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# Wasted expertise: Why doesn't retrofit include residents?


## Abstract

Retrofitting social housing is key to reaching urgent climate goals. Integrating residents as a stakeholder in retrofit processes can transform social housing into sustainable homes. Residents are experts in the way they live and reliance on techno-optimist approaches to deep energy retrofit fail to utilise their situated knowledge. This research provides new insights into effective retrofit decision-making processes that prioritise social equity alongside environmental goals. Fifteen semi-structured interviews with Housing Association, Architect, and Architect-led cooperative stakeholders in various European locations, were investigated using a thematic analysis, to answer the following research question: *"How do stakeholders (not)utilise residents' situated knowledge and expertise in retrofit design?"*. Five themes were identified in the data, ascending from the least inclusive to most inclusive of resident stakeholders: external factors influence decision-making; building design is the priority; integrated communication between high-level stakeholders and resident stakeholders; importance of social value; and residents have choice. The results identified three key components to sustainable retrofit: (1) *architects and passive design-thinking,* (2) *retrofit technologies should complement passive design*, and (3) *resident expertise can balance building needs, energy needs, and social needs.* Hybrid decision-making processes should prioritise resident stakeholders to address actual needs, avoid tokenism, and ensure residents' central role in internal governance. Results can guide high-level retrofit stakeholders and policy-makers in shaping hybrid retrofit processes and empower social housing residents to engage with retrofitting projects.



## Keywords

Situated knowledge, techno-optimism, renovation, social housing, decision-making

# 1 Introduction

The EU and the UK have committed to reach climate neutrality by 2050 [1,2]. More urgently, EU countries are mandated to reduce greenhouse gas emissions by 55% by 2030 compared to 1990 levels [1], while the UK targets a 50% reduction in direct emissions from public sector buildings by 2032, against a 2017 baseline [2]. Social housing retrofit plays a pivotal role in these agendas, as evidenced by the EU's Energy Performance of Building Directive (EPBD) 2002/91/EC [3] and initiatives such as the UK's Social Housing Decarbonisation Fund (SHDF). Alongside energy improvements, aims include alleviating fuel poverty, increasing green jobs, fostering the retrofit sector, and improving residents' wellbeing [4]. These aims reflect a holistic approach to retrofit [5], aligned with the triple bottom line conceptualisation of sustainability—social, environmental and economic categories [6].

Various terms—adaptation, renovation, refurbishment, and retrofitting—refer to the upgrading of existing buildings [7]. The term 'retrofit' will be used in this article to emphasise the act of raising the building to a higher standard [7,8]. Retrofit strategies primarily adopt three technical improvements [9]: enhance building fabric thermal properties through airtightness and insulation, improve systems efficiency, and integrate renewable energy sources [10]. Deep Energy Retrofit (DER) focuses primarily on environmental sustainability by combining technologies to reduce energy consumption by 60-90% [11]. High levels of airtightness rely on mechanical heat and ventilation systems, such as MVHR [12], to stabalise internal air quality [13]. Other electrical systems can include heat, ventilation and air conditioning systems (HVAC) [13], smart lighting systems including LED lights [14], and upgrading heating and hot water systems [15]. DER exploits technology to reach end point energy performance targets.

A reliance on technology in retrofit takes a techno-optimist approach. Danaher's [16] comprehensive review defines techno-optimism as the belief that technology is instrumental to ensure "the good does or will prevail over the bad" (p.54). Hornborg [17] criticises techno-optimism for its failure to address ecological and social inequalities exacerbated by technology. There are many concerns with techno-optimism in retrofit: (1) performance gaps between predicted and actual energy needs can reach as high as five times the predicted energy improvements [12]. (2) An over-reliance on retrofit technologies negates the certainty of obsolescence. (3) Inoperable windows can lead to future overheating, and cooling costs, in an era of increasing global temperature rise. (4) DER disregards historically accomplished design strategies with energy performance benefits, including operational windows, solar gains, thermal mass, and other passive solutions that evolve throughout the days and seasons. (5) Finally, non-energy benefits (NEBs) including comfort, modernity, health, and safety, [18,19,20] have been found to be more important to social housing residents than energy-related benefits, in two previous studies [20,21].

Recent studies [20, 22] underscore residents' inclusion to ensure fairness and equity, especially for marginalised groups. This is emphasised in Sunikka-Blank et al., [23] which found that the preferences of homeowners in retrofit "were in sharp contrast" (p.116) to the preferences of those in different socio-economic settings. Social housing residents have unique "situated knowledge" [24] as experts in the way they live [25,26,27,28,29,30]. Lovell [31] explains that close collaboration between producers and consumers of social housing can help form new socio-technical systems that rely on deep understanding of consumer preferences, as opposed to the speculative private sector housebuilding. Combining high-level retrofit stakeholders' partial perspective with resident stakeholder insights can yield "transformative knowledge" [24] that enhances project sustainability. Bulkeley et al., [32] show this through their investigation into solar hot water technologies social housing dwellings in São Paulo. Well established social housing movements in São Paulo are advocating for improvements in social housing quality. The state orchestrated "several multi-stakeholder discussions on the topic" [32: p.30] to align new sustainability interventions with improvements in quality of life. Literature shows integrated retrofit processes should engage residents early [20,25,26,28,29,33,34], adopt collaborative decision-making [25,28,29,31,35], integrate feedback to address challenges [25,26,29], safeguard future residents' use [25,26,27,30], and address social needs [29,33]. However, to what extent high-level stakeholders utilise this knowledge remains unclear.

This study aims to bridge this gap by examining how high-level stakeholders incorporate residents' situated knowledge in retrofit decision-making processes. This research seeks to provide new insights into effective retrofit decision-making processes that prioritise both environmental goals and social equity, contributing to inclusive and sustainable retrofit practices.

# 2 Materials and methods

## *2.1 Context*

Since 2021, key funding mechanisms, including the UK's SHDF and EU's Next Generation Funds (NGF), have prompted social housing retrofit throughout Europe. A qualitative semi-structured interview approach was taken to explore how high-level stakeholders have integrated resident expertise in social housing retrofit processes. This approach allowed participants to describe experiences and opinions in depth, with prepared questions guiding conversations to enable conclusive results. Climate change is an emergent process "which may be predictable in terms of trends but largely unpredictable in detail" [36]. By investigating processes of decision-making in retrofit, results can be adapted to meet future climate pathways. Consequently, the decision-making processes explored in this study are not fixed to individual contexts but offer insights that can be applied across various scenarios.

Broers et al. [20] developed a semi-structured interview guide to examine social housing retrofit in the Netherlands through the lens of energy justice. Building upon their work, interview questions underwent scrutiny and refinement together with the results of a literature review [25,26,27,28,29,30,33,34,37], to generate a novel interview guide (see Table A in the supplementary material) addressing the following research inquiries:

1. Could the participation of people living in social housing improve retrofit solutions more than end point performance targeted retrofit?
2. How can social housing retrofit be safeguarded for future residents?
3. Is DER the best approach for holistic sustainability?
4. What do inhabitants include as important in retrofit, that is not included in the energy retrofit process?

## *2.2 Participants*

A final 12, of 30, high-level retrofit stakeholder interviews were analysed for this study. Three of these interviews included two participants. In accordance with Table 1, HA_1a & 1b and A_3a & 3b represent two interviewees from within the same company, while AC_6a & 6b represent the cooperative client and architect respectively. Therefore, data from 15 participants has been analysed (see Table 1). Recruitment of participants was based on convenience, provided they had the required skills and experience. The research does not include interviews with resident stakeholders because the investigation aims to explore how high-level stakeholders perceive, interpret, and incorporate residents' needs, preferences, and situated knowledge into retrofit decision-making processes. By focusing on high-level stakeholders, the study examines the systemic approaches, challenges, and opportunities in integrating resident expertise from the perspective of those designing and implementing retrofit strategies. This process-oriented approach allows for insights that can be adaptable to future scenarios and varying contexts, rather than being fixed to individual project outcomes, responding to the emergent and unpredictable nature of climate change challenges, and shifting resident priorities.

