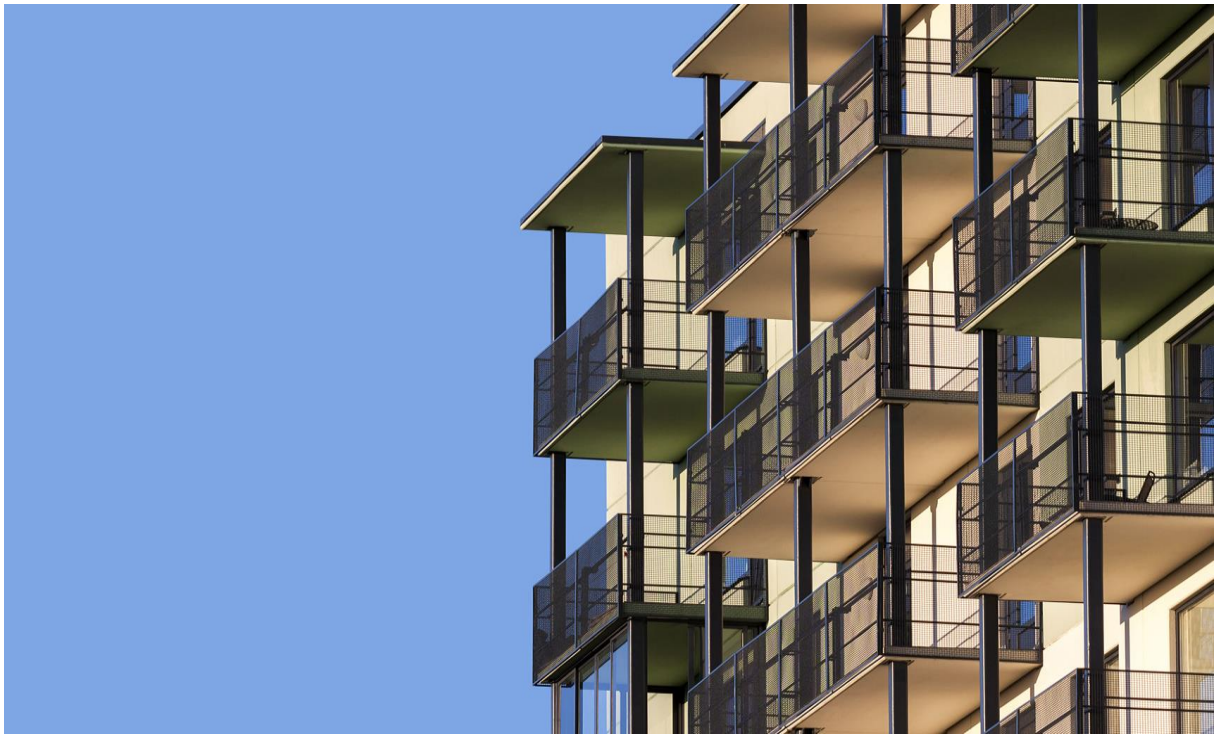
BuildHeat

D5.2 - Managing Human Factors in Retrofit Projects



Standardised approaches and products for the systemic retrofit of residential BUILDings, focusing on HEATing and cooling consumption attenuations

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1 Introduction

The BuildHeat Project investigates and trials a set of reliable, energy-efficient and affordable retrofit solutions for multiple-occupancy residential buildings. The project case study sites are in Rome, Zaragoza and Salford, Greater Manchester. Central to understanding the role of these solutions is a consideration of human factors: the experiences of residents in relation to heating and cooling, and the impact of retrofit measures upon their comfort, health and practices.

This report discusses the effective management of human factors during retrofit projects and is based on a number of assumptions that underpin the approach.

- Successful retrofit needs to be "human-centred" in terms of its design delivery and use. Evidence suggests that poor understanding of human factors can lead to the failure of retrofit projects in terms of the delivery or their long-term performance against their desired objectives.[1] [2]
- This potential project failure could be considered *human-centred project risk*. As such it needs to be identified and actions are taken to manage and mitigate it.[3]

This report is designed to address the following issues;

- Identification of issues highlighted through literature to provide an evidential base for the approach.
- Understanding the stages of a retrofit project as experienced by the delivery team within the context of user engagement.
- Identify potential occupant risks and issues that might occur at each stage.
- Identify current best practice in supporting the effective design, delivery and ongoing use of retrofit projects.
- Categorise and discuss examples of different types of intervention.
- Identify how these approaches have been applied within the case studies in the BuildHeat Project.

[1] Brown, P., Swan, W. and Chahal, S., 2014. Retrofitting social housing: reflections by tenants on adopting and living with retrofit technology. *Energy Efficiency*, *7*(4), pp.641-653.

[2] Seligman, C., Darley, J.M. and Becker, L.J., 1978. Behavioral approaches to residential energy conservation. *Energy and buildings*, *1*(3), pp.325-337.

[3] Swan, W., Fitton, R. and Brown, P., 2013. Managing behavioral risks in large scale social housing sustainable retrofit projects in the UK. In *ECEEE Summer Study Proceedings* (pp. 661-668).

2 Literature Review

The literature on the issues of human factors as applied to retrofit, energy and housing is extensive. This project is very much focused on practical application, so the literature review has been designed to focus on the issues of human factors as they may be experienced by the delivery teams.

2.1 Rationale for Retrofit

Retrofit, in the context of this report, relates to physical changes to a property's energy performance and includes improvements to:

- Fabric (e.g. loft, cavity and solid wall insulation)
- Systems (e.g. central heating, ventilation systems, on-site renewables)
- Appliances (e.g. energy-efficient lighting and household goods)
- Feedback systems (e.g. smart meters and energy monitors)
- Controls (e.g. programmers, thermostats)[4]

Retrofit in the EU has been driven by a series of policy objectives; carbon dioxide emissions, fuel poverty and energy security. Across the EU, heating and cooling the built environment accounts for 36% of CO_2 equivalent emissions and 40%[5] of energy consumption. Whilst new build housing has an important role to play in mitigating overall emissions and providing positive examples of sustainable low-energy approaches, retrofit continues to have a vital role. To use the UK as an example, given that 70% of the building stock existing in 2010 can be expected to still be in use in 2050, strict low-carbon standards for new build cannot in themselves meet substantial carbon reduction ambitions for the building stock as a whole and retrofitting the current stock is an essential part of a mitigation strategy[6].

The issue of fuel poverty, or energy vulnerability, has been subject to increasing interest not only in the UK and Ireland, initially the focus of much of the research but across the EU and internationally. Different countries have different challenges with poverty potentially being a bigger driver than external environments. As noted by the Eurostat data northern European

[4] Swan, W., Ruddock, L., Smith, L. and Fitton, R., 2013. Adoption of sustainable retrofit in UK social housing. *Structural Survey*, *31*(3), pp.181-193.

[5] EU Commission (2018) European Commission – Energy, https://ec.europa.eu/energy/en/topics/ energy-efficiency/buildings , Last Visited 12/09/18

[6] Kelly, M.J., 2009. Retrofitting the existing UK building stock. *Building Research & Information*, *37*(2), pp.196-200.

countries such as Sweden and Finland, suffered far lower incidences of fuel poverty than countries such as Portugal and Greece.[7]

Ultimately, fuel poverty is a condition whereby householders cannot afford to adequately heat or cool their homes as a result of a combination of financial stress, ineffective technologies, or poorly performing building stock. Even when people are able to cover their energy bills this can often be at the expense of other aspects of the household budgets, whether food, school uniforms, or family and social life. Fuel poverty can therefore have substantial impacts upon physical health as well as mental wellbeing. With the fuel-poor disproportionately likely to live in energy-inefficient homes and lack the capital to move or invest in the fabric of their homes and support for retrofit is therefore particularly important.[8]

In the context of growing interest in managing network capacity and balancing peak loads, retrofit also has an important role to play in helping to limit overall energy consumption and reduce the differential between heating periods and the rest of the year.

Whilst these are the societal and policy drivers, it should be added that for the individual householder the motivation for retrofit could be as simple as creating or enhancing comfort or taking advantage of cost savings at a particularly opportune moment such as when other major repairs and renovations are being carried out.

These policies have filtered down into member states and led to the development of retrofit programmes, whether EU funded, such as ERDF or H2020 projects, or supported through individual mechanisms such as loans (Germany, UK) or supplier obligations. The success or failure of many programmes can be understood in the context of how effectively they have responded to consumer need[9].

Understanding why consumers might engage with retrofit is an important step in having them engage with a retrofit project.

Different types of consumer. Householders represent a range of characteristics[10] and situations and these can have implications for approaching retrofit. As we discuss below, it is important to understand:

- The impact of tenure on their retrofit choices and experiences. Whether they are in socially-rented, privately-rented or owner-occupied accommodation has an impact on the options available them.

Special requirements and vulnerabilities. Householders may have physical or mental conditions that mean they will benefit greatly from retrofit but at the same time, these conditions

[7] Thomson, H. and Snell, C., 2013. Quantifying the prevalence of fuel poverty across the European Union. *Energy Policy*, *52*, pp.563-572.

[8] Boardman, B., 2012. Fuel poverty synthesis: Lessons learnt, actions needed. *Energy Policy*, *49*, pp.143-148.

[9] Murphy, L., 2013. Retrofitting existing dwellings: Lessons from the policy instruments of front-runners. *Retrofitting the Built Environment*, pp.81-95.

[10] Haines, V. and Mitchell, V., 2014. A persona-based approach to domestic energy retrofit. *Building Research & Information*, *42*(4), pp.462-476.

may make them more vulnerable to noise and other disruption during the retrofit process. They may have access requirements that need to be taken into consideration during construction and, potentially, decanting. Family composition, caring responsibilities, and shift working arrangements may also affect the extent to which households can cope with disruption and uncertainty.

- What is driving a householder[10], or landlord[4], to engage in retrofit will have a bearing on how much they are prepared to pay, what sort of payback period they will accept, and how much disruption they will put up. It will also affect their choices of approach or technology: for example, is the priority saving money, reducing emissions, or being comfortable.

Understanding these issues and which drivers need to be responded to is an essential first step in addressing these risks.

2.2 Resident Engagement

The importance placed on resident engagement reflects the notion that not only is it important to understand the requirements, practices, vulnerabilities and sensitivities[1] of householders undergoing retrofit, but also that in order to understand these it is desirable to consult directly with residents[11]. A further reason importance is placed upon resident engagement is that involvement throughout the retrofit process, and input into planning and design can help to increase buy-in and therefore improve outcomes once the retrofit home is in use.

Talking to or otherwise consulting with residents will help those planning retrofit to begin a discussion on how householders currently use their homes and what comfort practices they deploy and to understand how the retrofit process might affect them[3]. This may entail, for example, identifying vulnerabilities and particular requirements. In the post-retrofit in-use phase there are then opportunities to talk about how to get the best out of the retrofitted home including realising the benefits they want whether reducing carbon emissions, improving comfort, or saving money.

