraints, particularly due to varying requirements across different local authorities. A streamlined planning process is needed nationwide.
- **External architectural features:** Planning constraints related to preserving the external appearance of properties.

Tenant and funding issues

- **Tenant objections:** Resistance from tenants regarding the disruption caused by retrofit works.
- **Funding access:** Difficulty in securing suitable funding for small-scale projects, essential for comprehensive retrofits.

Technical complexities

- **Technical barriers:** Issues with technical complexities of PAS (Publicly Available Specification), such as eaves overhangs, adjacent properties, passageways, and internal features like door/stairway locations.
- **Thermal improvement difficulties:** Specific challenges with timber-framed houses, bungalows with low pitch roofs, and properties requiring significant loft insulation improvements.

What are the main challenges or barriers you encounter when retrofitting 'hard to treat' properties?

The following excerpts highlight key points and common themes raised by the respondents.

Health and safety

- **Worker and tenant safety:** Ensuring health and safety involves measures like asbestos testing, air monitoring, and using specialized fixings for external wall insulation (EWI), which often proves ineffective, necessitating extensive use of standard drill bits and specialized waste disposal due to bituminous asbestos substances.

Tenant co-operation

- **Tenant resistance:** Some tenants refuse or make it difficult to complete certain retrofit works, such as fitting extractor fans, adding to the challenge.

Structural and technical challenges

- **Internal wall insulation:** Retrofitting solid wall dwellings often requires removing and reinstating kitchens, bathrooms, and staircases, causing significant disruption to occupiers.
- **Structural issues:** Discovering structural issues like subsidence during technical inspections requires remediation before retrofitting.
- **Complexity and cost:** High complexity and cost of retrofit works, including the need to achieve deep retrofit levels for electrical and oil-heated stock, often deter customer consent and contractor commitment.
- **Specification standards:** Historically, a lack of clear and practical specification standards for retrofit, though this is improving.

Planning and regulatory barriers

- **Planning approval:** Challenges in obtaining planning approval, particularly in conservation areas.
- **Seasonal constraints:** Time of year issues, such as nesting birds, can impede progress.
- **Compliance requirements:** Balancing compliance with PAS2035, building regulations, planning, Distribution Network Operators (DNO), and legal issues without incurring excessive costs or disruptions.

Environmental issues

- **Damp and mould:** Existing damp and mould issues must be addressed before retrofitting can proceed for some types of issues and some measures (sometimes the measures are the solution).

Financial constraints

- **Cost and viability:** High costs and financial constraints often make retrofit projects financially unviable for social housing providers, with significant investment required for effective solutions like EWI or internal wall insulation (IWI).

Please rank the following factors based on their impact (1 being the most significant barrier, 7 being the least)

The survey asked respondents to rank the main challenges or barriers they encounter when retrofitting HTT properties (Figure 3). The top-ranked challenge was "Cost constraints," followed by "Technical complexity," and "Regulatory requirements" such as Trustmark and PAS 2035. "Occupant disruption" and "Local planning restrictions" were also significant concerns, though they varied more in importance among respondents. "Lack of suitable technologies" and "Lack of knowledge" were ranked as lesser challenges, with more respondents considering them lower-priority issues. The chart highlights the diverse range of barriers faced, with cost and technical issues being the most pressing. Note that the lowest ranking measure is not necessarily unimportant, it is just a lower priority.

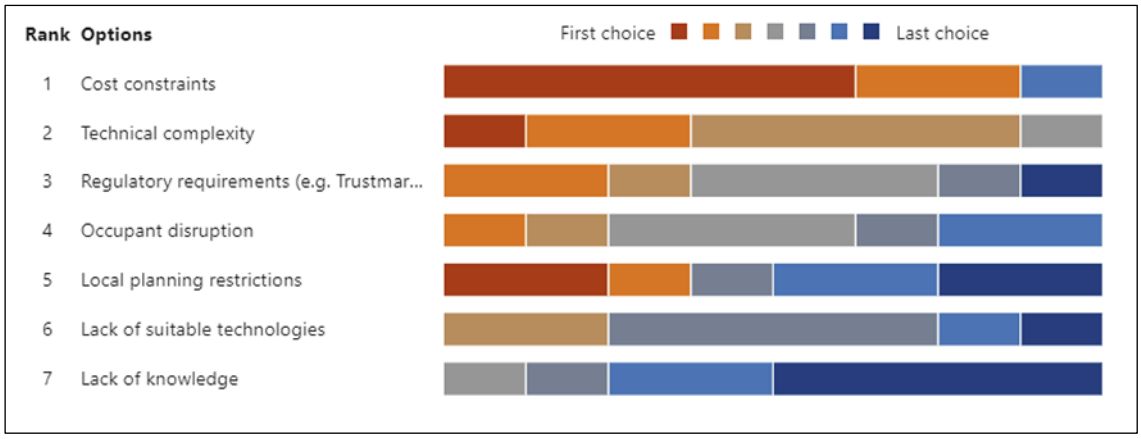

Figure 3 Ranking of constraints for retrofitting HTT properties

How do you prioritize 'hard to treat' properties within your portfolio for retrofit?

The survey asked respondents about the primary criteria they use for prioritizing energy efficiency retrofit projects of HTT properties. Two respondents indicated they prioritize based on EPC ratings, while one respondent each cited considering occupancy demographics and geographic location. The majority of respondents, however, selected "Other" as their criteria, indicating a variety of additional factors being considered. These included, **(1)** cost to treat coupled with impact on resident and remaining lifespan of property, (2), on an archetype basis: EPC ratings, customer feedback, cost effective solutions, (3) both EPC and Fuel poverty are used and (4) Technical Considerations / Funding Availability / Demographics / EPC. This diversity suggests that multiple considerations play a role in decision-making for retrofit projects.