Two sampling techniques were applied: (1) key informant sampling [38,39] targeted knowledgeable professionals identified via conferences, the European Responsible Housing Awards, and a secondment at Housing Europe (the European Federation of Public, Cooperative & Social Housing); and (2) snowball sampling [39]. Interviewees were professionals working for a range of European stakeholders including municipalities, local authorities, housing associations, building owners, cooperatives, architects, and academics. Job roles included company directors, asset managers, architects, engineers, retrofit coordinators, energy officers, and researchers.

The interviews investigated retrofit processes using example projects as references. As shown in Table 1, participants drew on their experiences differently: some provided detailed accounts of decision-making processes from single retrofit projects that served as in-depth examples, while others referenced multiple projects to illustrate patterns in their approach to resident engagement. Example projects served as reference points to ground discussions about stakeholder relationships and resident involvement. This approach allowed for a better examination of stakeholders' decision-making processes and variables, rather than individual project outcomes.

Inclusion criteria determined usable interviews: all questions were answered, retrofit projects had been completed, monitoring or feedback was received, and resident communication was prioritised. Twelve final interviews were selected for analysis: eight from technical stakeholders—including architects and architect-led cooperatives; and seven from third sector housing associations (HA). While each stakeholder promotes the sustainable retrofit of social housing, specialisations vary. Specialisations can, generally, be grouped into two categories, deep retrofit and technological specialisations, or social sustainability specialisations (see Figure 1). As shown in Figure 1, there is no clear divide between stakeholder group and specialisation and two housing association participants specialise in both groupings, to varying extent.

| Acronym | Stakeholder | Country | Number of Dwellings | Project Discussion | Retrofit Specialisation |
|---|---|---|---|---|---|
| A_1 | Architect | England | Unavailable *<br>Unavailable ** | Multiple Project Examples | Sustainability—longevity, minimal maintenance, good technology.<br><br>Building Information Modelling (BIM) and digitalisation (digital guide application and energy models). |
| A_2 | Architect | England | 10,000 *<br>>100 ** | Multiple Project Examples | Deep retrofit and zero-carbon sustainability.<br><br>Supporting funding bids. |
| A_3a | Architect | England | 450 *<br>350 ** | Multiple Project Examples | Working with residents and local neighbourhoods.<br><br>100% public sector clients. |
| A_3b | Architect | England | 450 *<br>350 ** | Multiple Project Examples | Working with residents and local communities.<br><br>100% public sector clients. |
| A_4 | Architect | The Netherlands | 430 *<br>2,500 ** | Multiple Project Examples | Enhance the neighbourhood with communal spaces, resident development areas, and municipal investment. |

| | | | | | |
|---|---|---|---|---|---|
| AC_5 | Architect-led cooperative | Spain | None *<br>11 ** | Single Project Focus | Promote cooperative housing models.<br><br>Upskill members in co-operative processes and management. |
| AC_6a | Architect-led cooperative | Germany | 106 *<br>2,873 **<br>7,000 *** | Single Project Focus | Promote cooperative housing models. |
| AC_6b | Architect-led cooperative | Germany | 60 *<br>400 ** | Single Project Focus | Sustainable materials and energy efficiency |
| HA_1a | Housing Association | The Netherlands | 51 *<br>373 **<br>10,265 *** | Multiple Project Examples | Transform care homes for older people, prioritising residents. |
| HA_1b | Housing Association | The Netherlands | 51 *<br>373 **<br>10,265 *** | Multiple Project Examples | Transform care homes for older people, prioritising residents. |
| HA_2 | Housing Association | Scotland | <50 *<br><500 **<br>3,000 — 35,000 *** | Single Project Focus | Start from a resident wish-list and resident approved high level feasibility study.<br><br>Deep retrofit<br><br>Post Occupancy Evaluation. |
| HA_3 | Housing Association | England | 20 *<br>Unavailable **<br>13,588 *** | Multiple Project Examples | Deep retrofit and zero-carbon sustainability.<br><br>Trialling innovation |
| HA_4 | Housing Association | Spain | 110 *<br>714 **<br>1,764 *** | Single Project Focus | Housing for highly at-risk residents |
| HA_5 | Housing Association | England | 1,100 *<br>73,000 **<br>125,000 *** | Multiple Project Examples | Focus on space heat demand—decarbonise and keep bills low. |
| HA_6 | Housing Association | Denmark | 100 *<br>3,000 **<br>7,500 *** | Multiple Project Examples | Generate social mixing.<br><br>Deep retrofit |

* Approximate number of dwellings undergoing retrofit design or completion in 2023

** Approximate total number of dwellings retrofitted

*** Number of dwellings under ownership and management

**Table 1:** list of interview participants

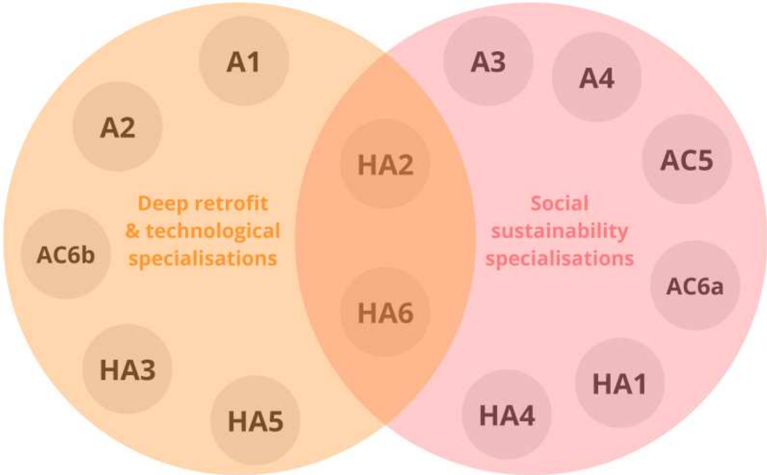


**Figure 1**: Venn diagram of stakeholder specialisations in social housing retrofit processes.

### *2.3 Data Collection*

Data collection took place from March–October 2023. Interviews were conducted via the Microsoft Teams application, offering two advantages: (1) enabling interviews with stakeholders throughout Europe and (2) facilitating recording. These recordings proved invaluable for subsequent transcription and analysis. The duration of interviews varied between one hour and two hours. As part of the [removed for peer review] project implementation, The European Commission offered ethical guidance to be followed as part of the ESRs projects via a management structure. The network management structure includes an Ethics and Data Management Committee (EDMC) responsible for the fulfilment of ethics and data management compliance, in line with the EC guidance and the ESR projects, which includes this study. Ethical clearance, consent, and data protection and storage adhere to the guidelines of [removed for peer review], conducted in accordance with the Regulation (EU) 2016/679 (General Data Protection Regulation), confidentiality principles, and the national laws.

### *2.4 Data Analysis*

Interviews were analysed using reflexive thematic analysis, developed by Braun & Clarke [40,41], with the research question *"How do stakeholders (not)utilise residents' situated knowledge and expertise in retrofit design?"*. This approach is inductive as coding and theme development were driven by the data, rather than pre-determined constraints. The analysis took a critical realist approach, acknowledging stakeholders' narratives are shaped by social and professional power dynamics, but valuable insights into their perspectives and experiences can also be achieved. Initially, analysis focused on semantic meaning but became more latent with every subsequent review. Data familiarisation began when editing automated transcriptions and noting the scope of residents' input, including an apparent distinction between HA and design-led practice approaches. Initial coding through NVIVO produced 83 code labels. Code labels were allocated to portions of the interviews as a word or group of words summarising a specific meaning related to the research question. Code labels were then clustered into patterns of significance. Thematic maps were generated for each potential theme by reviewing the codes, the coded data, and the full dataset. The core concept of each theme was heterogeneous, distinguished by considerations affecting decision-making in retrofit. The code labels under each theme were then grouped into subthemes of similar meaning. These subthemes were then grouped into fewer themes. This process was iterative, with subthemes shifting between themes as latent ideas became articulate. Extracts from the interviews were then chosen to illustrate the final themes.