2.3 User Centred Delivery

The concept of user centred delivery of retrofit is concerned with the consideration of the domestic retrofit project as a service that is being delivered to an occupant rather than a technical solution to an issue of energy consumption. Energy-efficient retrofit should be considered as a sociotechnical problem[12],[13]. Energy consumption in the built environment is a

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[11] Jansson-Boyd, C.V., Robison, R.A., Cloherty, R. and Jimenez-Bescos, C., 2017. Complementing retrofit with engagement: exploring energy consumption with social housing tenants. *International Journal of Energy Research*, *41*(8), pp.1150-1163.

[12] Swan, W., 2013. Retrofit innovation in the UK social housing sector: a socio-technical perspective. *Retrofitting the Built Environment*, pp.36-52.

[13] Tweed, C., 2013. Socio-technical issues in dwelling retrofit. *Building Research & Information*, *41*(5), pp.551-562.

complex interaction between external environments, fabric, systems, controls, and building occupants. An understanding of building occupants is central to the effective delivery of retrofit.

If we are to consider the issues of adoption of retrofit, we need to consider what the drivers may be for specific individuals to make the decision to adopt. Different individuals will have different views as to why they should engage with retrofit. Some examples may be:

- Economic – engaging with retrofit to reduce energy consumption.
- Comfort and Health – engaging with retrofit to improve the comfort of the home or to relieve symptoms of chronic illnesses.[14]
- Values – engaging with retrofit for environmental reasons such as climate change[15].
- Aesthetics – engaging with retrofit to improve the physical or design quality of the home.[16]
- Life stage – certain trigger points may lead to home improvements, such as the presence of young children.[10]

While the decision to adopt retrofit is important, the occupant can also be important in driving the nature of the retrofit, such as the different technological choices made, and the way in which retrofit is delivered[1]. Some examples of this might be:

- Avoiding highly technical solutions with individuals who are not engaged with digital technology.
- Ensuring that controls or systems can be used by people who may have disabilities.
- Recognising how to support vulnerable occupants during disruptive retrofit works.

User centred retrofit will recognise the current practices of individuals when considering changes to heating and ventilation. Many comfort-seeking practices are deeply engrained and major changes to heating and ventilation systems need to reflect that these may influence how the occupant engages with new technology. If a major change in these practices is required, handover and ongoing support (see 2.4 and 2.5) will need to be considered.

The second issue to consider is the issue of the delivery of retrofit. Understanding risks such as language barriers, health or other needs is essential if retrofit is to be effectively delivered.

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[14] Howden-Chapman, P., Crane, J., Matheson, A., Viggers, H., Cunningham, M., Blakely, T., O'Dea, D., Cunningham, C., Woodward, A., Saville-Smith, K. and Baker, M., 2005. Retrofitting houses with insulation to reduce health inequalities: aims and methods of a clustered, randomised community-based trial. *Social science & medicine*, *61*(12), pp.2600-2610.

[15] Fink, H.S., 2011. Promoting behavioral change towards lower energy consumption in the building sector. *Innovation: The European Journal of Social Science Research*, *24*(1-2), pp.7-26.

[16] Sherriff, G.A. and Swan, W., 2016. Greater Manchester green deal communities programme scheme exit paper.

Issues such as clearing possessions for access, decanting to properties while work is done or where work is done in situ need to take account of the fact that a single solution for occupants is rarely appropriate. These issues range from the language and mode of communications, to practical issues such as limited mobility. Evidence suggests that those delivery teams that take account of these issues have smoother delivery and are therefore less liable to resistance from occupants, with the associated delays and project management issues that can arise[3].

2.4 In Use Issues

There is significant literature of the Jevons Paradox, or 'take back effect' of energy efficiency improvements[17]. This can mean that intended energy savings are not achieved, however this should be balanced against situations where occupants have moved from unhealthy to healthy internal environments, as under heating properties is associated with a wide range of health conditions[18].

One of the most significant issues with retrofit is the change in the way a property's heating is controlled. Research suggests that this can create significant problems from occupants, and they are often left with no long-term support. In the absence of more formal structured handover procedures, they will rely on informal advice from friends or family, or use the system in a way that meets their needs but may be suboptimal in terms of energy efficiency[1].

Research from the wider construction literature indicates that handover processes are essential for the effective operation of energy-efficient buildings. Some of these processes, such as Soft Landings[19], advocate a period of post-occupancy evaluation[20]. This may be valuable in providing long-term support to customers, as well as evaluating new technologies which may be new to the market.

2.5 Long Term Effectiveness of Retrofit

Any retrofit will generate its benefits over a long period. Many products have 20-year life spans in which savings are made. However, there are a number of issues that need to be addressed if long-term benefits are to be maintained[21]. A major issue is maintenance – fabric improvements and heating systems may require maintenance to ensure that they continue

[17] Galvin, R., 2014. Making the 'rebound effect' more useful for performance evaluation of thermal retrofits of existing homes: defining the 'energy savings deficit' and the 'energy performance gap'. *Energy and buildings*, *69*, pp.515-524.

[18] Liddell, C. and Morris, C., 2010. Fuel poverty and human health: a review of recent evidence. *Energy policy*, *38*(6), pp.2987-2997

[19] Way, M. and Bordass, W., 2009. *The soft landings framework: for better briefing, design, handover and building performance in-use*. BSRIA.

[20] Gupta, R., Gregg, M., Passmore, S. and Stevens, G., 2015. Intent and outcomes from the Retrofit for the Future programme: key lessons. *Building Research & Information*, *43*(4), pp.435-451.

[21] Hens, H., 2010. Energy efficient retrofit of an end of the row house: confronting predictions with long-term measurements. *Energy and buildings*, *42*(10), pp.1939-1947.

performing. Poorly maintained insulation may allow water access, which can damage their performance, while poorly maintained heating systems will reduce in efficiency over time. There is a consideration that technologies should be robust where maintenance is unlikely to be frequent.

Many properties will change hands over time. Properties that have active energy efficiency may prove problematic. There are examples of individual taking high performing homes and adding heating systems that are not technically required due to the difficulty of selling a property, or because they are unaware of the performance of their property and are upgrading unnecessarily.

3 Road-mapping Occupant Engagement

3.1 Human Factors Risk Management

The purpose of the management of human factors in retrofit projects is designed to ensure that the outcomes are effective for the different stakeholders either directly within the project, or those more widely impacted such as policymakers or funders. Ultimately, this approach is focused on generating positive outcomes for the project for a wide variety of stakeholders. Here we focus on issues specifically related to occupants. However, in many cases lack of effective management of the human factors, risks will lead to wider project failure.

In the development of the roadmap of occupant engagement there are 3 phases of project delivery where there are opportunities to engage with residents. While the whole path will have a number of interconnections, these three phases have been identified as delivering different categories of intervention.

- Pre-construction
- Construction
- Handover and Post-Occupancy

It should be noted that during each of these stages, interventions are also influenced by a range of other project factors such as the technology selected, capacity of the delivery team and individual resident needs.

3.2 Baselining

The baseline assessment is designed to assess the scale of the retrofit challenge and identify your organisation's initial starting point. The assessment will ensure you have a clear idea of your aims. It will also help your organisation plan activity that will facilitate effective resident engagement and maximise take-up of measures. The answers given will help to inform your baseline assessment report which will:

- Outline the issues and challenges you want to address
- Highlight gaps in your approach
- Identify potential people risks relating to take-up, installation and in-use
- Identify possible interventions
- Provide further recommendations
- Make any necessary changes

In addition, this assessment aims to ensure that appropriate policies and procedures are in place before commencing a project. There are three elements that need to be considered

- Baselining the project
- Baselining the delivery team
- Baselining the occupants

3.3 Baselining the Project

An initial step is to fully understand the project that is being delivered and the wider context. The baselining of the project may include some of the following issues;

Project Description and Objectives – this will allow the delivery team to understand what needs to be achieved at the very highest level. It is likely the project will have an overall objective which, allowing for occupant needs, will need to be understood and delivered.

Target Beneficiaries and Stakeholders – this does include occupants but may look more widely in terms of funders, local policymakers, and community groups. It is important that those impacted by the project are assessed within a stakeholder analysis exercise.

Timescales and Phasing – this is important as any engagement or interventions with occupants will have to be planned into the main project plan.

Budgeting – while the main budget of the project should be considered, it important to understand that occupant engagement will also have to be embedded within the budget. This may include costs associated with the production of written and digital materials, ongoing communication with residents, the delivery team for the training of staff, and separate workshops for occupants. Budget and staff time therefore needs to be allocated and consideration should be given to whether it will be necessary to appoint a specific householder liaison person or whether this role can be ring-fenced in an existing role.

The goal of this process is to ensure that the issue of occupant experience and behaviour is embedded within project processes and appropriately budgeted.

3.3.1 Baselining the Delivery Team

The delivery team should be baselined as this will also determine what is appropriate to deliver. If there are no basic systems and limited skills to address occupant engagement, it is possible that the skills may potentially have to be brought in, or that training needs may be identified. The key issues to identify are:

Existing skills and experience – is there strong experience of working with occupants? What types of interventions have been undertaken and what past successes and failures have there been?

Existing policies and processes – what management systems are in place to manage the process. Is there a clear understanding of risks and issues in delivering occupant engagement such as data protection or occupant and worker safety? Is householder engagement recognised at senior management levels; for example, is it a standing item on the delivery teams agenda?

Available resource – what staff-time and other resource is available to bring to the project.

Understanding what the delivery team can bring and how they might be able to manage the project helps the team make decisions as to what a programme might look like. A team that has limited experience may take the opportunity to build a basic process to manage the issues, while a more experienced team may look to innovate in respect of the interventions it chooses to develop and apply.

3.3.2 Baselining Occupants

Understanding occupants is an essential part of the process. The nature of the occupants, their specific needs and their context all shape the possible interventions that should or should not be applied in certain cases. It should be noted that these issues can also shape the project delivery, and in some cases, the technology that is delivered.

Tenure - Whether they are in socially-rented, privately-rented or owner-occupied accommodation has an impact on the options available to householders and the ways in which they experience retrofit. The issue of tenure also shapes the contractual relationships, and this will shape issues of communication, including redress if things go wrong during the project: will the project, for example, deal directly with the householder or with a private or social landlord?