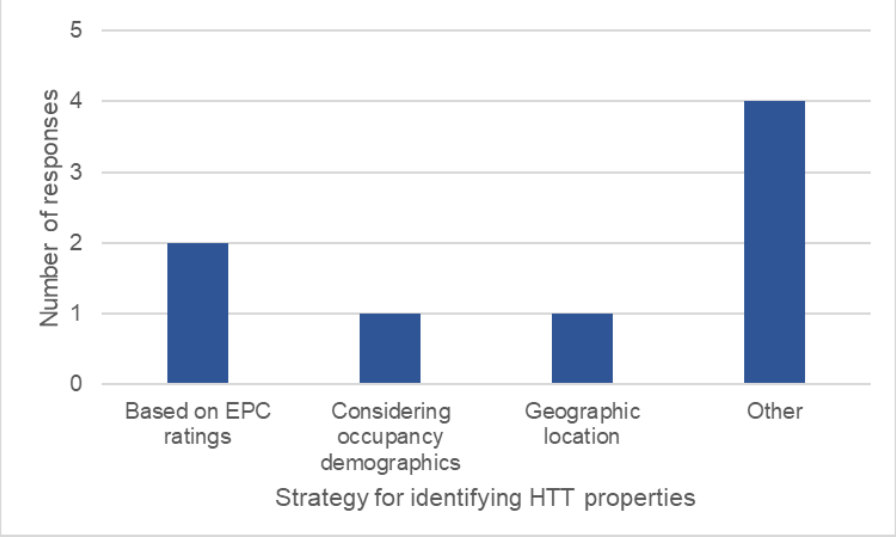

Figure 4 Strategy used for identifying HTT properties

What strategies or approaches have you implemented or are considering retrofitting 'hard to treat' properties?

The survey revealed that the most common energy efficiency measures for HTT properties include external and internal wall insulation, both used by seven respondents (Figure 5). Renewable energy sources, like solar panels, were also popular among seven respondents. Loft insulation was implemented by six respondents, and energy-efficient heating systems by five. This highlights a focus on improving insulation and incorporating renewable energy to enhance the energy efficiency of these challenging properties.

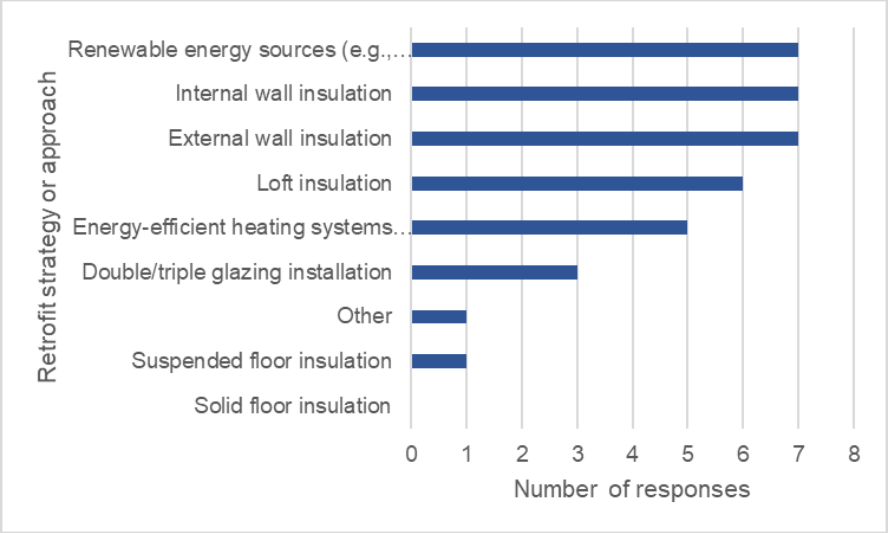

Figure 5 Strategies or approaches implemented or are considering retrofitting 'hard to treat' properties

Do you collaborate with external stakeholders or partners (e.g., local authorities, energy companies, community organizations, academia) to address challenges related to retrofitting 'hard to treat' properties?

The survey asked whether organizations collaborate with external stakeholders, such as local authorities, energy companies, community organizations, and academia, to address challenges related to retrofitting HTT properties. Out of the respondents, only three indicated that they engage in such collaborations, while five do not. This highlights a significant area for improvement, as collaboration is seen as crucial for enhancing the effectiveness and efficiency of retrofit projects. By working together with various stakeholders, organizations can share resources, knowledge, and best practices to overcome the challenges associated with retrofitting HTT properties.

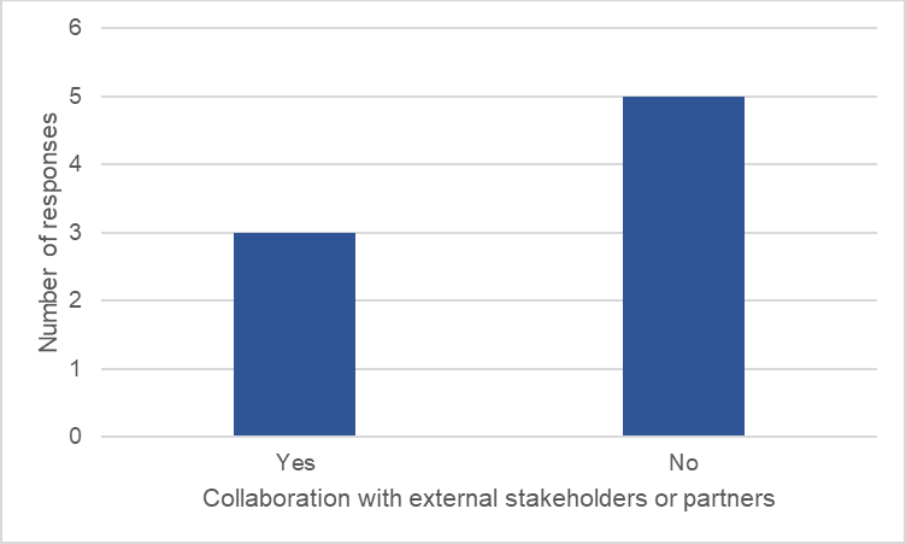

Figure 6 Collaboration with external stakeholders or partners

Please describe the nature of these collaborations and their impact.

There were 3 responses to this question, which are summarised below.

Collaborative efforts to retrofit HTT properties have aimed at increasing knowledge, securing funding, and improving resource use. Joining consortia and training programs helps organizations learn from each other and build expertise. Hiring external consultants brings in specialized knowledge and ensures compliance. These partnerships also make it easier to access grant funding and use procurement frameworks, keeping projects within budget. There is also a recognition of ongoing collaborations, showing a commitment to continuous improvement through shared learning and resource pooling.