# 3. Results

Five final themes were delineated from the semi-structured interviews: (1) external factors influence decision-making; (2) building design is the priority; (3) integrated communication between high-level stakeholders and resident stakeholders; (4) importance of social value; and (5) residents have choice. Each theme includes three associated sub-themes, as illustrated in Figure 2. The themes ascend from the least inclusive to most inclusive of resident stakeholders.

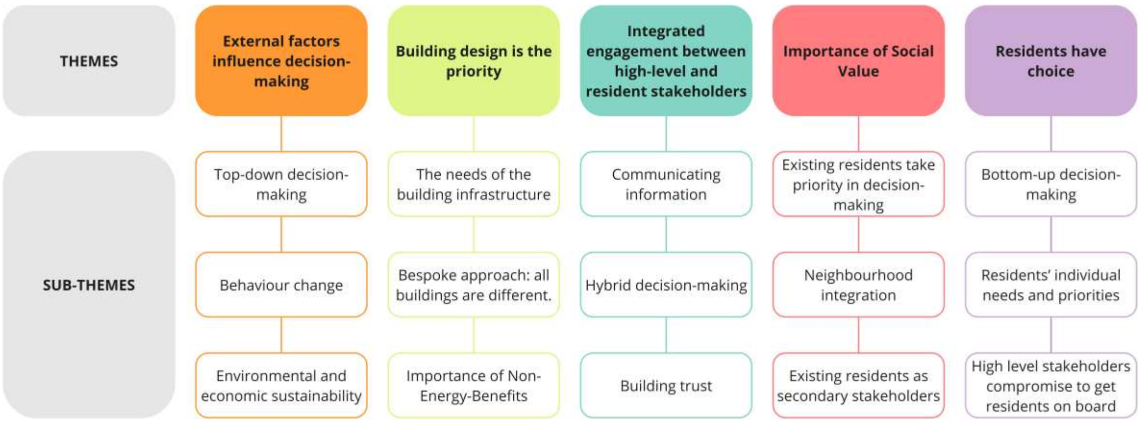


**Figure 2:** Thematic map of themes and sub-themes.

## 3.1 External factors influence decision-making

This theme focuses on external influences that impact retrofit, including legal frameworks and guidance. Residents' expertise is not prioritised because decision-making is based on obligations regarded as outside the scope of residents. There are three subthemes: top-down decision making, behaviour change, and environmental and economic sustainability.

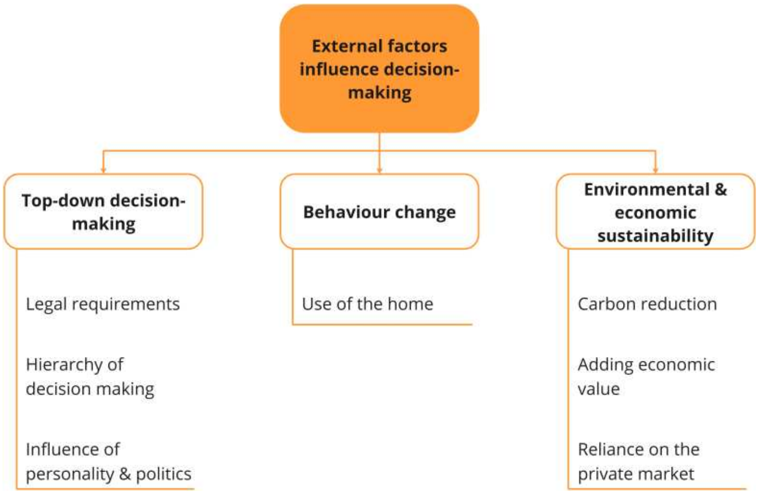


**Figure 3:** Thematic map of theme *External factors influence decision-making*.

### *3.1.1 Top-down decision-making*

Participants highlighted raising permit rejections with political authorities and that environmental obligations have been influenced by developers. Removing planning permission for retrofit was suggested to increase uptake and reduce time, but others used delays to increase engagement.

> *"…the government have taken* [environmental] *things out of building regulations. I think that's because they get too much sway from developers, they're all about profit".* (HA_3)

Some participants expressed spending deadlines are frustratingly tight—decanting alone can take two years—making engagement scheduling difficult. When local councils are low on funds, a phased retrofit approach occurs over time. Funding is often tied to energy performance, retrofit certifications, or other frameworks pledges. Most participants identified problems with existing frameworks. For example, many participants expressed the goal to reach an energy performance certificate (EPC) rating EPC-C to reach funding requirements. However, EPC-C may not reduce fuel poverty. Further, frameworks and certifications undervalue engagement.

When residents leave and architects join later stages, building owners remain the only consistent stakeholders. Participants mentioned other external challenges: owners refusing party wall insulation reduces efficiency; compulsory decanting; a 'retrofit designer' under PAS 2035—the British standard for management and delivery of retrofit dwellings [42]—diminishes architects' influence and engagement; and inconsistent stakeholder teams. As shown in Figure 3, a hierarchy of decision-making becomes inevitable.

Many participants communicated personality and political influence. Architects described project leaders setting a tone, positive when advocating for social improvement but negative when strained professional and personal relationships impact success. For instance, when residents opposed a Mechanical Ventilation and Heat Recovery (MVHR) system during a meeting, the project lead firmly insisted, rather than discussing alternatives or using product demonstrations to assuage concerns. In this case, top-down decision-making eroded the trust between high-level stakeholders and residents, setting a tone that continued throughout the project.

> *"I've never worked alongside an organisation that was so run by the personality of the person running it. Which in this case probably hasn't been positive… in terms of final decision-making, that person's opinion and personality will make a big difference".* (A_2)

Most participants emphasised the need for systemic change in retrofit approaches: protection from political and personal changes; allocate a retrofit fund from rent, distributed as needed; address void properties first; increase retrofit advisors' role; increase developer obligations; encourage bottom-up retrofit design; and release public information campaigns. In these ways, retrofit becomes a consistent force for inclusion and protection of residents at-risk of vulnerability.

### *3.1.2 Behaviour change*

Many participants explained that project success hinges on residents' interaction with their homes post-completion. Sometimes, retrofit can facilitate behaviour change; for example, switching stoves from gas to electric. Other behaviours are expected to change, such as smoking indoors. But this can be difficult and disorientating for residents. Alternatively, initiatives that raise the autonomy of residents and their access to heating and hot water revitalise buildings and residents alike. For instance, residents using off-peak electricity to save money will have greater flexibility should retrofit increase energy efficiency.

> *"A resident told me, '…I can only put it on at 11 at night because otherwise it's expensive and I have to set the alarm for 5:45 to get up and turn it off'. Her sleep patterns are governed by her hot water cylinder currently".* (A_1)

It is vital to understand why residents have certain habits, to mitigate distress. For example, one group of residents were resistant to fireplace removal as the area was prone to power cuts, but were reassured their homes would not drop more than one degree. This depends on residents' interactions with technology and digital information, which can be difficult to teach residents at-risk of vulnerability, either due to capacity or general resistance. For some participants, energy models should reflect uncertainties of behaviour change. Further, low-income residents are often already responsible energy users and once they can afford to heat their homes, are more likely to incur a rebound effect.

> *"But in one of the studies, they* [energy company] *realised that when the retrofitting has been done, there's actually a bump in energy consumption. Because people can actually afford it now. The rebound effect".* (HA_4)

### *3.1.3 Environmental and economic sustainability*

Participants mostly discussed carbon reduction through operational carbon—the carbon emissions resulting from energy used to operate the dwellings. Embodied carbon, circularity, and life cycle carbon costing to calculate savings were also mentioned. Passive solutions included: cork, external wall, and cavity wall insulation; increased airtightness; and improved acoustic performance. Active mechanical solutions included: photovoltaic (PV) panels and other renewable energies; efficient MVHR systems, including heat pumps; biomass; and efficient lighting. Measures were chosen according to the retrofit approach, but when operational carbon was prioritised, environmental sustainability focused on DER.