Owner-occupiers will have their own money invested in the property and most likely in some if not all of the retrofit. They will likely have been closely involved in planning and designer the improvements and have the final say over the work. The extent to which social tenants have been involved in planning and design will vary by project and organisation but can be minimal. Tenants may feel that improvements are being 'done to them' and this can have an influence on the ways in which they engage with contractors as well as the extent they get the full benefits of the new system. Where tenants have had a problematic relationship with their housing provider – rent arrears or anti-social behaviour, for example – this may affect their perception of the retrofit organisation and contractors since they are seen to be acting on the housing provider's behalf. On the other hand, social housing providers are often able to provide mechanisms to effectively engage with tenants through, for example, tenants' and residents' groups and community liaison officers. Tenants who rent from private landlords may feel less involved than social tenants and owner-occupiers: they are likely to have little say over the upkeep of their home and not enjoy the more transparent relationship with their landlord that many social housing providers are able to offer.

Language and Culture – it is often an assumption that individuals will speak the local language, but repeated retrofit projects have proved this not to be the case. Understanding language needs is important, as are any cultural issues that may shape interventions. Levels of literacy are also a consideration and mean that reliance on written materials is unlikely to be sufficient.

Vulnerability – any work with individuals who may have special needs should be approached carefully and with sound preparation. Households may require specific plans for working with them depending on the nature of the retrofit and the occupant. Any project where teams are in the property for extended periods of time will require a sensitive approach and it may be necessary to provide temporary homes – referred to as decanting – to tenants. Social housing providers will often have good information relating to the vulnerability of tenants and approaches that are likely to be appropriate. It is worth noting that physical, mental and financial vulnerabilities are increasingly evident in the private rented sector where support mechanisms are unlikely to be well-established.

Age – Understanding the age composition of the household may assist in the anticipation of vulnerabilities. Older people may have health issues that make them particularly vulnerable to the disruption of the retrofit process and they may have difficulties accessing information online. People of all ages, and older people, in particular, may be cared for by other adults and

it will be important to liaise with their carers to assess the need to preventative measures such as decanting or the provision of respite space. At the other end of the spectrum, families or individuals with children at home will have other requirements and be particularly concerned about the impacts of retrofit on their children's sleep, health and educational attainment. Whilst it is important to emphasise that retrofit will bring benefits in terms of health and financial saving to older and younger people, it is also important to ensure that they are comfortable with the retrofit process and that they are protected from its impacts.

Digital divide – there is often an assumption that people have the same access to digital services. Retrofit projects may rely on digital services for interventions such as feedback or control. However, it is important to ensure that people are not excluded from key services due to their lack of digital access, which may be related to ability or the costs of technology and connectivity. Those technologies that may be heavily reliant on wireless broadband might therefore not be appropriate in all cases.

3.4 Risk Identification

Risk management generally starts with risk identification. While baselining can help by providing the context, the detailed risk management for human factors should be considered in terms of the process stages.

3.4.1 Pre-Retrofit Risks

The specific nature of pre-retrofit risks is often driven by tenure. Where there is a separate asset owner, such as in social housing, pre-retrofit risks are largely shaped by the business case and broader acceptability issues amongst the residents, who may be obstructive if not properly engaged, although ultimately, the landlord may have rights of access, dependent on the specific legal context within each country. However, where there is a private householder, the decision to invest may be more complex, with issues such as life stage, aesthetics and comfort taking far greater precedence and a central to the decision to adopt or reject a retrofit offer. This complexity is further exacerbated in multiple occupancy dwellings where multiple independent decision-makers are required to act in concert.

Some of the key issues that need to be addressed during pre-retrofit are:

- What benefit is being sold? As highlighted earlier, different occupants will require to be sold different aspects of retrofit in order for them to effectively engage. Understanding the drivers for different occupants is an issue that can be addressed in the baselining studies. Research has indicated that issues as diverse as comfort, health, financial savings, aesthetics and asset value can all influence the decision-making process.
- Trust between the occupant and delivery partners. One of the main barriers of many home improvement works is the lack of trust between the occupant and the delivery partners. This can be an issue in social housing but is a major issue in the private sector. In some cases, where large retrofit programmes have been undertaken, local authorities have used their brand to support private sector companies, such as energy companies, to deliver retrofit in an area.

- Funding and financing issues. This can be a major barrier for individuals in the private sector, as “deep” retrofit can often be expensive. Programmes such as the Green Deal in the UK failed partially due to the cost of finance, while more successful models generally used low or zero interest rate approaches, such as Germany’s KfW programme.
- Decision barriers are barriers which may limit an occupants’ ability to make the decision to retrofit. This may be a lack of awareness around the issues or apathy around the potential disruption they may perceive that is involved. This will lead to a decision not being made in favour of the status quo.
- Lack of knowledge and understanding may be viewed as a resident addressing their own risk. This is particularly true with new heating systems or controls that may work differently from their current systems. Residents may reject these new options as they worry they may not understand how to use the new systems. There have also been issues of residents not understanding what they currently have installed in their properties, which can influence whether to retrofit or not. This can be particularly true of insulation or other non-visible improvements and residents may reject an offer thinking they already have it.
- Resistance to change is common among certain households who may not want to adopt a new approach within their home. This is particularly true where improvements are installed on a rented asset. A new technology that is not understood and has not been selected by the occupant can create a level of resistance in terms of accepting the new technology as an improvement.

3.4.2 Delivery Risks

While there are a series of technical risks in delivery that can influence the performance of the retrofit, the human factors are often more specifically concerned with the management of the delivery process. If residents are not well managed or communicated with, they can become uncooperative and make the smooth delivery of the project difficult.

- Access refusal can be a major risk is social housing programmes. While, ultimately, access can be gained, it can add to the cost of a project and prevent the retrofit works from being undertaken in an efficient manner. The baselining phase of the study should highlight these risks and a plan to address this put in place. This may become an issue in private projects where communication is poor and the occupant is not clear when access should be provided.
- Practical barriers such as clearing storage spaces to allow work to take place may need to be undertaken by the delivery team to allow clear access to install retrofit. In some cases, an occupant may not be able to clear the space, and this may require support.
- Occupant cannot remain on site. It may be that an occupant cannot remain in the property during the retrofit. This is particularly true of elderly, disabled or vulnerable people, such as young children. This needs to be identified in the baselining element of the study and project planning needs to be put in place to manage this risk.
- Conflict with delivery teams. Any level of major construction works can be stressful, as the work is carried out in people’s homes, which they view as “defensible space”. Issues such as poor workmanship, untidy working space or rudeness will lead to conflicts. There is

also the potential risk of more serious issues; delivery teams should make sure that both the delivery team and the occupant are protected from serious assault, or accusations of assault, through approaches such as vetting procedures and lone worker policies.

- Locus of decision making and contractual power. Where an occupant has paid the workers there is more power in the hands of the occupant to make decisions with the delivery team. This is less true in social housing, so it is important that the resident is not left feeling powerless in their own home. How conflict is managed can have a major impact on project delivery in the residential sector.

3.4.3 Handover and Post-Occupancy

The outcomes of an energy efficient retrofit are generated in the post-occupancy phase. There is significant detriment to the outcomes of the project if the improvements are poorly specified or installed. This is equally true if they are incorrectly used by the occupant. Many improvements may be considered “passive”, where the occupant does not need to intervene to gain the benefit, but this does not take into account the systemic nature of domestic energy consumption. Even insulation can be rendered less effective by window and door opening behaviours.

- Comfort taking – if the desired outcomes for our retrofit project is the reduction of energy consumption or reduction of carbon emissions, then the issue of comfort taking or Jevons Paradox, needs to be considered. By making a property more energy-efficient, we are essentially making energy “cheaper”, by allowing an occupant to achieve the same outcomes for less money. They may decide to improve their comfort levels and use more energy, meaning efficiency savings are not achieved. This should be viewed in the context as to whether previous comfort levels might be considered acceptable.
- Understanding how to use the property can be a major issue. Handover and ongoing support are not only an issue in retrofit but is also an issue in the wider construction industry. New systems of heating and control can create major issues. A common issue is the change of heating systems and controls. The transition from high-grade heating such as a gas-fired boiler to a lower grade of heating, such as a heat pump, will require different approaches to heating the home. A failure to communicate this could lead to the user applying previous approaches to the new system, therefore using it in a way that is was not designed to do. This leads to a lack of performance, which is usually blamed on the technology.
- Access to information and support can be a major barrier. While initial handover may be robust, it is often that ongoing support may be required. A lack of access to ongoing support may lead to individuals relying on less effective “fixes” to resolve their immediate problem. However, these fixes may often lead to suboptimal performance of the home.

4 Understanding Interventions

In section 3 we identified the potential risks that may arise during a domestic retrofit project. This section is focused on the following elements;

- Defining and understanding what we mean by an intervention.
- Identifying types of intervention and the relationship of multiple interventions.
- Identifying specific examples of interventions and supporting management and evaluation process.

4.1 Understanding Interventions

An intervention, in the case of this report, is defined as any action that is undertaken to change the decision making or behaviour of an occupant in order to increase the adoption, delivery and effective use of energy-efficient retrofits. Each stage is related to the previous stage, so the process should be considered in the whole. However, the main aspects are listed here.

At **pre-installation stage**, interventions should ensure that residents understand why retrofit is taking place and that they accept retrofit.

At **delivery stage**, interventions should ensure that residents accept retrofit and are able to make use of the newly retrofitted building and the technologies within it, enjoying the benefits whether in terms of financial savings or increased comfort.

At the **in-use**, or post-delivery stage, interventions should ensure that residents are able to continue to make effective use of the retrofitted building and the technologies within it and that residents promote retrofit amongst neighbours, friends and family.

In summary, the anticipated outcomes are that

- residents understand why you are retrofitting;
- resident accept retrofit;
- residents use retrofit;
- residents promote retrofit;

Interventions do not always fit neatly into one category. However, the categories below provide a useful starting point. This indicates where interventions might sit under the following categories:

- Resident awareness
- Residents knowledge
- Resident acceptance
- Resident benefiting and sustaining
- Management processes

- Monitoring and evaluation

4.2 Intervention Examples

4.2.1 Resident Awareness

Resident awareness is the first stage of engaging residents, where basic information around the process and potential benefits of a proposed retrofit is shared.

Documentation

Documentation is a 'passive' but important form of engagement and provides a way to ensure that householders have the information they need to understand the retrofit process and make related decisions. It may include letters, briefings, and newsletters and can be distributed directly to participating householders or to community centres, communal areas and facilities such as health care facilities. The approach can also be used as a prompt or reminder (which may vary by season and stage of retrofit) on how to get the best out of new features such as heating controls.

It may be combined with messaging around energy saving as also provide evidence of the results of participation and impact. When creating documenting and planning dissemination, it is important to consider factors gathered during baselining including language, levels of literacy and the level of technical knowledge and engagement in decision-making that can be expected of householders: the latter will relate closely to tenure.

Multimedia

Video and online content can help to provide information in a creative and engaging format, and householders can return to it periodically to remind themselves of important information. Fun and engaging material can be actively shared between participating householders to create a community around retrofit. Visual presentation can be understood more easily by many people, especially in areas where literacy is low, and subtitles can be used for translation and accessibility.