What approaches do you take to enhance the knowledge and skills of your staff or contractors involved in retrofitting 'hard to treat' properties?

The survey asked organizations about the approaches they take to enhance the knowledge and skills of their staff or contractors involved in retrofitting HTT properties (Figure 7). The most important finding is that seven respondents prioritize access to technical resources or online materials. This is closely followed by the use of training programs or workshops, cited by six respondents. Knowledge-sharing networks or peer groups are also a significant approach, utilized by five respondents to facilitate the exchange of best practices. Collaboration with industry experts is another key strategy, mentioned by four respondents.

Figure 7 Approaches taken to enhance the knowledge and skills of staff or contractors involved in retrofitting 'hard to treat' properties

Can you share below any specific examples of successful energy efficiency retrofit projects in 'hard to treat' properties within your portfolio?
What were the key factors contributing to their success?

Respondents shared several useful case studies, which are presented below:

Cast iron properties

- Factors for success: A well-planned program with an effective team managing contractors and tenants. Early surveys before commencing work allow time to address individual issues.
- Collaboration: Worked alongside seven contractors and received EEM awards for the project.
- Communication: Regular contact with contractors to discuss and resolve issues, with lessons learned from past mistakes to improve future efficiency.

External Wall Insulation (EWI) projects

- Implementation: Many properties received EWI under schemes like CERT/CESP/ECO, though the quality of these installations varied.

Flat-roofed bungalows

- Project details: Successfully completed 104 units to PAS 2035 standards, involving whole-house thermal improvements such as EWI, roof insulation, and replacement double glazing and doors under SHDFW1.
- Key elements: Complete removal of existing roof coverings.

Solid wall properties

- Project Details: Completed 31 units to PAS 2030 standards with EWI under LAD1B.
- Success factors: Compliance with PAS standards and effective tenant engagement.

Synthesis of key success factors

- Collaboration and communication between retrofit professionals is essential for managing expectations, addressing issues, and ensuring smooth project execution.
- Setting clear project expectations and outcomes from the beginning, thorough project planning, and continuous review are crucial.
- Engaging tenants effectively to ensure cooperation and smooth project execution.

What are your long-term plans and strategies for improving the energy efficiency of 'hard to treat' properties in your portfolio?

The survey investigated the long-term plans and strategies for improving the energy efficiency of HTT properties. The most significant finding is that all eight respondents are applying for government grants to fund their energy efficiency projects. Engaging with residents or communities is another crucial strategy, mentioned by six respondents, highlighting the importance of tenant involvement. Exploring alternative funding sources and advocating for policy changes or improvements were each cited by five respondents, indicating a proactive approach to securing financial support and influencing regulatory frameworks. There were 3 responses in the other category. These included (1) Asset disposal / demolition and reprovision, (2) Creating a practical plan for our stock, and (3) Stock Viability Assessments.

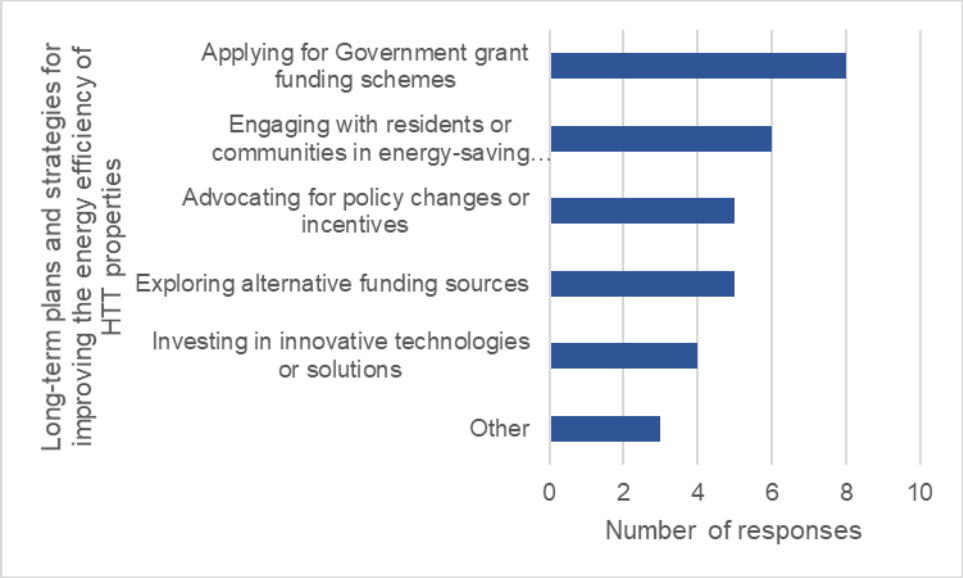

Figure 8 Long term plans and strategies for improving the energy efficiency of HTT properties

Are you intending to participate in future rounds of Government funding (such as SHDF wave 3) that helps to improve the energy efficiency of housing?

It was useful for us, as the consortium lead for SHDF wave 2.1 to understand whether existing members of our consortium were intending to participate in future public funding

rounds to retrofit social housing. Figure 9 indicates that the majority of respondents were intending to participate with the remainder (3 responses) undecided.[3]

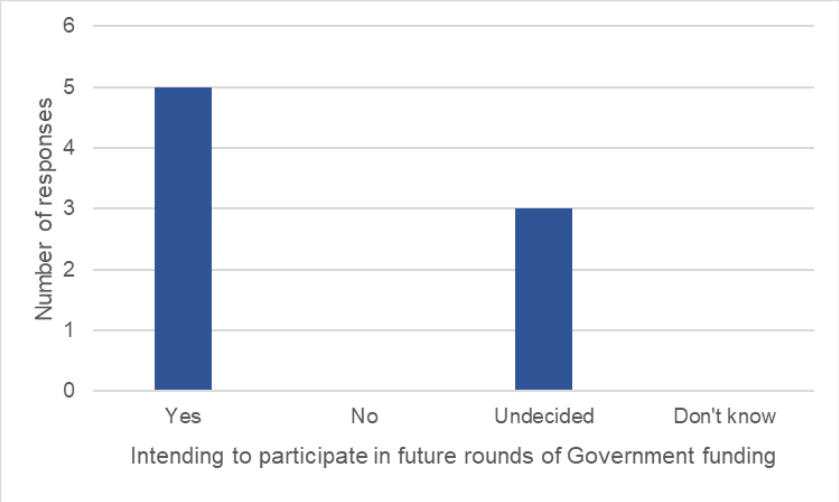

Figure 9 Intent to participate in future rounds of Government funding to improve the energy efficiency of social housing

Is there any other information or insights you would like to share regarding improving energy efficiency in social housing properties, particularly those deemed 'hard to treat'?