DER's reliance on techno-optimism particularly emphasises heat pumps. UK Building Regulations (updated in 2021) and the EU Heat Pump Action Plan (halted in December 2023) encourage heat pump specification. But many participants felt conflicted about heat pumps because they are: manufactured abroad, new technology, will become obsolete due to better future technologies yet will still require maintenance, less efficient than gas central heating, require maximising airtightness, expensive, large, loud, and disliked by residents.

> *"…in 15 years time, when all of these Japanese and Taiwanese air source heat pumps breakdown and no one can fix that cause the company is closed".* (A_3a)

> "*we're conscious that even though we're retrofitting electric systems with air source heat pumps, they're still less efficient than gas central heating…they actually have higher than normal energy bills…I'm not convinced that air source heat pumps are the way to go, but we're fitting them everywhere in new builds, in retrofits."* (HA_2)

Some participants, particularly architects, expressed that passive solutions must balance technology. For example, designing ventilation, heating, and thermal performance strategies together, combining mechanical and passive solutions, to allow each strategy to complement the other. This helps safeguard against technological redundancies, rapidly changing climates, protect from rising electricity costs exacerbating fuel poverty, and increase flexibility to respond to changes.

Participants stressed realistic budgeting; for example, removing and replacing wall fixtures alongside External Wall Insulation (EWI). Retrofit projects are long-term and some participants encouraged intermediary interventions such as replacing boilers. Many participants explained raising economic value as necessary to convince building owners to retrofit. Examples included adding bedrooms, homes, and shared space, splitting dwellings, and increasing flexibility for evolving households. As shown in Figure 3, social housing retrofit relies on the private market in three key ways:

(1) Fund retrofit. HAs cross finance with rent or sales from other housing stock; grants, which come with conditions including quantity over quality; and relying on donated materials or time.

(2) Facilitate long-term investment. Long-term net zero government support would encourage new supply chains, investment in solutions such as better monitoring, and attract businesses and high-level housing to facilitate social mixing.

(3) Access housing. Private stock owned by investment funds should be retrofitted as social housing, rather than building new.

## 3.2 Building design is the priority

This theme explored how the existing building influences decision-making, placing value in retrofit for enhancing design. Residents' situated knowledge can play some role in gathering insights. There are three sub-themes, as shown in Figure 4: the needs of the building infrastructure, bespoke approach: all buildings are different, and importance of NEBs.

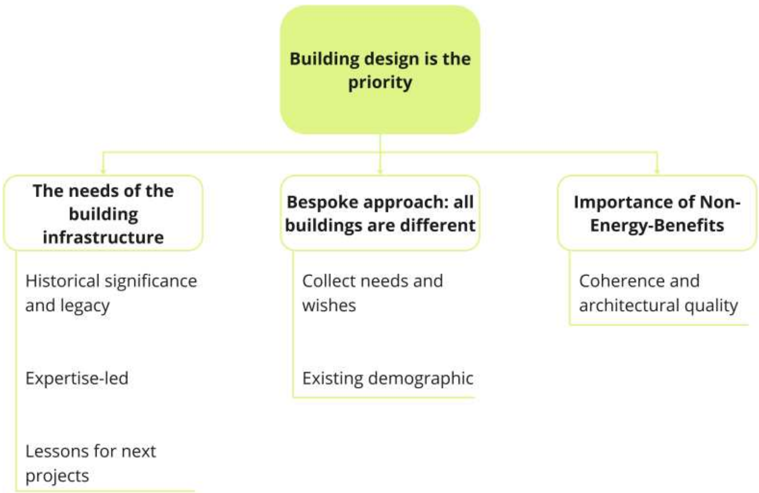

**Figure 4:** Thematic map of 3.2 theme *Building design is the priority.*

### *3.2.1 The needs of the building infrastructure*

According to several participants, infrastructural needs dictate retrofit measures. Some participants begin with technical reports assessing energy reduction potential. This is particularly important during DER which aims interventions at performance targets. Additionally, not all construction methods warrant all solutions. For example, building fabric informs insulation type. Infrastructural reports are essential for repairs and developing suitable designs. Architects look beyond infrastructural issues, toward liveability and habitation. Architects are uniquely placed to collaborate with residents, starting with retrofit assessments that should capture resident diversity.

> *"The first thing is the retrofit assessment is intended to pick up the diversity of who's living there at the moment". (A_2)*

Many participants expressed challenges and opportunities of working with existing buildings. Listed buildings protect their historical significance and legacy by maintaining initial design intentions. Architects and HAs agree the evolving socio-political history of social housing should be retained. This includes maintaining as much fabric and design as possible, even when not listed. However, all existing buildings come into conflict between initial design and updated building regulations.

> *"The planners were like, 'well, changing the roof heights* [to insulate]. *Hmm…one of the rigours of this original estate was that it's got this consistent roof height', so that took a bit of persuasion".* (A_2)

Several participants discussed learning from each retrofit for future iterations: discovering residents' opinions through post occupancy evaluation (POE), or events such as informal gatherings; gathering patterns of issues within typologies; and grouping recurring needs.

> *"When we start with the participation method, we also start with planning to rebuild it, because we know already people want to live not in one room anymore, they want to have two rooms".* (HA_1a)

Each iteration tapers time and cost. Implementing POE, however, often needs improvement.

### *3.2.2 Bespoke approach: all buildings are different.*

All participants agreed buildings are unique, requiring a bespoke retrofit approach. Two key differences are: (1) maintenance issues, even within the same typology; and (2) each resident demographic has different requirements. Some participants collected the needs and wishes of residents during infrastructural assessments, to balance solutions between housing needs and residents' input.

> *"It's bespoke to every property, we haven't set rules. We have to follow certain technical design requirements. But it all comes back to that word 'balance'".* (HA_5)

Others implemented a phased approach, leaving opportunities to adjust further: fabric-first measures leave opportunities for low carbon technologies; deferring boiler replacement until it breaks; and designing for future use, such as a ramp to enter a bungalow. Adaptability mitigates risk and safeguards future use.

Household needs of residents at-risk of vulnerability requires investigation. While a few participants proposed adapting residents to fit buildings, most proposed customising buildings.

> *"…maybe these are places for artists and students and people who don't mind being a bit cold if they can have a nice big space to play in and then you can do things like put radiant heat in".* (A_1)

A deep understanding of existing demographics, associated needs, and how to translate information into buildings is vital. This includes disabled access, but also more detailed design such as no reflective surfaces for residents with dementia. Situated knowledge and social organisations advocating for residents are crucial to this investigation.

### *3.2.3 Importance of Non-Energy-Benefits*

Architectural coherence and design quality largely represent NEBs of retrofit. Several participants emphasised flexibility in design. Flexible open or closed plan kitchens, working from home opportunities, future children, and options to change communal space, all featured. The HA concerned with older people homes collaborates closely with the same architect on every project, within a design philosophy around modular space allocation. Some modules have permanent functions such as shared kitchens, others are more flexible such as art modules. For architects, architectural quality of retrofit enhances residents' lives. Beautiful, pragmatic design featuring daylight and passive ventilation provides residents with a sense of integrity. When energy performance is the priority over liveability, it can diminish the quality of the space and residents' lives. For example, recessed porches increase the surface area of the elevations, and therefore heat loss, but they are used in good weather as outdoor spaces for residents to sit and interact with neighbours. Removing that interaction with the street would increase energy efficiency but decrease residents' quality of life.