Material can help to explain the retrofit process, manage expectation during delivery, and to provide guidance on how to make the most of living in a retrofitted property. Multimedia can be used in combination with other methods, for example as part of a visit by a community advisor. Access to the internet may be a consideration and it may be useful to have some copies of the material available on digital media such as DVD or make resources available in communal areas. Internet access may be particularly problematic for older people and it may be beneficial to arrange screenings and information sharing at community events.

4.3 Resident Knowledge

Knowledge is related to awareness: there are times when residents will want to find out more about retrofit and seek advice specific to their situation.

Home visits

Home visits can be carried out at each stage of retrofit and provide an opportunity for face-to-face communication and for householders to ask questions about all aspects of retrofit. It is particularly useful for staff to be able to discuss issues in the home where they can see first-hand any problems that are arising from retrofit and anticipate any complications. It is also often beneficial for the householder to discuss the issues in situ: the home visitor can for example provide advice whilst demonstrating how to use particularly heating and cooling technologies.

Home visits can also help to build a relationship of trust with residents, although it is vital that home visits are only carried if they are comfortable with the approach and at a time convenient for them, and that appointments are arranged in advance. It is important to be sensitive to cultural expectations relating to entering others' homes and it will be necessary to take differences in residents' lifestyles and household composition when talking about issues in the home into account.

Community open days

Community open days bring together community at a familiar location and provide residents with the opportunity to gain information, find out what is involved in retrofit and how it will benefit them. It may also provide opportunities for residents to make or contribute to decision-making, from colour of render to type of technology. Organising a community open day will take careful planning and preparation, including consideration of the target audience, the appropriate venue, and a suitable date and time. It will likely be beneficial to involve any stakeholders and it is important to ensure they are well briefed and understand the importance and purpose of the event. There are advantages to linking the session with other events and open days to reach a wider audience. In the later stages of retrofit, however, it may that the event is relevant only to those who have taken part in the retrofit process.

Focus Groups

Focus groups are a process of dialogue often focused on a particular set of questions and aiming to seek views, understand concerns, generate ideas and influence projects. At certain stages in retrofit, it will be useful to canvas opinion from householders and stakeholders and potentially mediate contrasting viewpoints. A focus group works best when there is a clear purpose and focus and is led by a skilled moderator who can provide structure to the discussion whilst not influencing it. Related approaches include panels and forums, whilst individual interviews can also be useful; these, however, are more time consuming and may not be as effective a way of balancing different viewpoints. Written, visual and multimedia materials can be used in the groups to provide information and talking points.

Physical product demonstrations

Physical product demonstrations offer a 'touch and feel' experience for residents and an opportunity to see how products work and to ask advice from experts. Residents can see first-hand how retrofit can work through factors such as the feeling of warmth and comfort in rooms. Seeing and experiencing such factors can help to normalise technologies and reduce the 'fear factor' whilst increasing confidence and trust. As in the case of community meetings, it is important to carefully consider timing and location and to potentially offer several different opportunities at different times of the day and in different residential hubs. Parking and accessibility by foot, cycle, public transport will be an important consideration. Demonstrations can be incorporated into other events, such as community open days. The demonstrations need not only be given by staff and 'experts': householders often become 'champions' for technologies and approaches and can be very effective at convincing other residents about the benefits.

Retrofit design workshops

Design workshops provide an opportunity for residents to feed in their own thoughts and discuss design issues during the planning stages. Residents themselves are a vital source of information and bring with them the experience of living in their homes and their communities. They will likely have thought about potential improvements. Facilitating participation can bring genuine improvements to the design of projects and boost residents' acceptance of, and commitment to retrofit. As mentioned above, when organising any events, it is important carefully consider timing, location and accessibility and as well as ensuring that those most vulnerable are able to participate. Careful consideration should also be given to how residents are involved, and it may be beneficial to nominate resident representatives from existing community groups. It is important to be clear and transparent on the scope of the meetings and the extent to which residents can make contributions to the designs and be honest about the way budgetary and regulatory constraints, as well as existing design criteria, may limit the extent to which residents' ideas can be taken on board whilst also identifying aspects of the project with which they can creatively engage.

4.4 Resident Acceptance

Resident acceptance entails residents understanding the purpose of retrofit and being aware of and comfortable with the changes that will be made and the process that will be followed.

Incentives and disincentives

Incentives and disincentives can be used to reward people for specific actions and discourage others. They are often financial, including cash and vouchers, but can also include offers such as access to training courses, decorating and other home improvements, or energy-efficient products. This approach is best used when residents are unlikely to take up measures without it since there is the risk that an overreliance on incentives could make it difficult to engage with residents in the future without similar offers. Incentives can help to make residents feel more positive about some of the 'hassle factors' of retrofit, such as having to decorate or clear the loft, but it should be recognised that not everyone will be able to respond: if a person is physically unable to clear loft then any amount of financial incentive is unlikely to effective.

Incentives can set a difficult precedent when they are used to encourage ongoing actions, such as reducing the thermostat point, since once they are removed the behaviour made change back. Incentives can also be community-based, and therefore can help to drive social norms around retrofit and encourage neighbours to take action together: for example, the incentive could be improvements to a community centre that represent the amount of energy saved. Ethical considerations are important, particularly in relation to vulnerable households: to some a medium cash incentive may cause them to accept something they do not genuinely want in order to feed their family that week.

4.4.1 Resident Acceptance: Removing practical barriers

Respite and decanting

In the context of retrofit, respite refers to the provision of areas that residents can use during times when their own homes are subjected to disruptive or messy work or activities that would threaten their health and safety. It is possible, for example, to use communal areas, void flats and properties, show homes and local community facilities as long as these are kept free of disruption. It is good practice to provide some catering and entertainment facilities in these areas. Decanting, on the other hand, refers to the practice of providing temporary or alternative accommodation for residents over a longer period whilst work is being carried out on their home. Both approaches reduce the impact on residents of the work, and therefore reduce the risk of stress or health impacts, whilst also helping to reduce the possibility of damage to residents' property. Decanting is particularly useful when whole house retrofit is being carried out. It is important to decide carefully which approach is most appropriate, balancing costs and disruption, and to talk to residents about their preferences. If residents are left with water and energy services running at the end of each day, for example, they may prefer to stay in their own home. It is good practice to organise and pay for decanting, to make arrangement for the storage of extra luggage, and to consider special requirements relating to, for example, accessibility and pet care. Resident expectations should be carefully managed, and it is important to confirm how long the work will take and when they can return to their property.

Contractor services

It is important to consider the services provided by contractors and the methods and procedures adopted by them. Factors that can help to shape an excellent service to residents include always wearing staff ID badges and numbered jackets, distributing an accurate programme of works and daily progress reports, the use of battery power rather than the residents' electricity, adopting a 'just in time' approach that ensures that materials are only brought onto site when needed, and providing a hotline phone number for residents to raise any issues. The contractor should be introduced to residents: it may be appropriate to do this at events such as community open days.

Clearing services

Clearing services are professional services to assist residents in packing and storing items that ready for retrofit and/or decanting, it can include loft clearance. It is an effective way to reduce the level of inconvenience and stress for residents and can help to address perceptions about the level of disruption caused by retrofit. Older people, those with young children, and those with vulnerabilities may be more likely to benefit from this service.

4.4.2 Resident Benefiting and Sustaining

Resident volunteers and champions

The intervention involves the recruitment of individual champions and volunteers, therefore building on the skills available in the community to bring messages about retrofit and related issues such as energy efficiency to the wider community. It is particularly useful before retrofit, as a way of engaging residents to increase acceptance, and after retrofit, to help residents get the best out of their retrofitted home. Community volunteers are often in a position to influence and a trusted source of information and may be able to reach residents who may otherwise 'fall through the net'. It is important however to take care, not all residents will be trusted, and some may create divisions between parts of the community. Involving volunteers in this way can help to retain the legacy of a retrofit process after works have been completed, but it is also important to take into account that residents may move on, whether to another home or community, or to another life stage less compatible with taking on volunteering activities. This approach may be combined with incentivisation to provide some recognition of time commitment involved.

Peer-led approaches

Individual householders are often members of one or more communities and engaging with them in this way can help to create networks of learning and support that enable residents to get the best of retrofit and help to foster and maintain changes in behaviour. The approach is predicated on the idea of social norms or shared opinions, and that these can encourage people to learn from those around them.

Pledges

Pledge cards, and online approaches, can set out actions and simple steps to cutting energy bills and carbon emissions. The approach reflects the principles of community-based social marketing, in which it is understood that initiatives to promote behavioural change are often most effective when they are carried out at a community level and involve direct contact with people. People who are committed to an activity are more likely to respond in a positive way and more likely to respond to this activity. There is however no guarantee that behavioural change will be sustained, and pledges should not be seen as a 'one-off' intervention.

4.5 Management Processes

Training workshops

To successfully deliver retrofit and ensure support from all, staff and resident champions will need training. Training workshops and sessions may be outsourced and offered external agencies with specialisms in communication and resident engagement. These training workshops should be regularly updated throughout the life of the project. Retrofit issues and community approaches are still relatively new, and many staff may be unaware of exactly what retrofit is and what it involves. Technical and community staff may lack knowledge about corresponding areas of work. Training sessions also provide a forum in which concerns can be aired, feedback can be given, and issues can be resolved as the retrofit process progresses.

Handling conflict on site

It is important to have a procedure in place that will help to deal with any issues, concerns and complaints raised by residents during the process. This will involve careful liaison with contractor services and may be the focus of training workshops. It is important to take into account positive and negative experiences of retrofit, resident recommendations of services, resident confidence in the measures being carried out on their homes, and future demand in the context of available support. Effectively managing conflict can help to limit delays and disruption, resolve issues earlier rather than later, maintain cost-effectiveness and increase resident satisfaction.

Involving the private sector

Engaging the private sector in retrofit is important but also presents a number of challenges. These challenges are complicated further when targeting homeowners, private landlords, renters and leaseholders. The needs of private residents will differ to social renters and although barriers to take-up, in terms of disruption and acceptability, are broadly similar there may also be scepticism about taking advantage of grants that are available to part fund or fully fund work and a reluctance to take on additional debt. Working with private householders will, therefore, require particular messaging that recognises the benefits to them as well as their likely concerns.

4.6 Monitoring and Evaluation

Information gathering

It is important to set realistic goals in relation to monitoring and evaluating projects. This can be used to demonstrate how the project has work and the impact it has had. Without it is not possible to prove that retrofit has been effective or delivers value for money. It is likely that the most effective approach will be a combination of the following and that monitoring and evaluation should be carried out throughout the project and regularly reviewed.