There were 4 responses to this question, which are synthesised into the following key themes:

Cost and compliance pressures:

- Grant programs should account for the higher costs of retrofitting HTT homes, including kitchen and bathroom replacements, tenant decanting, and compliance with PAS standards.
- Fire safety, damp, mould, and condensation issues consume significant portions of social landlords' budgets.
- Mandatory energy performance standards in social housing could help focus efforts on all properties.

Government funding and management:

- Simplification of government funding mechanisms is needed to reduce excessive administration, and reporting requirements.
- There is perceived to be a "general distrust" from the government towards local authorities and housing associations, which hampers effective project management.

PAS 2035 and retrofit process challenges:

[3] NB: Many respondents would have been aware at the time they were completing the questionnaire that SHDF wave 3 was on the horizon but would probably not have studied the published draft guidance.

- Technical compliance with PAS 2035 can restrict improvements, particularly in complex cases where construction details need revisions.
- The retrofit process must consider holistic approaches for social housing tenants, who may struggle to understand or select retrofit recommendations.

Feasibility and market constraints:

- IWI options are often not feasible for pre-1919 terraced properties due to their design and characteristics.
- The complexities and timescales of funding bids and project completion pose significant challenges.
- The market is currently 'overheated', leading to a shortage of suitable contractors with adequate knowledge of PAS requirements.

Energy performance and EPC challenges:

- Fluctuations in EPC banding and SAP points between EPC and EPR assessments affect compliance with schemes and funding requirements, complicating the retrofitting process for HTT properties.

Discussion

Retrofitting HTT homes is crucial for achieving the UK's energy efficiency goals and improving the quality of life for residents in social housing. This discussion aims to explore the challenges and strategies associated with retrofitting HTT properties, based on our research findings. We will address our four key research questions: what makes a home hard-to-treat, the percentage of social housing stock considered HTT, the strategies adopted by registered providers, and the support or innovation needed for effective retrofitting. By examining these aspects, we aim to provide a detailed understanding of the retrofitting landscape across the Midlands and offer actionable insights for practitioners and policymakers.

To begin with, we will explore the factors that contribute to a home's classification as HTT.

Building related factors

According to existing literature, HTT homes are characterized by features that make energy efficiency improvements technically challenging or prohibitively expensive. These often include solid wall constructions, non-standard construction types, and properties with unique (or significant) architectural details.

Our findings also indicate that design and structural issues are primary factors making homes HTT. These issues include struggling with retrofit designs, difficulties in achieving necessary SAP improvements, and specific challenges with internal wall insulation (IWI) in functional areas like kitchens and bathrooms. Additionally, properties with architectural features such as alleyways, traditional roof lines, and Edwardian brick features pose significant retrofit challenges.

Technical barriers are frequently cited in the literature as major obstacles to retrofitting. Effective solutions often require specialized knowledge and techniques that can be costly and time-consuming. Our findings indicate that technical issues with both IWI and EWI are

significant barriers. These include the disruptive nature of IWI, particularly in kitchens and bathrooms where replacements would be required, and the practical difficulties of EWI in areas with narrow alleys or limited space for scaffolding. Other technical challenges include narrow cavities, system-built properties, mansard roofs, and the installation of solar panels on certain property types.

Planning and regulatory issues

Existing literature on the topic highlights the complexity of planning laws and that the need to preserve the aesthetic and historical value of buildings often hinders progress.

We found that planning permission and regulatory barriers further complicate the retrofitting process. Respondents highlighted the difficulties in obtaining planning permission for older properties and those in conservation areas, as well as the costs associated with meeting local authority requirements for detailed architectural drawings. Heritage considerations also pose challenges, particularly with properties that have Victorian facades or other historically significant features.

Resident and tenant considerations

Existing literature indicates that tenant engagement and minimizing disruption are crucial for the success of retrofit projects. Effective communication and involvement of tenants in the planning process can mitigate these issues.

Our findings showed that disruption to tenants, particularly those with additional needs or vulnerabilities, was a significant issue. Resistance from tenants due to the inconvenience and disruption caused by retrofit works can delay or halt projects.

Financial and strategic concerns

Our findings indicate that investment decisions are critical, with registered providers questioning the worth of retrofitting certain properties. Issues like the 'let-ability' of properties, potential to reach energy efficiency standards, and deciding whether to invest in or dispose of HTT properties are central concerns. Financial barriers are consistently highlighted in the literature, with the high costs of retrofitting often cited as a major obstacle. Long-term investment strategies and cost-sharing mechanisms are suggested as potential solutions.

What Percentage of the Social Housing Stock Could Be Considered Hard-to-Treat?

Our review of literature indicated that there are varying assessments of the number of homes that are considered HTT in the English and UK housing stock. This variability is influenced by the different criteria used to define HTT properties. However, estimates highlight that a significant proportion of the existing housing stock, around 10 million homes, could be classified as HTT, underscoring the urgent need for effective retrofitting strategies.

Our survey inquired about the percentage of housing stock that respondents consider HTT. The results indicated a range of responses:

The most common response, indicated by three respondents, was that 21-30% of their housing stock is HTT. Two respondents estimated that 0-5% of their housing stock falls into this category. One respondent each estimated 6-10% and 41-50% of their housing stock to

be HTT. The estimates are likely to depend heavily on the specific circumstances of the registered providers (RPs), such as the previous disposal from their stock of HTT properties, the prevalence of terraced housing in built-up areas, and ratio of off-gas to on-gas homes, amongst other factors.