> *"It would be really easy to do a desktop analysis saying, 'yeah, we'll put some glass doors across there', and suddenly we've taken the connection that those residents have with the outside world. That makes health worse, shortens life, makes people a little bit miserable".* (A_1)

## 3.3 Integrated communication between high-level stakeholders and resident stakeholders

This theme highlights high-level stakeholder and resident stakeholder engagement and the importance of two-way communication. Comprehensive communication and engagement leaves scope for collaborative decision-making. There are three sub-themes, as shown in Figure 5: communicating information, hybrid decision-making, and building trust.

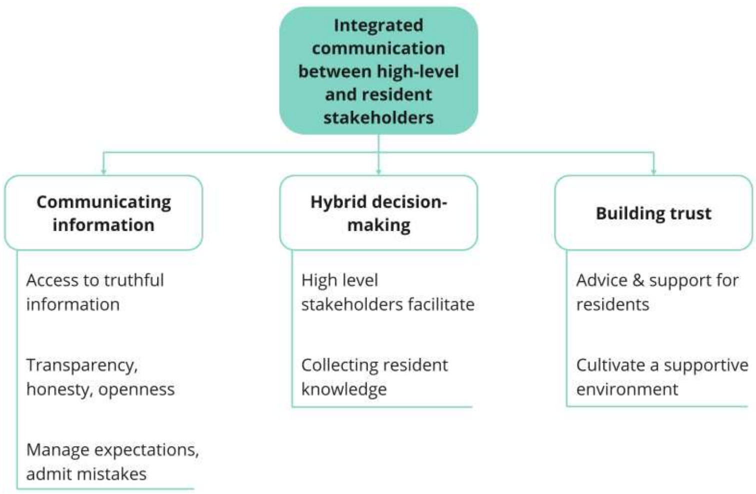


**Figure 5:** Thematic map of theme *Integrated communication between high-level stakeholders and resident stakeholders.*

### *3.3.1 Communicating information*

All participants expressed transparent, honest, and open communication as necessary throughout all retrofit stages. Relaying mistakes and managing expectations is valuable to avoid exacerbating vulnerabilities. This includes fair warning about visits, cost implications, and timelines. All participants prioritised residents' access to truthful information to effectively communicate benefits, integrating communication with a dedicated Resident Liaison Officer (RLO) or regular on-site presence to respond to daily concerns. Participants found communication fundamental to dispel rumours, bring residents along the energy journey, and ensure residents felt heard and safe. For example, in neighbourhoods where people felt unsafe joining events at night, engagement activities were scheduled throughout the day or during summer months.

Some participants described alleviating language and cultural disparities. Most participants included translations, accessible language, and adjusting designs to household needs. Other participants found creative ways to deeply understand the experiences of marginalised residents to better inform design choices. Such as virtual reality (VR) that emulates the experiences of residents with dementia.

> *"You put on VR goggles and it shows you what someone with dementia sees. You go 'wow, I had no idea that colour and pattern have such a distinct impact'. That really informed our design choices".* (HA_2)

### *3.3.2 Hybrid decision-making*

As shown in Figure 5, participants discussed many methods of collecting knowledge: community outreach; workshops to collect needs and wishes; working groups; demonstrating options; and one-to-one discussions, imperative preparation for decanting. This enabled hybrid decision-making by translating knowledge into design iterations. For example, when a group desired to attract young families, space allocation facilitated bicycles and prams, as well as wheelchairs. This hybrid model utilised top-down governance to engage in bottom-up practices.

> *"There were initially two bathrooms in this apartment and we wanted only one because it was cheaper. There was a coalition between the natives who wanted two bathrooms* [one for guests]*, and immigrants who wanted separate bathrooms for women and men. We maintained the two bathrooms".* (HA_6)

Other participants described high-level stakeholders in an advisory role, providing technical and architectural assistance to support resident decision-making, fostering inter-cooperation. Hybrid decision-making strikes a balance between technical guidance and residents' needs.

### *3.3.3 Building trust*

Most participants explained that building trust is key to engagement, beginning with cultivating a supportive environment with residents as integral team members. Most participants, particularly architects, explained that engaging residents early in the design process builds personal relationships, streamlines decision-making, and reduces conflict. Building these relationships is tricky, requiring transferable skills that social housing managers may not have. Many HA participants revealed personal relationships with residents are lacking and should be integrated into management infrastructure. Management of the architect-led cooperatives already value personal relationships, making it easier to initially approach retrofit.

> *"We try to visit them once a year. So that you know each other, and that's very helpful in the time where you have a problem. Most of them, if they call us, I know them. So that's much easier to talk and to solve problems if you know each other".* (AC_6a)

Some participants emphasised selecting contractors with transferable skills, particularly people-skills when working in occupied homes. Others mentioned employing mid-size companies with fewer workers to maintain a familiar workforce for residents.

## 3.4 Importance of social value

This theme explores the social impact of retrofit in terms of wellbeing and quality of life for residents and the wider neighbourhood. Residents' situated knowledge can guide decision-making. Three sub-themes were identified, expanded in Figure 6: existing residents take priority in decision-making, neighbourhood integration, and existing residents as secondary.

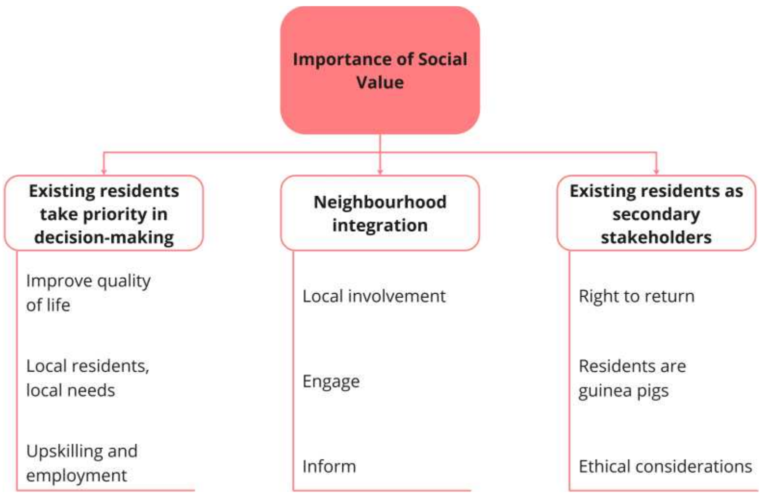


**Figure 6:** Thematic map of theme *Importance of social value.*

### *3.4.1 Existing residents take priority in decision-making*

Most participants agreed residents' right to comfort and housing quality travels beyond energy performance. Crucially, quality of life requires social and environmental connection to reduce isolation. Connective spaces included guest dwellings for cooperatives, activities for residents, gardens, and allotments. Participants explained the significance of empowering residents with autonomy and ownership over their rental homes. This could be community building activities, fundraising, self-organisation, and raising self-sufficiency. Further, participants discussed raising residents' social role within existing or formative communities. Particularly popular with architects, energy advocates emerged from within existing residents to teach, convince, and advocate for others. Other social value examples included bringing residents along the climate journey, implementing community hubs, energy cafes, help decluttering, and direct resident support. Direct resident support is necessary to advocate for individual residents' needs and evaluate project success, socially, environmentally, and economically. For example, when a resident consistently felt cold, although the retrofit met the promised heat demand, they were supported in finding solutions.

> *"We had to convince her 'you should maybe go and see a doctor if you're feeling cold in a 25-degree room'. It turns out she had kidney failure that was causing a bit of issue as well".* (HA_2)

Many participants emphasised knowing existing demographics and the benefits of local knowledge to satisfy local design, programme needs, and safeguarding. Safeguarding included resident retention, adaptable common areas and floor plans, and protecting residents from exploitation or mistreatment. Assistance from social departments and organisations are a vital resource.

> *"I was taking somebody's gas out and they said 'I'm not gonna be able to cook'. 'Yeah, we'll give you a nice electric hob'. And they said 'no, we cook on open flame'. And that was a cultural and semi-religious reason for that".* (A_1)

Upskilling and employment within existing residents boost social value. Paid opportunities occurred for young people, engagement, demonstration dwelling access, and existing initiatives, including funding children's illustration and music classes. Some participants hired contractors who employ skilled residents and upskill others. This is a significant opportunity to raise social value alongside economic prospects within the current retrofit labour shortage.