Surveys

Surveys can gather resident feedback and can be carried out face-to-face, by post, by phone, or over the internet. They can be combined with effective feedback, which provides a good understanding of energy use and the reinforcement of positive behaviours and actions. It is likely to strengthen the credibility of engagement work and increase the likelihood that residents will respond to future exercises. Surveys are particularly useful for customer profiling, assessing perceptions of retrofit, identifying barriers, measuring resident satisfaction, seeking feedback on performance, and evaluating some specific interventions.

Face-to-face interviews

Interviews offer a way of exploring in more detail issues that have been raised at other points of a retrofit process. For example, resident surveys may show that a particular part of the retrofit is problematic, and interviews will provide explanations as to the extent and nature of the impact upon residents. Interviews allow for deeper, more qualitative information to be gathered, and share advantages with other person-centred approaches that help to build relationships of trust with residents. It is usual to carry out interviews with a subset of residents that provide a level of representation, where a paper or online survey may aim at full coverage. Interviews can be more expensive and time-consuming, but as part of a wide information-gathering strategy, they provide a qualitative complement to surveys and monitoring.

Monitoring

Monitoring of physical characteristics of the home and energy consumption is a way to establish the baseline and help to measure the impact of retrofit. It involves the regular collection of information and periodic analysis to identify and possibly measure change over a period of time. It can be used to measure the impact of retrofit as a whole and of particular measures; benchmarking of residents and the housing provider; estimate the impact of retrofit on energy consumption and therefore energy bills and carbon emissions; and to provide data with which to provide feedback to residents about their savings. It is important to measure throughout the process rather than simply after completion.

5 Baseline and Occupant Surveys

This section of the report documents and discusses the results of a baselining survey; understanding the situation, before improvements have taken place, of residents living in the three case study areas. It starts by situating this study within the wider human factors research in the project, then describes the methodology and delivery of the survey, and presents and discusses the results. The following section considers how the approaches outlined in this report have been applied in the case studies.

5.1 Baselining Study Design

Over the course of the BuildHeat project, surveys are used to provide data that profiles participant households, measures resident satisfaction pre- and post-retrofit, and provides an evaluation of specific measures. This first survey gathers information about the households, the heating and cooling systems available to them, and their heating and cooling practices.

In particular, the following list was established by project partners to represent essential data that would enable us to establish a robust baseline on the participant households:

Demographics	• Number and ages of occupants • Employment status • Main language used in the home
Comfort	• General perceptions of comfort and satisfaction with their home
Heating and keeping warm	• Primary heating system • Secondary heating system • Other actions to increase warmth • Control of systems • When the heating system is used
Cooling and keeping cool	• Typical cooling practices • Additional cooling practices
Heating water and using hot water	• Hot water system • Hot water use
Other uses of energy	• Appliances
Paying for your energy	• How they pay for their energy • How much their energy costs

Table 1 Summary of themes covered in the survey

5.2 The Case Studies

5.2.1 Zaragoza

The Zaragoza Case Study site is shown in Figure 1. Zaragoza has a semi-arid climate with low rainfall of approximately 320mm per annum. Temperatures vary between highs of 40ºC+, with an average high of 31.5ºC in July to record lows of less than -10ºC, with an average low of 2.74ºC. This can be exacerbated by high wind chill, due to prevailing northerly winds affecting the Northern façade of the building.

Figure 1 Location and features of Zaragoza retrofit

The Zaragoza Case Study building has 53 dwellings of which 49 were occupied at the time of the Energy Audit. The walls of the building are constructed of brick with a cavity filled with rock wool. The glazing is single glazed units. Overall, the building is rated as E using the Spanish Energy Performance Certificate.

The installed heating was electrical, with units in each room, however, there is a high prevalence of secondary heating. These radiators are controlled using a manual thermostat on the radiator. Some dwellings contained cooling systems. In the majority of properties, ventilation is provided naturally through window opening. Domestic hot water was provided by a 50l electrical boiler in each dwelling.

Through the BuildHeat project thermal insulation with reflective nanoparticles was added to the outside of the building, part of it containing PV panels to provide electricity to the building an 'active energy facade'. Units in the homes contain heat pumps and technology to maximise the use of solar energy generated through the façade.

5.2.2 Salford, Greater Manchester

Salford is a densely populated city located in the North West of England in the Greater Manchester conurbation. The case study is shown in Figure 2. The average maximum temperature in August, the warmest month is 19ºC, with an average minimum temperature of 12ºC. In January, the coldest month, the equivalent temperatures are 2ºC and 7ºC. The

average temperature throughout the year is 10.4ºC and on average 941mm of rain falls annually.

The BuildHeat project installed ground source heating units in the 102 flats in Albion Tower in the Pendleton area of Salford. Insulation was added and the windows retrofitted. Before BuildHeat the flats were heated using individual gas boilers. The homes are social housing and the building is owned and managed by Salix Homes.

Figure 2 Location of Salford retrofit

Figure 3 shows when respondents to the two surveys say they normally use some form of heating in their home. The relatively small sample size in Salford notwithstanding, the chart suggests that Salford residents start using heating earlier in the year, whereas Zaragoza residents are more likely to continue using heating into the spring.

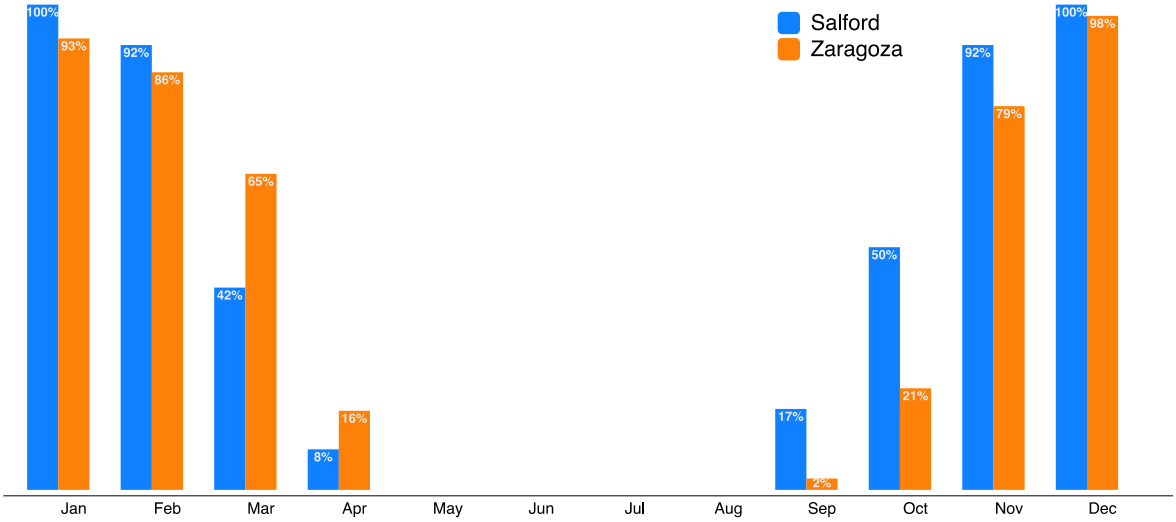

Figure 3 During a typical year do you and your household normally use some form of heating in your home? (Salford N=12, Zaragoza N=43)

5.3 Survey Overview

5.3.1 Survey Structure

With a view to capturing the human factors data, the survey takes the following form.

- Household demographics including household composition, employment status and language;
- Current level of satisfaction with the internal climate of the home;
- Heating systems and practices;
- Concern cooling systems and practices;
- Consumption of hot water;
- How householders currently pay for their electricity and gas;
- Space for householders to add any additional comments.

Care has been taken to ensure that the questionnaire is user-friendly whilst also allowing for a robust analysis. Householders generally had assistance when completely the questionnaire, and additional guidance was produced to aid this process. This included lists of potential systems and appliances in the home: these were available for reference for five of the most technical questions.

Experience of carrying out this type of questionnaires has shown that conducting the surveys in person improves the quality of the answers and reduces anxiety and confusion in residents that may not fully understand the systems they have in their home. Therefore, this survey has been designed to be completed by the resident in the presence of, and with assistance from, a knowledgeable person.

5.3.2 Survey Delivery

The survey delivery mechanism was different in the two areas: in Zaragoza, the questionnaires were carried out with householders by social workers, associated with the housing provider, who were already familiar to them; in Salford, University of Salford researchers conducted the interviews. The Zaragoza surveys were conducted early in 2017 and again in 2020. The Salford survey was conducted in January 2020. These dates were chosen in order to give occupants a period of time in which to become accustomed to their retrofitted homes.

Prior to delivery, University of Salford staff worked with project representatives in Zaragoza to discuss potential issues and challenges with the questionnaire and adapt the questions and approach accordingly. There was some concern about the nature of the questions and how they would be received by the tenants. These centred on privacy and the potentially personal nature of the questions, especially those concerning health and disability and it is fair to say that these concerns resulted in a pragmatic choice to restrict such questions. There was also concern about repetition, with the potential for tenants to be asked questions in this survey that had already been dealt with in the earlier technical survey.

The questionnaires for Zaragoza were translated into Spanish and Italian respectively and delivered in these languages. Informal training was given to the team members who would be carrying out the surveys to seek consistency in the delivery of the questions. The answers were then translated into English by Zaragoza colleagues and University of Salford staff for the purpose of analysis and inclusion in this report.

In Salford, Salix Housing staff assisted the researchers by granting access to the building and organising for a letter to be sent to all occupants to inform them that the survey was happening. Please note that no pre-retrofit survey was conducted in Salford. This reflects the later stage at which Albion Tower entered the BuildHeat project as a case study.

6 Results of Occupant Surveys

6.1 Survey of Occupants in Salford

6.1.1 The Sample

The Salford interviews were carried out in January 2020 by researchers based at the University of Salford. The Salford case study involved a housing authority-owned tower block containing a total of 102 individual properties. Salix Homes, the property management company responsible for the block, identified 10 properties that should not be approached for an interview due to issues relating to vulnerability. A letter informing residents about the research and offering the opportunity for residents to opt-out of the research led to 2 further properties choosing to not participate. At the door, an additional 8 householders declined the opportunity to take part. From the remaining properties, a total of 13 surveys were completed by a single representative from each property, representing 13% of all the households in the block.

The characteristics of the sample taking part in the Salford interviews are as follows:

- 4 female, 9 male interviewees (representing 31% and 69% of the sample respectively);
- The properties were primarily single occupancy. Across the 13 households, 17 adults (over 18) were represented;
- Aged from 45 to 89. None of the interviewees were aged 18-24, 25-34, or 35-44; 4 were 45-54; one was 55-64; five were 65-74; three were 75 years or older;
- 8 of the households (62%) contained at least one person aged 65 or above;
- There were no children living at any of the households involved with the survey, although several interviewees mentioned that children and grandchildren regularly visited;
- The interviewees gave the following as their employment status: three were ‘employed full-time’ one stated they were ‘unemployed’ and 8 were ‘retired’ The remaining individual selected ‘volunteering part-time’ (7.5%).