The variability around these numbers could also be attributed to the different methods used by RPs to identify HTT homes. Our survey findings showed that while some rely on EPC ratings, others use a combination of criteria, including occupancy demographics, geographic location, and various other factors. Specifically, respondents highlighted the importance of considering the cost to treat coupled with the impact on residents and the remaining lifespan of the property. Some RPs prioritize based on archetype, combining EPC ratings, customer feedback, and cost-effective solutions. Others use both EPC and fuel poverty indicators or focus on technical considerations, funding availability, and demographics.

This diversity in criteria underscores the complexity of identifying HTT homes and suggests that multiple considerations play a role in decision-making for retrofit projects. It highlights the importance of RPs having a thorough understanding of their housing stock, which is crucial for making informed cost analyses and investment decisions. Establishing a consistent approach to identifying HTT properties can provide a more accurate baseline for addressing the challenges and planning effective retrofitting strategies.

What strategies are registered providers of social housing adopting to retrofit these properties?

Our investigation into the strategies adopted by RPs for retrofitting HTT properties reveals several critical approaches and practices. Drawing on literature, focus group findings, and survey responses, this section synthesizes the key strategies and highlights commonalities.

Established and innovative technologies

Recent case studies emphasize the importance of using both established and innovative technologies for retrofitting HTT homes (HM Govt, 2023).

Participants in our focus groups reported mixed experiences with air source heat pumps (ASHP), noting particular challenges with wall space in terraced homes and issues such as maintaining temperature and noise vibrations. The "fabric first" approach was widely endorsed, prioritizing energy efficiency measures like external wall insulation (EWI), despite budget constraints.

Our findings from the survey identified that successful case studies involved detailed early surveys and structural assessments, which are crucial for understanding the unique characteristics of each building. Projects like the retrofitting of cast iron properties and flat-roofed bungalows highlighted the effectiveness of thorough planning and collaboration with contractors.

Collaboration and communication

Findings from the literature indicates that effective retrofitting requires collaborative decision-making, resident-centric approaches, and dedicated retrofit coordinators to ensure smooth project execution (HM Govt, 2023).

Our findings showed that collaboration among contractors, stakeholders, and the use of skill and knowledge partnerships with universities were deemed important. Participants also noted the importance of expert customer liaison to improve tenant engagement and address operational challenges.

Similarly, case studies highlighted the success of collaboration and regular communication with contractors to manage expectations and resolve issues. Projects benefited from setting clear expectations and outcomes from the beginning, thorough planning, and a continuous review process.

What further support or innovation is needed to retrofit hard-to-treat homes?

Focus group participants emphasized the importance of sharing comparative cost information for retrofitting measures, such as EWI. Comprehensive cost data across larger geographic areas would help understand the differences between 'standard' and HTT homes.

Respondents to the questionnaire also highlighted the need for grant programs to account for the higher costs associated with retrofitting HTT homes, including kitchen and bathroom replacements, tenant decanting, and compliance with PAS standards. Fire safety, damp, mould, and condensation issues also consume significant portions of social landlords' budgets.

There was a desire for a centralized resource library containing information on tackling difficult features in retrofitting projects. Detailed examples and case studies were deemed crucial for providing insights into successful approaches.

Gaining public buy-in for technologies like air source heat pumps (ASHP) is challenging. Strategies are needed to improve customer awareness and acceptance of innovative low carbon heating solutions.

Recommendations and considerations

Addressing the challenges of retrofitting hard-to-treat (HTT) social homes requires innovative solutions in several key areas. These include technical and building-related factors; planning and regulatory issues; resident and tenant considerations; financial and strategic concerns; and retrofit approaches. Additionally, improved collaboration and communication are essential for success. Innovations in each of these domains are crucial to effectively tackle the complexities of retrofitting HTT homes. This chapter presents a series of recommendations and considerations aimed at promoting innovations that make the retrofitting process efficient, effective, and inclusive for all stakeholders. The recommendations are divided into two specific areas: research and knowledge building and industry stakeholders. As the Midlands Net Zero Hub, supported by the Department for Energy Security and Net Zero, we refrain from making direct policy recommendations. However, the findings from the research suggest areas of consideration for various stakeholders, including government bodies. These findings will be compiled and shared with the department to inform future planning and decision-making processes.

Recommendations for research and knowledge building

A thorough understanding of the financial implications of retrofitting hard-to-treat (HTT) homes is essential for housing providers. To support this, the following actions could be beneficial:

- Sharing comparative cost information: It would be valuable to develop and distribute detailed cost data, particularly cost per metre for external wall insulation (EWI). Ideally, this information should cover various geographic areas and HTT housing types (e.g., crosswalls as a specific category). This would help housing providers gain a clearer understanding of the financial challenges associated with retrofitting HTT homes in comparison to standard housing.

Sharing successful strategies for retrofitting HTT homes is equally important in fostering learning and replication. To this end:

- Create a comprehensive case study library: Stakeholders could benefit from establishing a resource library that showcases examples of how difficult-to-retrofit features in HTT homes have been successfully addressed. This library could include specific case studies, methodologies, and detailed descriptions to enhance understanding and facilitate replication. National and local examples, with a practical 'nuts and bolts' approach, would make the case studies particularly valuable compared to more generic examples.

Recommendations for industry stakeholders

Our findings highlight the importance of collaboration among contractors, retrofit professionals, and the use of skills and knowledge partnerships. Participants in the research study emphasized that expert customer liaison plays a key role in improving tenant engagement and addressing operational challenges. To support this, the following actions are suggested:

- Enhancing customer buy-in for low carbon heating technologies: Stakeholders could develop strategies to increase customer support and acceptance of technologies such as air source heat pumps (ASHP). This might include educational campaigns and direct engagement efforts to build public trust in, and understanding of, low carbon heating technologies.

Addressing technical challenges and ensuring compliance with PAS 2035 is also critical for the success of retrofitting projects. The following actions could be considered:

- Improving understanding and compliance with PAS 2035: Offering enhanced training for contractors and housing providers could help them better understand and meet PAS 2035 requirements, especially when working with complex properties such as pre-1919 terraced homes.
- Establishing a PAS 2035 Implementation Panel: A dedicated panel could be set up to address any grey areas or challenges in the application of PAS 2035. This panel could provide clear and practical guidance to ensure successful and compliant retrofitting projects.