### *3.4.2 Neighbourhood integration*

Many participants described neighbourhood strategies to extend social value. Local involvement included: (1) employing local tradespeople, contractors, and companies trading as cooperatives. This stimulates local economies, but also facilitates relationships between neighbours, raising the social role of local workers. (2) Integrate neighbourhood ambassadors, particularly neighbours with existing social and cultural roles. This creates a strong local environment, grounding social housing as a community and life hub.

> *"This champion out of the broader community now gives some lessons or talks with people on how important it is to move, to exercise".* (HA_1a)

Measures were also taken to engage existing residents with neighbourhood residents. Real and virtual message boards inform residents of transport timetables, local activities, and shared public events. For example, concerts, happy hour, bicycle repair stations, talks from politicians before elections, and homework club on donated computers. Local bulletins and publications widened communication, to convince other residents to demand retrofit, building owners to retrofit, and advocate for participation. A public information campaign was also suggested to empower residents and homeowners to engage with retrofit.

### *3.4.3 Existing residents as secondary stakeholders*

Participants explained few households exercise their right to return, possibly because: moving is bothersome and residents are comfortable; changing school is disruptive; older people moved into assisted living; and residents' needs are unmet, for example larger apartments increase rent, and the change from collective to individual water meters.

*"...when we retrofit, we* [change from collective to] *metres in the apartments. And there were some families, bigger families, also from good Muslim backgrounds, where they use so much water taking baths etc., so they couldn't afford to stay".* (HA_6)

Some participants financially incentivised permanent relocation, or undertook administrative tasks and moving expenses for decanting. Equal return support may have incentivised residents to return and encourage consistent engagement. Engagement processes should not stop, however, when residents change. Participants acknowledged that large-scale retrofit could take 10-15 years, benefitting a different generation. But often, residents envision a better life and home for their descendants, prompting patience.

> *"Another year for them to have a better later life or their kids or grandkids have a better life and better outcomes, for them it's just it's like a day or a week. It's like it doesn't matter".* (A_3a)

Many participants mentioned social housing residents are "guinea pigs", innovating and testing solutions to convince homeowners to retrofit. Retrofit technologies and procedures will inevitably need improvement and can become obsolete. This is an ethical dilemma, as funding prioritises social housing, despite still testing solutions.

> *"…they're* [social housing residents] *paying as an early adopter for this technology and ten years down the line, everyone pivots to another and they're stuck with the old rubbish heating system".* (HA_2)

Participants identified many ethical issues of de-prioritising residents' needs: exacerbating fuel poverty—gas per consumption unit is cheaper than electricity in the UK; resident fatigue—survey fatigue, construction fatigue impacting sleep, and monitoring fatigue; and exploitation—exploiting personal stories for resources could glorify residents' vulnerabilities.

> *"…you need to be able to say someone whose been living in the street for two years is going to have to one of these apartments. These are powerful messages for communication purposes and for getting resources".* (HA_4)

## 3.5 Residents' choice

This theme concerns residents' choice in the retrofit process and the response of high-level stakeholders to those choices. Residents' situated knowledge can be fully utilised in decision-making as they are the primary stakeholder. Three sub-themes were identified, expanded in Figure 7: bottom-up decision-making, residents' individual needs and priorities, and high-level stakeholders compromise convince residents.

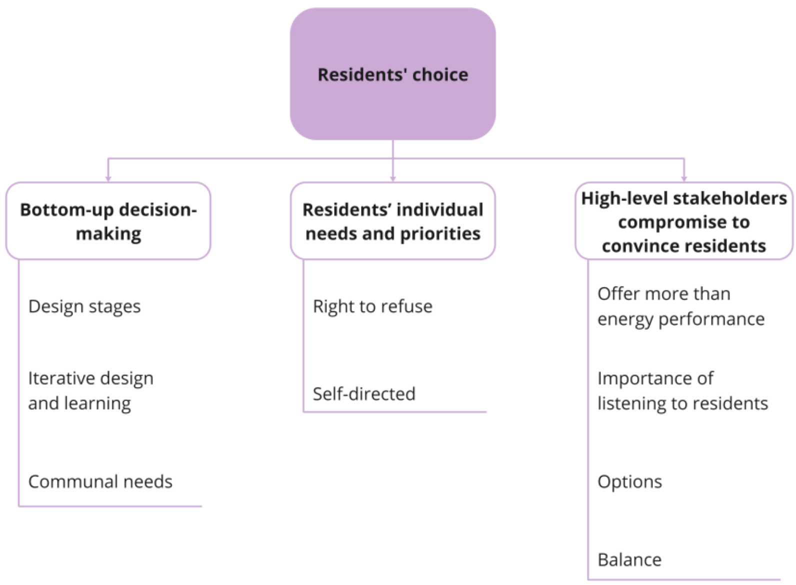

**Figure 7:** Thematic map of theme *Residents'choice.*

### *3.5.1 Bottom-up decision-making*

Bottom-up decision-making ranges between (1) residents' willingness to care for collective space, prompting or excluding designs, (2) allocation of collective space, and (3) self-building. Largely bottom-up processes add significant time and pressure onto residents.

> *"You start with a lot of energy and motivation because it's really exciting. But it requires a lot of meetings, a lot of time, a lot of viewing, education, renouncing your personal life.* (AC_5)

Some participants gathered data from residents before design work, often prompted by legal requirements including mandated referendums. Some practices encouraged residents to communicate needs and problems early, but minute design oppositions such as lightbulbs lead to conflicts and delays.

Tenant committees or working groups—with resident representation to avoid bias—were often assembled, sometimes making difficult design compromises for time and budget constraints. Managing expectations during bottom-up processes is ethically challenging with groups at-risk of vulnerability; changes and delays could cause distress. Specialist social organisations can advocate on tenant committees on behalf of residents at high-risk of vulnerability. Residents can then decorate and furnish post-completion. Opportunities for bottom-up decisions post-completion are sparse. Residents can distribute shared facilities, such as PV energy, allocate shared spaces, and advertised benefits or events.

Many participants, especially HAs, stressed thoroughly assessing residents' suggestions before proposing re-iterations to avoid unrealistic promises, maintain trust, and manage expectations. Engaging residents in high-level feasibility studies before planning permission can mitigate future opposition, saving time. Extensive bottom-up decision-making involved refining designs until residents saw their input reflected. Communal needs are mostly developed in the architect-led co-operatives and one HA who retrofit care homes.

> *"We have an inspirational meeting first and then eight weeks later, we show them and say, 'do you recognise your inputs?' Then they say, 'yes, I recognise it' or 'you missed something'. And then we take that, make it final, and say, 'OK, these are the wishes' and then we make work sessions during six or eight weeks together with them".* (HA_1a).

### *3.5.2 Residents' individual needs and priorities*

Every participant identified residents' priorities above retrofit. They may be time poor, have limited resources, insecure work, physical issues, mental health problems, fled war, or fear the unknown. These priorities leave residents with two key choices: (1) refuse works, or (2) refuse to engage. All participants shared one or both of these issues.

> *"Often people that are living in social housing have some other issues too.* [sic] *they have enough issues and things on their plate. And then a renovation is like 'not also a renovation', so they're quite scared".* (A_4)

Most DER projects, however, will require residents to decant their homes. This can be legally enforced but will cause subsequent issues including delays, trust breakdown, and negative mental health. Some participants suggested overcoming refusals by simply knocking on doors to discover how retrofit processes could alleviate individual pressures. This could be simple communication to ease fear or reassure residents of their safety and security. Sometimes, residents want to see examples before deciding. If they continue to refuse, some participants suggested moving on. Successful completions could convince residents later.

### *3.5.3 High-level stakeholders compromise to convince residents*

Most participants agreed residents need more than energy improvements, beginning with a welcoming meeting space.