In the following analysis, the householder answers relating to their experiences prior to the installation of BuildHeat are considered first. These are followed by the analysis of householder answers relating to their perception of the changes brought about by the installation of the system.

6.1.2 Comfort and Energy Practices Prior to BuildHeat

In the Salford case study, no pre-retrofit survey was carried out. Instead, retrospective questions were incorporated into the post-retrofit survey.

Given the relatively small sample size of the survey in Salford, the researchers spent time talking to each respondent in order to get some more in-depth information. These discussions are recorded in this report in the form of quotations.

Householders were asked to complete a set of questions relating to comfort and practices related to energy consumption prior to the installation of the BuildHeat system. The answer options responded to frequency: ‘not at all’, ‘not very often’, ‘some of the time’, ‘most of the time’, ‘all of the time’.

Figure 4 gives the responses for the first of these statements: **'My home was warm enough in winter'**. It shows that all respondents felt that their home was warm enough 'most of the time' or 'all of the time' (33% and 67% respectively). Figure 5 gives the responses for the second of these statements: **'My home was cool enough in summer'**. It shows that all respondents felt that their home was cool enough 'most of the time' or 'all of the time' (25% and 75% respectively).

In the charts that follow, the percentages are calculated from the total number of interviewees. Given that not all respondents answered every question, the percentages do not always add up to 100. One Salford respondent answered none of the closed questions (preferring to talk generally about their experiences) and the total is therefore taken to be 12.

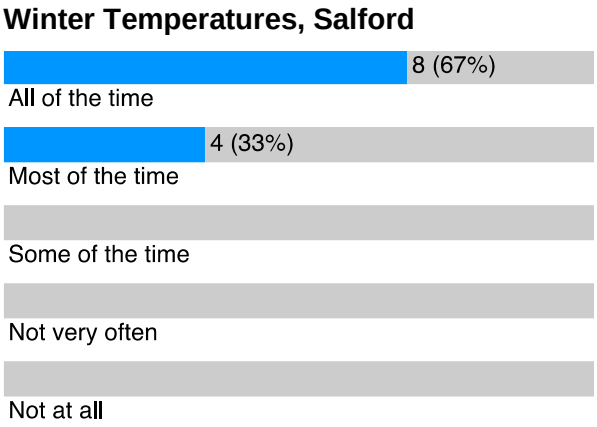

Figure 4 Responses to 'My home was warm enough in winter' number of households, Salford

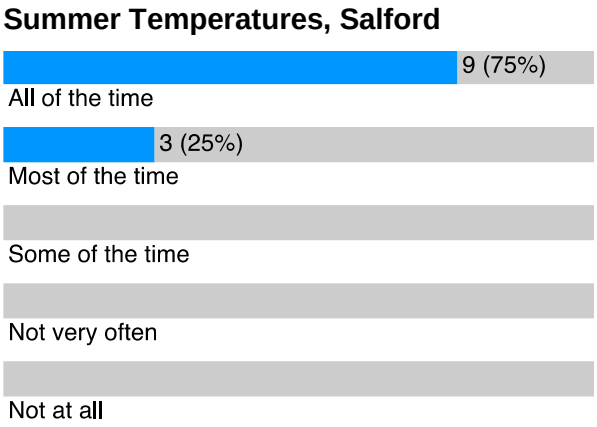

Figure 5 Responses to 'My home was cool enough in summer' number of households, Salford

The next time items related to the conditions of respondents' homes prior to the installation of BuildHeat. Figure 6 gives the responses for the first of these statements: **'My home was draughty'**. It shows an even split of respondents, with half of them experiencing instances of draught, and half of them experiencing none. Of those experiencing draughts previously, these we fairly evenly spread across those experiencing draughts 'not very often', 'some of the time', and 'most of the time' (8%, 25%, and 17% respectively). Figure 7 gives the responses for the second of these statements: **'I had condensation or mould in my home'**. It shows that the majority of respondents felt that their home experienced these conditions 'not at all' (58%).

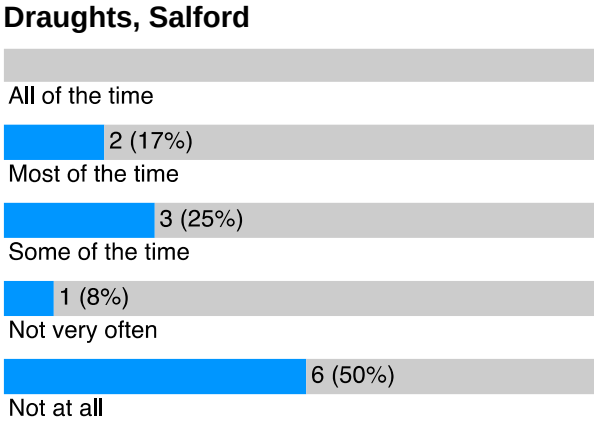

Figure 6 Responses to 'My home was draughty' number of households, Salford

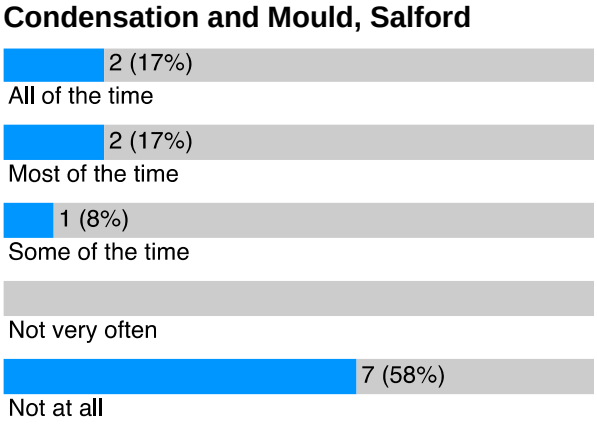

Figure 7 Responses to 'I had condensation or mould in my home' number of households, Salford

The next two items related to respondents' perceptions of their energy use prior to the installation of BuildHeat. Figure 8 gives the responses for the first of these statements: **'I worried about the amount of gas and/or electricity used in my home'**. It shows that the majority of respondents worried about their energy use 'not at all' (75%). Figure 9 gives the responses for the second of these statements: **'I tried to be energy-efficient at home'**. It shows that the majority of respondents tried to be energy-efficient 'all of the time' (67%).

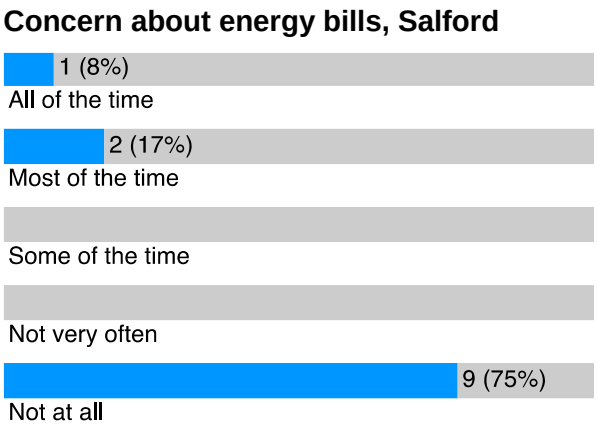

Figure 8 Responses to 'I worried about the amount of gas and/or electricity used in my home' number of households, Salford

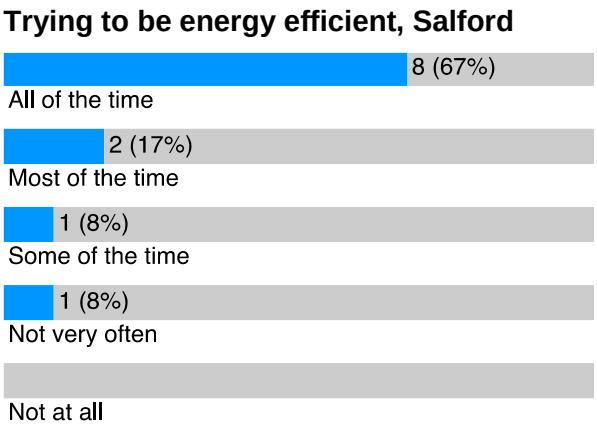

Figure 9 Responses to 'I tried to be energy-efficient at home' number of households, Salford

6.1.3 Comfort and Energy Practices Post-BuildHeat

Figure 10 represents general attitudes towards the changes represented by the installation of the BuildHeat system. It provides the responses to the statement: **'In general, how do you feel about the changes made as part of the BuildHeat system?'**. The responses available related to degree of happiness: 'Very unhappy', 'slightly unhappy', 'neutral', 'slightly happy', 'very happy'. It shows that the majority of respondents reported being either 'very unhappy' or 'slightly unhappy' (75%).

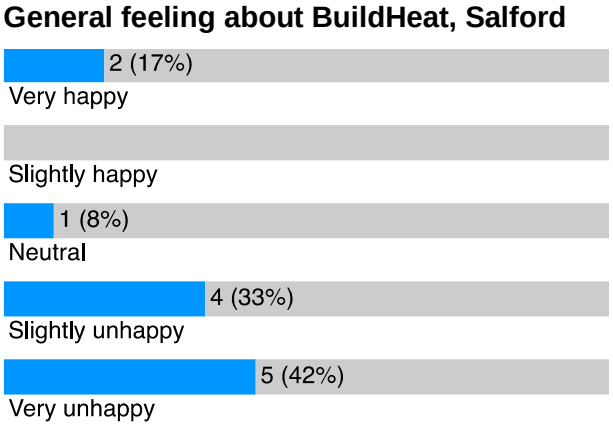

Figure 10 Responses to 'In general, how do you feel about the changes made as part of the BuildHeat system?' number of households, Salford

Although positive comments about the retrofitted heating system were provided, Figure 12 reflects a general mood of dissatisfaction towards the new heating system. Characteristics that were welcomed by some included the move away from gas on the grounds of safety, appreciating the environmental benefit of the new system, its more modern appearance, and liking the approach of maintaining a consistent level of ambient heat – '*They call it ambient heat. You don't get too hot. You don't get too cold. It's just a nice level in the flats'*. Another satisfied resident described using the heating more regularly with his previous system and believes that the new rendering, insulation, windows, and doors have helped in this regard.

In the discussions with residents, however, these factors were counteracted, and arguably dominated, by tenants' more negative experiences with the BuildHeat system, its installation, and management. In order to better understand their attitudes, householders were asked a set of questions about their comfort and energy-related practices since the installation of the BuildHeat system. These items required householders to reflect on changes occurring as a result of the installation of the system. The first two items related to the temperature of residents' properties, the answer options being: 'much colder, 'slightly colder', 'about the same temperature', 'slightly warmer', 'much warmer'. Figure 11 gives the responses for the first of these statements: **'Compared to before BuildHeat, in the winter is your apartment…'**. It shows that the majority of respondents felt that their home is now either 'much colder' or 'slightly colder' (59%). Figure 12 gives the responses for the second of these statements: **'Compared to before BuildHeat, in the summer is your apartment…?'**. It shows that the majority of respondents felt that the apartments were now 'about the same' temperature (67%).