Conclusions

Retrofitting 'hard-to-treat' (HTT) social housing is essential for the UK to achieve its energy efficiency and net-zero goals, reduce fuel poverty and improve the living conditions of residents. To understand the significant challenges involved, we collected data using focus groups and a questionnaire survey of social housing providers delivering retrofit programmes across the English Midlands. We identified the primary barriers to retrofitting HTT homes as technical and structural complexities; financial constraints; tenant issues;

and planning and regulatory hurdles. However, the key to overcoming these challenges lies in collaboration, clear communication, thorough project planning, and effective tenant engagement.

The findings suggest that sharing cost data of projects among social housing providers could help address some of the financial barriers, while creating centralized resources and case studies can guide successful retrofitting projects. Additionally, wider public awareness and acceptance of innovative retrofitting solutions, such as heat pumps, are crucial for their broader implementation.

Encouraging collaboration between housing providers, technology firms, and policymakers, as well as developing clear guidance for retrofitting listed buildings and properties in conservation areas, can further support these efforts. Technological innovation and strong policy support are also vital to drive progress.

In summary, while the cost of retrofitting HTT social housing remains a significant hurdle, the research indicates that with the right strategies, collaboration, and support, it is possible to transform HTT properties into sustainable, energy-efficient homes. These efforts not only contribute to national sustainability goals but also significantly improve the quality of life for residents.

Limitations

This research involved focus groups with 14 participants from 9 social housing providers, supplemented by an online survey with 8 respondents. While the findings provide valuable insights, there are some limitations to consider.

Firstly, the relatively small sample size does not capture the full diversity of experiences and challenges faced by all social housing providers. Additionally, the focus group format, while allowing for in-depth discussion, may have led to some participants dominating the conversation, potentially skewing the results.

Despite these limitations, the research methods used—focus groups and surveys—are well-established for gathering detailed and meaningful data. The consistency of themes across both data collection methods supports the validity of the findings. The diverse experiences and practical insights shared by the participants offer a reliable overview of the key issues and successful strategies in retrofitting HTT homes.

Therefore, while acknowledging the constraints, we are confident that this research provides a credible and useful contribution to understanding and addressing the challenges in making social housing more energy efficient.

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Appendix A

Research design

We adopted a pragmatic approach and used a mixed methods research design to effectively address our research questions.

A research design that incorporates both quantitative data from a questionnaire and qualitative data from focus groups offers several benefits, using the strengths of both methodologies to provide a comprehensive understanding of the research problem. Below are some of the key benefits for our research.

1. Combining both methods enables triangulation, where findings from one method can be cross validated with findings from another. This increases the validity and reliability of the results, as inconsistencies can be identified and explored further.
2. Quantitative data can identify "what" is happening, while qualitative data can explain "why" it is happening. For example, a questionnaire might reveal that a significant percentage of homes are hard-to-treat, while focus groups can provide insights into the specific challenges and barriers faced by residents and housing providers.
3. The integration of both data types allows for a more nuanced analysis. Quantitative findings can guide the qualitative inquiry, helping to focus on specific issues that require deeper exploration. Conversely, qualitative findings can inform the interpretation of quantitative results, adding context and meaning.
4. Using both methods engages a broader range of participants. Some individuals may prefer the anonymity and structure of a questionnaire, while others may be more comfortable sharing their thoughts in the interactive setting of a focus group.
5. The combination of quantitative and qualitative data provides a robust evidence base for policy and practice. Quantitative data can support statistical generalizations that are crucial for policymaking, while qualitative insights can inform practical interventions and strategies tailored to specific contexts.
6. Each method has its own limitations. Quantitative research may overlook contextual nuances, and qualitative research may not be generalizable. By using both methods, the limitations of one are offset by the strengths of the other, resulting in a more balanced and thorough investigation.

Data collection

Focus groups

Using focus groups as a research method to collect data on HTT homes offered several benefits for this research. Focus groups encourage in-depth discussions and provide rich qualitative data that reveal the experiences, perceptions, and challenges faced by housing providers. This method encourages interaction and the sharing of ideas, leading to the discovery of nuanced insights and diverse perspectives that might be overlooked in surveys. Additionally, focus groups allow researchers to probe deeper into specific issues, clarify responses, and explore the reasons behind certain attitudes and behaviours. This interactive setting helps to identify practical solutions for retrofitting HTT homes by using the collective knowledge and experiences of participants.

The focus groups were carried out on 26/04/24 as part of the regular fortnightly forum conducted by MNZH for the SHDF wave 2.1 consortium. Invites to the forum alongside a preview of the questions to be asked during the focus group were provided by email to the regular MNZH mailing list.

Information on how the session was to be run was explained to participants at the start of the session by the lead author, alongside setting ground rules for participating in the focus group (Gray, 2014).

After a brief introduction and scene setting, the participants were divided into three groups using the MS Teams 'breakout rooms' feature. Previous experience using this approach had shown that it could be beneficial to encourage dialogue and elicit a diversity of views. Each of the breakout rooms had between three and four participants and two members of MNZH staff-one to moderate the discussion and the other to take detailed notes. A pre-forum meeting between members of MNZH staff had been conducted to run through the focus group session, and to provide guidance on the level of notetaking expected. Notes were taken on a shared PowerPoint document that allowed MNZH staff to see the emerging notes from each group. The moderator's role in the breakout rooms was to focus on the question at hand, to prompt further elaboration from participants and to encourage contribution. Although none of the moderators were experienced in focus group moderation, each had wide ranging experience of leading meetings, forums, and other stakeholder engagement activities.

At the end of each question discussion period (between 10-15 minutes long) the groups were combined and the designated moderator for each group provided a summary of the discussion to all participants.