> *"We have a low-income population, what helps is to put cake and coffee on the tables and give them a meal or give something and then they like to come. It's for a lot of people, a small party, to come in the evening and you have a nice wine, etc".* (HA_1b)

Architects are more likely to offer more than information sessions to convince residents to accept retrofit. Offering residents a new kitchen or electric stove cookery classes can increase retrofit engagement, acceptance, and support because their needs are prioritised and circumstances improved. Similarly, participants stressed the importance of constant discussion to convince residents that their lives can be better tomorrow.

Both architects and HAs mentioned active listening to residents. Participants explained that deeply understanding residents' needs can elevate design or interpret latent needs. For example, an expensive swimming pool request was interpreted as lacking access to one nearby, remedied by a transportation system. Many participants compromised by giving residents choice between designs, products, and finishes—simple but enjoyable. Others arranged viewings of demonstration dwellings, design studios, products, and materials. Options for heating systems are vital, especially with rising electricity costs and different home use. Choices can empower residents, granting autonomy.

> *"we're looking at infrared panels and systems that can go on the ceilings. Because they need that immediate heat, especially with the bills going up, but just in the room that they're in because they're not interested in heating the rest of the house".* (HA_3)

A balance must ultimately be made between residents' needs and energy performance improvements, which will not always align. Compromising with residents', such as leaving cooking gas, amending floor plans, offering a new kitchen, or not to legally evict, will cultivate trust and acceptance of other modifications. It is also important to strike a balance between active technologies typically feared by residents, and passive solutions deemed more acceptable. Participants explained that combining passive solutions with active technologies can reduce energy consumption between 20-70%.

# 4. Discussion

The interview participants included three key high-level stakeholders: architects, architect-led cooperatives, and housing associations. The specialisations outlined in Table 1 and grouped in Figure 1 have shown that tensions between technological retrofit solutions and deep retrofit on the one hand, and social impact such as enhancing public space on the other hand, exist for high-level decision-makers in social housing retrofit. Some stakeholders aim to reduce these tensions through hybrid decision-making, such as collecting resident wish lists (see HA_2 specialisation in Table 1). These hybrid approaches bridge both specialisations, suggesting that technical and social aims are not mutually exclusive. For instance, when compromising with residents' needs, such as leaving cooking gas or amending floor plans, alongside implementing complementary passive and active technologies, projects can achieve significant energy reductions while maintaining resident acceptance.

High-level stakeholders can utilise residents' expertise in retrofit design through top-down, hybrid, or bottom-up decision making. Challenges to resident inclusion occur when top-down structural systems, including legislation, DER frameworks and guidelines, and performance targets, are prioritised over individual and collective needs. Frameworks dedicated to performance targets remove resident stakeholders in favour of numerical performance targets, empowering high-level stakeholders to make decisions without resident input, in favour of techno-optimism [17]. This is echoed in building design. The participants agreed that each building has bespoke needs, offering ample opportunity to integrate residents. But top-down decision-making excludes residents in favour of technical expertise, rather than collaborating. Hybrid decision-making combines external frameworks and building design with residents as stakeholders, to meet actual, rather than perceived, needs. Integrated communication, engagement and feedback loops [25,26,29] can boost morale, reduce conflict, increase uptake, increase energy awareness [27,30], and save time [26]. Hybrid decision-making is on a scale (see Figure 8). When residents decide between pre-determined options, it can be viewed as 'tokenist' [37], but if initial engagement generated options, they are embedded with principles communicated by residents. If design revisions come after resident feedback, hybrid decision-making is solidified. As illustrated in Figure 8, raising social value also belongs on this scale. For social value to raise residents' wellbeing and quality of life, high-level stakeholders must develop a deep understanding of residents' needs, fostering collaboration and integration. When social value reaches the wider neighbourhood, hybrid decision-making is strengthened again, particularly through outreach, local access to needs, and access to local information. However, when existing residents become secondary to social mixing, new residents, or innovation, decision-making becomes top-down again under the guise of raising social value. The resulting displacement of existing residents supports the literature findings [33]. But by boosting social value through hybrid decision-making, it can increase collective socio-economic growth. When residents have choice in retrofit, beyond options, bottom-up decision-making places residents as the primary stakeholder. Technical experts then support. Participants explained when residents have choice and high-level stakeholders are willing to compromise, the efficacy and uptake of retrofit increased. But bottom-up decision making is extremely slow and places a lot of pressure on existing residents.

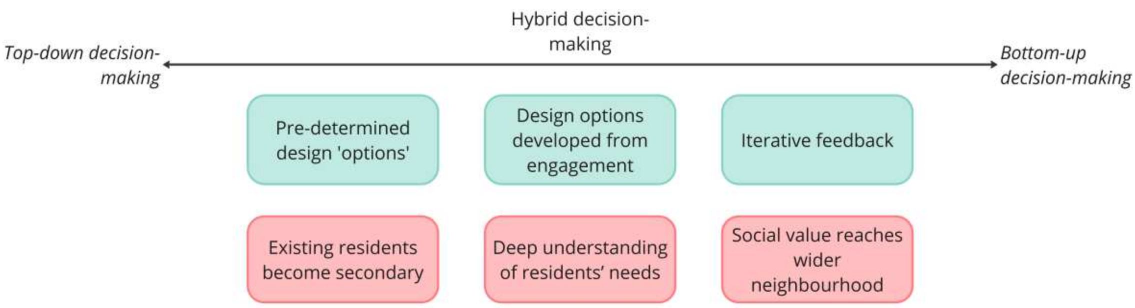


**Figure 8**: Scale of hybrid decision-making in retrofit.

Over-reliance on techno-optimism [16,17], as it works its way into policy, planning regulations, and legal frameworks are based on a set of assumptions and political world view that has seeped into architectural (retrofit) practices, minimising design. Energy habits are unlikely to change in line with new technologies [27,30], leading to excessive performance gaps [12]. Yet there is an assumption that energy frameworks work as expected, as evidenced by the de-emphasis of POE. High-level stakeholders who value resident engagement are often left unsupported, combating strict timelines, expensive technologies, lack of engagement funds, external pressures to stimulate extra economic value, and reliance on private markets for technologies, growth, and finance. This is indicative of broader technocratic and neoliberal trends that private markets can better respond to user needs [43]. However, project success often hinges on the personality of the project lead, resulting in inconsistent processes that can be distressing for groups at-risk of vulnerability.

Building design in retrofit can enhance the quality of living spaces and wider neighbourhoods but is typically undervalued compared with energy performance. Architects specialise in 'design-thinking' [26] and intensive collaborative practices that give designers decision-making power to integrate the needs and experiences of others. In retrofit, design-thinking can solve problems such as energy performance, spatial cohesion, and circulation, through design. This agrees with the literature that the social housing sector offers opportunity for design-thinking in retrofit technology and innovation because of the close relationship between producers and consumers but relies on close stakeholder collaboration [31]. Over-reliance on existing technological retrofit solutions through top-down decision-making, however, overlooks architectural principles and passive design. Energy performance targets focus on short-term results, while passive design is difficult to quantify and requires longer periods of monitoring and POE, which is currently undervalued. In the long-term, advancements in technology will outpace the next large-scale investment in social housing retrofit, which is currently an unknown period. Existing technologies are still expected to perform consistently and require specialised maintenance for products that may become obsolete. It is therefore important to approach technological retrofit solutions with design-thinking, integrating residents' needs and wishes with systems development by designing technologies with end users [44]. In this way, new socio-technical systems [31] are tailored to residents, creating cohesive designs that allow each retrofit strategy to complement the other.