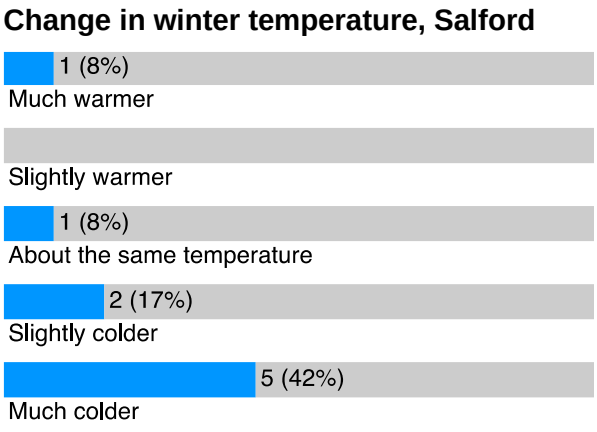

Figure 11 Responses to 'Compared to before BuildHeat, in the winter is your apartment...' number of households, Salford

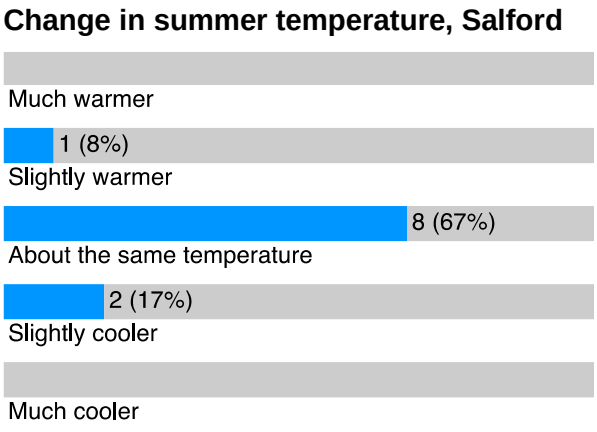

Figure 12 Responses to 'Compared to before BuildHeat, in the summer is your apartment...' number of households, Salford

As Figure 11 shows, most of the people we spoke to felt that their flat was on balance colder in the winter than before the retrofit. Concerns were raised, however, in relation to the experience of both extremes of temperature with some residents describing their property as now being too hot and others as being too cold. Comments relating to the experience of cold indicated that this could be to some extent a result of the ambient heating approach – such that the indoor temperature may have been 21 degrees but they did not feel that the system was working since the radiator was not warm, highlighting a potential gap between room temperature and perceived level of warmth.

Another identified factor was that after using hot water, e.g. for a bath, the flat could feel cold. They commented that the heating system appeared to have been deactivated while the water was heating (*'when you run a bath it will then reheat the hot water tank, so your heating goes off in the meantime – so you get out into a cold flat in winter'*). Another issue raised in relation

to experiencing cold temperature included draughts from the newly fitted windows (*'The windows are a nightmare. Draughts. May as well just have taken the windows out'*).

Overheating during the summer was less of an issue, as might be expected in a cooler climate where the emphasis of the installed system was on heating. Overheating can, however, also result in discomfort. This was experienced by some of the respondents. One had described waking up in the night and finding the heating was on and making the flat very warm. Another had found that their flat was sometimes overheating and becoming uncomfortably warm. This had affected his quality of life and he commented that it was '*embarrassing when people come round*' and that he felt that '*you're not in control of it*'.

The next item related to respondents' perceptions of the ease of use of the new system. Figure 13 gives the responses to the statement: **'Compared to before BuildHeat, is the process of controlling the temperature in your apartment…?'**. The answer options responded to ease of use: 'Much more difficult', 'slightly more difficult', 'about the same', 'slightly easier', 'much easier'. It shows that the majority of respondents felt that the process of controlling the temperature of their home is now 'much more difficult' (83%).

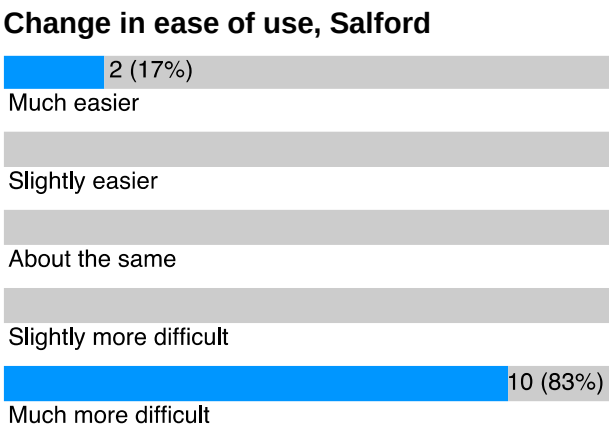

Figure 13 Responses to 'Compared to before BuildHeat, is the process of controlling the temperature in your apartment...' number of households, Salford

Figure 13 indicates that although a minority did feel that they were able to control the system to a satisfactory level, the majority of householders we spoke to felt that the new system was more difficult to control than the previous system. To some extent, this relates to the extremes of temperature, with part of the frustration of being hot or cold being a perceived inability to rectify the situation. The promise of the providers – mentioned by some of the respondents - that the system would be fully automated did not entirely reflect the experiences of the respondents, some of whom had needed to contact the housing provider to request that adjustments be made. In some cases, they had experienced delays over winter during which the system was not operational: *'I often wonder why we don't have control of our own environment. You've told us one thing but it's completely different.'* Some residents reported not fully understanding how the new thermostat works and had tried to learn through trial and error but not reached a point where they felt in control of it. One resident, for example, described their feelings that it is '*complicated*' for people to learn how to use the new system. '*A lot of people are trying to interfere with it too much*', she commented.

Interestingly, despite the majority of respondents describing their property as being too cold in the winter (Figure 4), only a small minority identified themselves as utilising additional heating sources (15%). In their comments, residents make reference to such items as portable heaters, as well as the use of additional clothing and blankets.

Figure 14 and Figure 15 give the responses related to perceptions of energy use. Figure 14 provides the responses to the statement: **'Since BuildHeat, has your awareness of your energy use…?'**. The responses available related to degree of such awareness: 'Decreased greatly', decreased somewhat', 'remained the same', increased somewhat', 'increased greatly'. It shows that all respondents' awareness of their energy use has now 'increased somewhat', or 'increased greatly' (100%).

Figure 15 gives the responses for the second of these statements: **'Compared to before BuildHeat, does your heating cost to run…?'.** The available responses related to the relative cost of energy use: 'Much less', slightly less', 'about the same', 'slightly more', 'much more'. It shows that the majority of respondents felt that the cost of their energy use is now either 'much more' or 'slightly more' (83%).

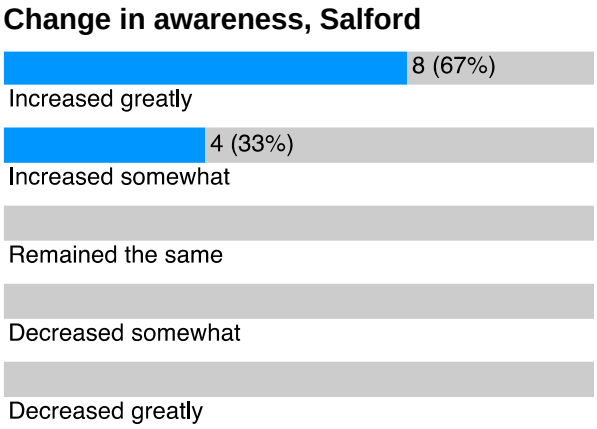

Figure 14 Responses to 'Since BuildHeat, has your awareness of your energy use...' number of households, Salford

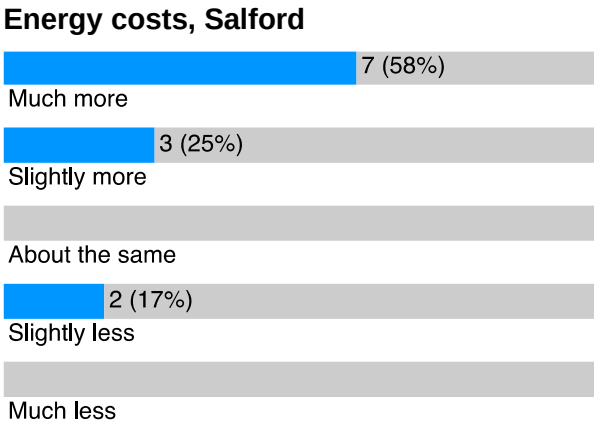

Figure 15 Responses to ''Compared to before BuildHeat, does your heating system cost to run...?' number of households, Salford

Across the sample, the change of heating system had caused people to be more aware of energy use. As the above indicates, however, for many of the residents this was in some cases through stressful experiences and having to worry about discomfort and cost rather than through what could be described as a positive engagement with energy. As an example, one resident reported that '*it stresses me out a lot*', adding that he now thought about energy much more than before: *'I never gave it a second thought… been here a number of years. I'd never stressed out about electricity or gas or anything'*.

One of the factors identified as contributing to increased awareness of energy use and of the apparent cost was the time in which it takes the system to reach the desired temperature, which is perceived by some as requiring a greater level of energy: *'It's too slow. It costs money to get to temperature.'* One of the respondents had decided to limit how much they used the heating system, activating it for approximately one hour in the evening to warm the flat as a way of controlling how much they were spending. Whilst this resulted in a self-imposed low temperature at other times of the day, this was out of concern for the high cost of the heating.

Figure 16 and Figure 17 give the responses related to health and heating and cooling practices. Figure 16 provides the responses to the statement: **'Compared to before BuildHeat, is your overall health…?'**. The responses available related to perceptions of a change in health condition: 'Much worse', 'slightly worse', 'about the same', 'slightly better', 'much better'. It shows that half of the respondents were felt that their health is now 'about the same' (42%). The majority of the other half of the sample felt that their health is now 'slightly worse' or 'much worse' (41%).

Figure 17 gives the responses for the statement: **'Compared to before BuildHeat, does the temperature of your apartment affect what you do at home…?'.** The available responses related to perceived changes in frequency in the need to engage in additional heating/cooling practices: 'Much less often', slightly less often', 'about the same', 'slightly more often', 'much more often'. It shows that the majority of respondents now engage in additional heating/cooling practices 'about the same' (58%).