Interview question development

The initial interview questions were generated from insights gained through the literature review and supplemented by knowledge gained through regular meetings with members of MNZH's consortium delivering retrofit programmes. The questions were then discussed and refined with other members of MNZH who have wide experience of stakeholder engagement with social housing providers. The questions developed for use in the focus groups are given below. As time was limited to less than an hour overall it was decided to limit the focus groups to five questions, with the final question conducted with the whole group rather than in the breakout rooms. Questions 1 and 2 were also combined into one breakout room session.

1. How do you define or describe a "hard-to-treat" home in terms of retrofitting?
2. What characteristics do you think makes a home hard to treat (HTT) or hard to decarbonise?
3. What are the main challenges or barriers you face when considering retrofitting these homes?
4. Have you had any past attempts or experiences with retrofitting hard to treat homes? What worked well and what didn't?
5. In your opinion, what support or resources would be most helpful in overcoming the challenges associated with retrofitting hard-to-treat homes?

Focus group data sample

There were a total of 14 external participants from 9 different registered providers involved in the focus group data gathering. Participants in the focus group were generally representative of the members of the SHDF wave 2.1 consortium, ranging from those retrofitting many hundreds of properties to those delivering smaller projects of less than 25 homes. Participants came from local authority housing providers, private registered providers of various scale, and a housing cooperative.

Questionnaire design

The questions in the questionnaire were initially developed from the researcher's familiarity with some of the common themes and concepts of HTT from regular monthly discussions with individuals involved with delivering retrofit programmes as part of SHDF wave 2. Furthermore, a review of current literature on the topic began to establish some of the common challenges and barriers of retrofitting HTT homes, which helped with question development. Preliminary analysis of some of the data originating from the focus groups also aided question development. Questions were constructed following guidance in Gray (2014: 354) to ensure that they were phrased in ways that are "clear, concise and unambiguous" and to avoid common pitfalls such as imprecision or leading questions.

The questionnaire used a mix of both qualitative and quantitative questions to get a comprehensive view of the research topic. This approach allowed us to quantify certain aspects of the data while also gaining deeper insights from qualitative comments. It was also beneficial to extend the data gathering to consortium members who were unable to attend the focus group session. Closed-ended questions, such as multiple-choice questions and other structured formats allowed us to generate quantitative data. Whereas open-ended questions allowed respondents to provide detailed, text-based answers in their own words. For example, a question like "What do you think are the main challenges in retrofitting hard-to-treat homes?" would generate qualitative data.

Questionnaire pilot

Piloting a questionnaire helps identify and correct errors in question design, wording, and technical aspects, ensuring clarity and relevance. It also improves the reliability and validity of the data collected, providing a more accurate and comprehensive understanding of the research topic. The questionnaire was piloted in the following way:

- Draft questions developed
- Draft questionnaire piloted by an internal member of MNZH team not involved directly in activities related to retrofit of housing
- Amendments made to the draft following written and verbal feedback
- Revised draft sent to a consortium member involved in retrofit programmes for review
- Questionnaire constructed in Microsoft Forms
- Questionnaire piloted in Microsoft Forms by three members of MNZH staff to ensure the form worked correctly and data was recorded successfully

The full set of questions included in the questionnaire can be found in Appendix B.

Ethical considerations

Participants were assured that their responses would be treated with the utmost care to protect their privacy. All data collected was shared internally within the Midlands Net Zero Hub strictly for the purpose of analysis and research. Additionally, aggregated findings may be shared with The Department of Energy Security and Net Zero to support broader initiatives related to the energy efficiency of UK social housing. Importantly, individual responses were anonymized and presented in aggregate form to ensure that participants cannot be identified.

Participants were informed that they could choose not to answer any questions or withdraw from the survey at any time without any consequence. This provision ensures that participants do not feel coerced and can freely contribute to the research.

By adhering to these ethical guidelines, this study ensured that participants' rights and privacy were respected, and that the data collected is used responsibly.

Questionnaire data collection

A link to the questionnaire in Microsoft Forms was sent out to each of the 23 members of MNZH's SHDF wave 2.1 consortium by email with an invitation to complete. The initial 'live' period of the questionnaire ran from 3/5/24 to 17/5/24. This was subsequently extended by a week to 24/5/24 with a reminder email and a subsequent reminder email two days before closure of the survey.

8 responses were received to the questionnaire. This was a 40% response rate[4]. We grouped the respondents according to the number of properties in their housing stock (*Figure 10*). It can be seen that there was a diversity of housing providers from those with less than 1,000 homes to those with 10's of thousands. The most common stock size was band 10,000-20,000, comprising 50% of the responses.

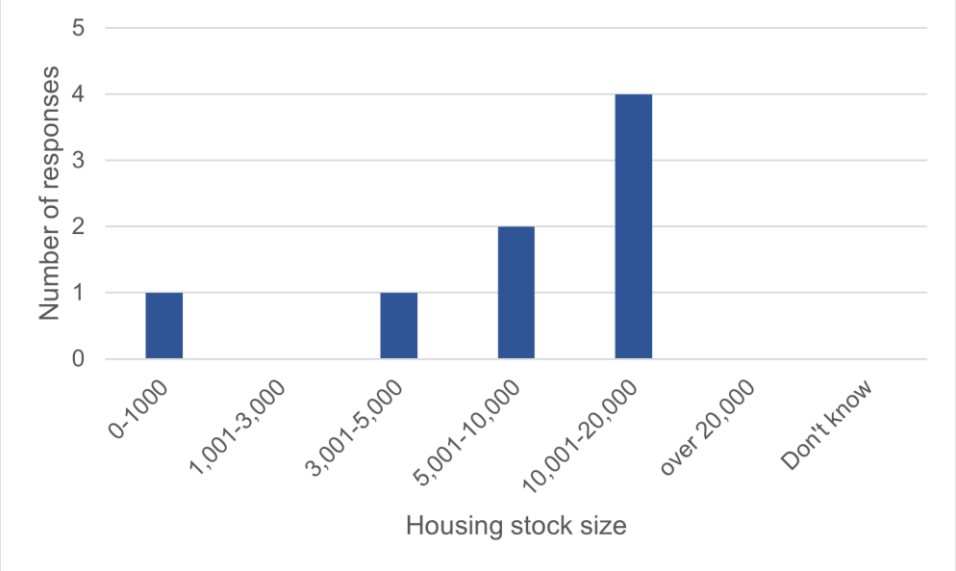

Figure 10 Responses to questionnaire by organisation housing stock size

[4] Please note the number of contacts receiving the questionnaire invite is lower (20) than the 23 SHDF 2.1 scheme members within MNZH's consortium due to some contacts being responsible for multiple schemes.