Architect participants championed design as a catalyst for long-term positive outcomes, acknowledging its potential to address structural and infrastructural issues alongside elevating the buildings' modernity, function, and performance. Strategies aimed to reduce energy consumption through passive design require less maintenance and are immune to technological obsolescence. Therefore, they should be considered first, serving as a baseline for technological solutions to further enhance energy performance. Desvallées' 2022 [45] found that while passive solutions improve thermal needs—thermal control, ventilation, insulation, reduce internal temperatures during summer, and increase internal temperatures during winter—thermal needs do not encompass cooking, lighting, and domestic hot water consumption. This shows that passive solutions should be the first but not last port of call. Passive solutions offer a stable foundation for long-term energy performance and should be complemented by active retrofit technologies to address the comprehensive energy needs of residents. But active technologies should still benefit from hybrid-decision making and design-thinking, not to overlook residents' needs and value that impact their energy decisions and behaviours [35].

As expressed in the literature [20,21], NEBs hold more importance for social housing residents than energy performance. Through collaborative efforts integrating residents' needs, wishes, and situated knowledge [24], bespoke solutions emerge, emphasising the importance of resident stakeholders and recognising each building's unique context. Social and environmental benefits are inherent in well-designed retrofit projects, which can raise the social conditions of neighbourhoods [33]. They can foster pride through accessible outdoor space, community amenities, and street views; enhance passive heating and cooling strategies; and improve quality of life. Further, sensitive construction choices and design integrity preserves historical and socio-political significance, increasing cultural sustainability [46].

Integrated communication improves the security and safety of residents, vital for groups at-risk of vulnerability. Stakeholder relationships often begin fractious due to previous communication breakdowns and lack of building maintenance. But consistent engagement and hybrid decision-making will help increase trust, relieving resistance, disempowerment, and systems misuse [27]. Participants and literature [33,34] agree that building trust, transparency, and honesty is tantamount to the success of social housing retrofit, particularly the delivery of low carbon technologies [35]. Trust should be ingrained in management to streamline retrofit processes, gather situated knowledge, and solidify relationships and support within groups at-risk of vulnerability. Engagement should be tactful, not to overwhelm residents. For example, maintaining familiar locations and workers. Further, communication and engagement is often not integrated or early enough. To achieve non-hierarchical, hybrid decision-making, residents should be a consistent stakeholder, even if the exact people change.

The SHDF and EPBD demand retrofit on worst performing properties first. If technological improvements occur alongside integrated decision-making and increased social value, investing in low performing properties first will have continuous benefits. Many participants expressed homes need upgrading foremost for people. As such, knowledge should also be gathered from local workers [29] who understand local dynamics. For example, local construction companies, social organisations, and resident liaison workers with shared cultures or languages present on site. Participants who value social community building organised events, discussion platforms, and outreach regarding energy saving information. Social housing retrofit should be ethical and not diminish quality of life by exacerbating fuel poverty. Added social value is beginning to become a funding requirement, with frameworks such as the HACT social value toolkit [47], and is a mandatory obligation in some construction contracts. But it is crucial to implement long-term social value. For instance, upskilling existing residents improves quality of life but also addresses labour shortages.

Residents' choices should utilise their unique expertise [25-30] to design sustainable environments that balance residents, housing, and energy needs. The scale of residents' choice can vary but residents enjoyed choosing interiors—in contrast to exhausting and disruptive construction processes. Residents' needs and priorities are often individual, but engagement aims to shift this mentality to the communal good. The aim is a reduction in climate change alongside local social value, forming connections through shared spaces [29] and raising collective responsibility. Facilitating design choices and bottom-up decision-making can help ensure long-term success and relationships with building owners, who maintain management and maintenance responsibilities.

# 5. Limitations

The research is concerned with views of HAs and architects, while no Local Authority interviews were included after applying the inclusion criteria. A typical issue found that Local Authorities are simply behind Housing Associations in terms of completion and have no feedback. This makes data difficult to obtain. As HAs operate in the third sector, it is unknown if decision-making processes are the same in publicly owned social housing.

Interviewing via the Teams application could have affected the inter-personal relationship between interviewer and interviewee, limiting the rapport and openness of communication compared to in-person interviews. However, Teams did allow for interviews with stakeholders in many European contexts, enriching the findings. While results are heavily weighted to Northern European countries, this could indicate that Northern Europe has more experience in social housing retrofit compared to Southern Europe. As Europe experiences increasing heat waves and flooding, the results do not explore how the unpredictability of climate change may be a greater or lesser preoccupation for stakeholders in different states. Further research could investigate the same themes from exclusively Southern European climates, where greater exposure to heat waves may create different retrofit priorities and approaches among social housing stakeholders.

Finally, while the five overarching themes aimed to provide comprehensive insights, a more in-depth analysis of each individual theme may have yielded additional nuances or subthemes that were not fully explored within the scope of this study.

# 6. Conclusions

Retrofitting social housing is key in achieving ambitious climate goals. Retrofit strategies should not only aim to enhance energy efficiency but also to address social, environmental, and economic concerns. Despite the emphasis on retrofit technologies, performance gaps and neglecting passive design remain concerns. Social housing residents value NEBs more than energy improvements and the literature emphasises the need for residents as retrofit stakeholders to ensure fairness, equity, and meet social needs. A thematic analysis was performed with the results of semi-structured interviews with 15 participants, to answer the research question: *"How do stakeholders (not)utilise residents' situated knowledge and expertise in retrofit design?".* The aim of this investigation was to understand from HA and Architects engaged in social housing retrofit, where the best opportunities for integrated retrofit processes lie.

A thematic analysis led to the following key points: (1) funding should be allocated for consistent long-term engagement, reducing overall costs, performance gaps, and conflict, while raising empowerment and mental and physical health. (2) Decanting support should extend to returning. (3) Design should become a conduit for sustainable solutions rooted in traditional passive design to evolving climates and technological innovation. (4) Embedding trust building between owners and residents into building management will streamline retrofit processes. (5) Better use of POE and informal stakeholder events to identify project learnings for new retrofit iterations. (6) A balance must be struck between quantitative energy performance and meeting residents' social needs. The socio-economic status of existing residents can be raised alongside forming neighbourhood communities.

The results outline three key components to sustainable retrofit. (1) *Architects and design-thinking.* Design-thinking in retrofit encourages collaborative practices that integrate the needs of social housing residents by valuing passive design strategies such as daylight and passive ventilation, cohesive spatial configuration, and modernity. (2) *Retrofit technologies should complement passive design.* Retrofit technologies and innovation can increase energy solutions and green jobs, combating shortages in skills, labour, and supplies. Retrofit technologies are, however, rapidly advancing. These technologies are frequently tested on social housing retrofit projects. Technological obsolescence also presents a problem; it means that as technologies become redundant new technologies replace them. At the same time, the already-installed technologies require continual maintenance. A nuanced approach to retrofit should see technologies complement rather than replace passive design. Passive design offers a stable foundation for long-term energy performance. (3) *Resident expertise can balance building needs, energy needs, and social needs.* When integrated communication and engagement utilises residents' expertise and knowledge in retrofit design, building retrofit is more easily accepted by residents, residents' actual rather than perceived needs can be met, and trust between stakeholders solidifies. In this way, residents can better engage with the design and use of both passive solutions and technologies, reducing energy consumption and increasing holistic sustainability.

Hybrid decision-making can facilitate retrofit with these three key components and bridge expert stakeholders' technical and social specialisations. These findings can be generalised to the wider retrofit sector by replacing the third component—resident expertise—with occupiers' expertise. This would permeate decision-making with the situated knowledge of building users, such as workers and maintenance staff in retrofitting office buildings. Further, findings can be generalised to publicly owned social housing, which are also occupied by marginalised groups of residents. Despite the majority of the interviews occurring with Northern European stakeholders, findings can be generalised to existing warmer climates, and indeed shifting and unpredictable climate change in Northern Europe, because the process of including the three retrofit components remains, regardless of the resulting design. While the scale of hybrid decision-making has been highlighted between options and iterations, further research should investigate the internal governance of integrated retrofit processes, leading to standardised procedural practices and increasing efficiency in retrofit decision-making.

# 6. Funding

*Removed for anonymity*

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