Data analysis

Focus groups

The qualitative data that emerged from the focus groups was analysed following the broad stages suggested by Salmons (2016) and indicated as follows:

1. Managing the data. The raw data from the focus groups was organised and tidied correcting any spelling errors and clarifying any uncertain notations with the original notetaker. Furthermore, this first read through of the data enabled us to become familiar with the scope and substance of what was collected.
2. Identification of main themes. Some major themes were deductively determined as they aligned with previous literature on the topic and our own research questions.
3. Coding. This involved close reading of the data and labelling by codes, adding new codes as they emerged.
4. Deepening understanding of themes. Relationships were developed between the themes. Also important at this stage was to identify any outliers or unusual cases that might prompt further investigation.

Questionnaire

The quantitative data from the questionnaire was analysed and charted using Microsoft Excel. Qualitative question responses were analysed in a similar way to the above by identifying key themes and linking to themes discovered in the focus groups.

Appendix B

Copy of Microsoft Forms questionnaire

Questionnaire for 'hard to treat' retrofit properties

Introduction:
Thank you for participating in this survey. Your input is valuable in understanding the challenges and strategies related to improving energy efficiency in 'hard to treat' social housing properties. Please provide accurate information to the best of your knowledge.

Your responses to this questionnaire are confidential and will be treated with the utmost care to protect your privacy. Please note that all data collected will be shared internally within the Midlands Net Zero Hub for the purpose of analysis and research. Additionally, aggregated findings may be shared with The Department of Energy Security and Net Zero to support broader initiatives related to energy efficiency of UK social housing.

Rest assured that your individual responses will be anonymized and presented in aggregate form to ensure confidentiality. Your participation in this survey is voluntary, and you may choose not to answer any questions or withdraw from the survey at any time without consequence.

Thank you for your cooperation and contribution to our research efforts.

* Required

1. Name of Housing Provider *

2. Your Email address *

3. Total housing stock (number of properties) *

- ◯ 0-1000
- ◯ 1,001-3,000
- ◯ 3,001-5,000
- ◯ 5,001-10,000
- ◯ 10,001-20,000
- ◯ over 20,000
- ◯ Don't know

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4. Estimate the percentage of your housing stock with an EPC rating **below** band 'C' (Select one answer) *

- ◯ 0-10%
- ◯ 11-20%
- ◯ 21-30%
- ◯ 31-40%
- ◯ 41-50%
- ◯ 51% and above
- ◯ Don't know

5. Considering the following definition: A 'hard to treat' property refers to a building or dwelling that presents significant challenges or complexities when it comes to implementing energy efficiency improvements. These challenges can arise from various factors, including the building's design, construction materials, structural issues, or occupancy patterns. In general, hard to treat properties may have characteristics that make standard retrofitting measures less effective or more difficult to implement.

   What percentage of properties in your portfolio would you consider 'hard to treat' in terms of improving energy efficiency? *

- ◯ 0-5%
- ◯ 6%-10%
- ◯ 11%-20%
- ◯ 21%-30%
- ◯ 31%-40%
- ◯ 41%-50%
- ◯ over 50%
- ◯ Don't know

6. Can you briefly describe some of the characteristics of these 'hard to treat' properties? *

7. What are the main challenges or barriers you encounter when retrofitting 'hard to treat' properties? *

8. Please rank the following factors based on their impact (1 being the most significant barrier, 7 being the least): *

- Cost constraints
- Technical complexity
- Occupant disruption
- Lack of suitable technologies
- Lack of knowledge
- Regulatory requirements (e.g. Trustmark, PAS2035)
- Local planning restrictions

9. How do you prioritize 'hard to treat' properties within your portfolio for retrofit? (Select one) *

- ◯ Based on EPC ratings
- ◯ Considering occupancy demographics (e.g., vulnerable residents or fuel poverty)
- ◯ Geographic location
- ◯ Other

10. What strategies or approaches have you implemented or are considering retrofitting 'hard to treat' properties? (Select all that apply)

- ☐ External wall insulation
- ☐ Internal wall insulation
- ☐ Loft insulation
- ☐ Suspended floor insulation
- ☐ Solid floor insulation
- ☐ Double/triple glazing installation
- ☐ Energy-efficient heating systems (e.g., heat pumps)
- ☐ Renewable energy sources (e.g., solar panels)
- ☐ Other

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11. Do you collaborate with external stakeholders or partners (e.g., local authorities, energy companies, community organizations, academia) to address challenges related to retrofitting 'hard to treat' properties?

- ◯ Yes
- ◯ No

12. Please describe the nature of these collaborations and their impact.

13. What approaches do you take to enhance the knowledge and skills of your staff or contractors involved in retrofitting 'hard to treat' properties? (Select all that apply)

- ☐ Training programs or workshops
- ☐ Access to technical resources or guidelines
- ☐ Knowledge-sharing networks or forums
- ☐ Collaboration with industry experts or research institutions
- ☐ Other

14. Can you share below any specific examples of successful energy efficiency retrofit projects in 'hard to treat' properties within your portfolio?

What were the key factors contributing to their success?

15. What are your long-term plans and strategies for improving the energy efficiency of 'hard to treat' properties in your portfolio? (Select all that apply)

- ☐ Applying for Government grant funding schemes
- ☐ Exploring alternative funding sources
- ☐ Investing in innovative technologies or solutions
- ☐ Advocating for policy changes or incentives
- ☐ Engaging with residents or communities in energy-saving initiatives
- ☐ Other

16. Are you intending to participate in future rounds of Government funding (such as SHDF wave 3) that helps to improve the energy efficiency of housing?

- ◯ Yes
- ◯ No
- ◯ Undecided
- ◯ Don't know

17. Is there any other information or insights you would like to share regarding improving energy efficiency in social housing properties, particularly those deemed 'hard to treat'?