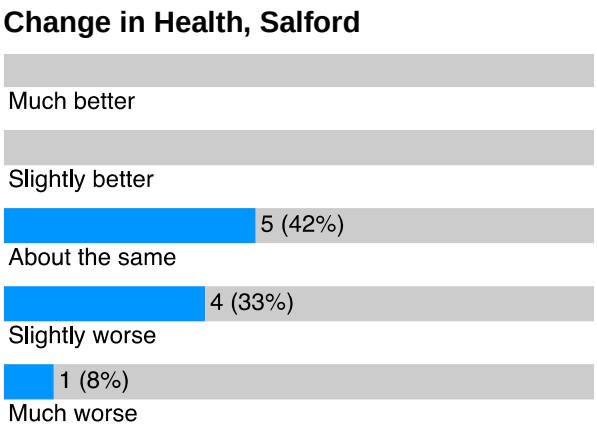

Figure 16 Responses to 'Compared to before BuildHeat, is your overall health...?' number of households, Salford

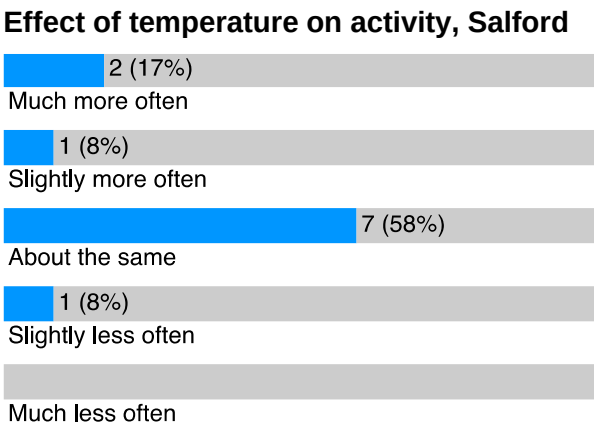

Figure 17 Responses to 'Compared to before BuildHeat, does the temperature of your apartment affect what you do at home...?' number of households, Salford

Figure 16 demonstrates that a notable proportion of the interviewed sample consider their health to be 'slightly worse' since the installation of the new system. Discussions of this largely related to the perception of colder temperatures within properties, which was earlier highlighted in Figure 11. In some cases, low temperatures were problematic in relation to health conditions such as arthritis. It is notable that only a relatively small number report having changed their habits in terms of additional heating behaviours. Some examples of these changes are the use of blankets and portable heaters more often than before the retrofit. As well as temperature, concerns were also raised about the level of noise produced by the system, which was reported to cause some sleep disturbances ('*It's too noisy. It has kept me awake. It needs soundproofing.*'). Several residents also identified an increased level of stress due to the loss of storage space where the heating unit had been fitted ('*I've lost my cupboard!'*).

6.1.4 Summary – Salford

In summary, the survey of occupants reveals a mixed set of experiences with some reactions to the BuildHeat retrofit mostly negative and some generally positive. Positive comments related to the removal of gas and the resulting increased perception of safety, the potential environmental benefits of the new system, its more modern appearance, and the approach of maintaining a consistent level of ambient heat. Taken together, however, the quantitative 'closed' questions and the qualitative 'open' questions and discussion suggest that negative experiences dominate. Concerns expressed by the respondents related largely to a perception of reduced warmth during winter and a reduced level of control of the heating system and therefore the temperature. Further issues included draughts due to the newly fitted windows, the noise levels created by the BuildHeat system, as well as the loss of storage space in accommodating the new heating unit. There was some evidence that these difficulties were impacting on wellbeing and in some cases specific health conditions. Additionally, concerns over cost were adding to stress and in some cases causing occupants to limit their use of the heating.

The findings also indicated potential approaches to addressing such problems, including better education for residents in making effective use of the system, as well exploring options to change perceptions relating to a gap between room temperature and perceived level of heat.

These findings should be understood in the context of the relatively small sample. Occupant comments and the statistical analysis are therefore indicative rather than representative. What these findings *do not* show is that the majority of respondents are unhappy. The findings do however indicate that some residents are dissatisfied with the system and are experiencing difficulties that are impacting on their health and their finances. In some cases, respondents feel that they have not been able to gain control of the system and therefore achieve the temperatures they would like. They also show that some residents – a minority of our sample - are content with the system, feel in control of it, and are not worried about cost. In this sense, the results are encouraging.

It is important to bear in mind the relatively short timescale of the study, with the systems having been installed for just over a year. Our conversations with the respondents imply that there have been some teething issues during this time and experiences of extreme temperatures and unreliability may reflect the occupants, heating provider and housing organisation getting used to the new system.

These caveats are however not reasons to ignore the concerns of the respondents and it is important to continue to engage with them to resolve issues and arrive at a situation in which they feel comfortable and are not stressed by concerns around cost. If occupants are concerned about finances, they may choose to switch off the system and therefore suffer from cold conditions, with associated health impacts. Our study indicates a need for ongoing intervention at a technical level to ensure that the system is performing correctly, but also that the provision of clear information about the system, how it operates, and what can be expected of it plays an important role. The new system requires a conceptual shift in understanding particularly in relation to when the heating should be turned on and off, and the thermostat up and down, as well as how the temperature of the apartment is perceived as something that is ambient across the whole space rather than specific to the radiators. These conclusions call for a continuation of technical maintenance and oversight, combined with effective and sensitive occupant engagement.

6.2 Survey of Occupants in Zaragoza

6.2.1 The Sample

The Zaragoza interviews were carried out by community liaison officers from housing provider Sociedad Municipal Zaragoza Vivienda, firstly in early 2017 and secondly in January 2020.

The characteristics of the 43 households taking part in the Zaragoza **pre-installation** interviews are as follows:

- 25 female, 18 male interviewees (representing 58% and 42% of the sample respectively);
- The interviewees were distributed across age groups 25-34 (2), 35-44 (7), 45-54 (19), 66-64 (6), 65-74 (5), 75 and older (4);
- 10 of the households (23%) contained at least one person aged 65 or above;
- 13 of the households (30%) contained at least one child of 5 years or lower;
- 20 respondents were 'out of work and looking for work and 10 were retired. The remainder were a homemaker (1), employed in some form (6) and unable to work or not looking for work (6).

The characteristics of the 33 households taking part in the Zaragoza **post-installation** interviews are as follows:

- 20 females, 15 males (representing 67% and 33% of the sample respectively);
- Aged from 22 to 88: one person aged 18-24, 3 aged 25-34, 4 were 35-44; 10 were 45-54; 10 were 55-64; 3 were 65-74; 3 were 75 years or older;
- 15 were 'unemployed', 9 were 'retired', 3 were employed full-time and 2 part-time, 3 identified as a 'homemaker' (8%); 1 identified as a 'student' (3%); the remaining 2 categorised themselves as 'other' (6%);
- 9 of the households (26%) contained at least one person aged 65 or above;
- 7 of the households (20%) contained at least one child of 5 years or lower.

6.2.2 Comparing Comfort and Energy Practices Before and After BuildHeat

In interviews both before and after the installation of BuildHeat, householders were asked to complete a set of questions on comfort and practices related to energy consumption. The answer options responded to frequency: 'not at all', 'not very often', 'some of the time', 'most of the time', 'all of the time'.

Figure 18 and Figure 19 give the responses for the first of these statements: **'My home was/is warm enough in winter'**. Figure 18 provides the findings from the 'pre' interview and Figure 19 provides the findings from the 'post' interview. Comparison of these figures reveals an apparent increase in home comfort during the winter. Where previously the majority of respondents reported that their home was warm enough either 'not very often' or not at all (68%), following the installation of the system, the majority now report their home to be warm enough either 'all of the time' or 'most of the time (74%).

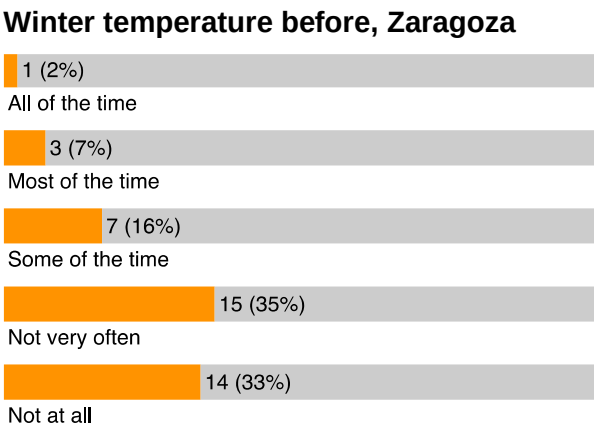

Figure 18 Responses to 'My home was warm enough in winter' number of households, pre-installation, Zaragoza

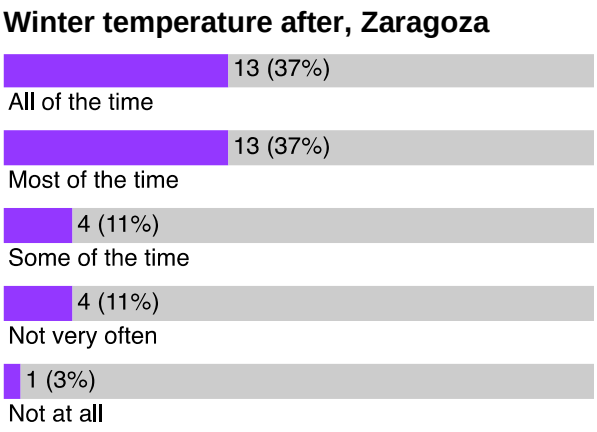

Figure 19 Responses to 'My home is warm enough in winter' number of households, post-installation, Zaragoza

Figure 20 and Figure 21 provide the responses for the second of these statements: **'My home was/is cool enough in summer'**. Figure 20 provides the pre-interview data and Figure 21 provides the post-interview data. Comparison of these figures again reveals an apparent increase in thermal comfort during the summer. Prior to BuildHeat, the majority of respondents reported their home to be cool enough either 'not at all' or 'not very often' (63%), following the installation of the system, the majority reported their home to be cool enough 'all of the time' or 'most of the time (74%).

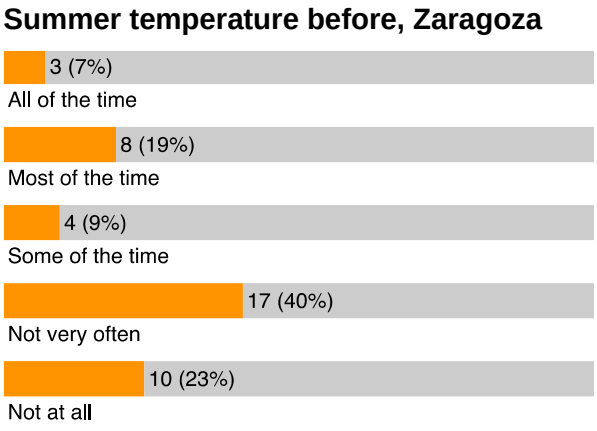

Figure 20 Responses to 'My home was cool enough in summer' number of households, pre-installation, Zaragoza

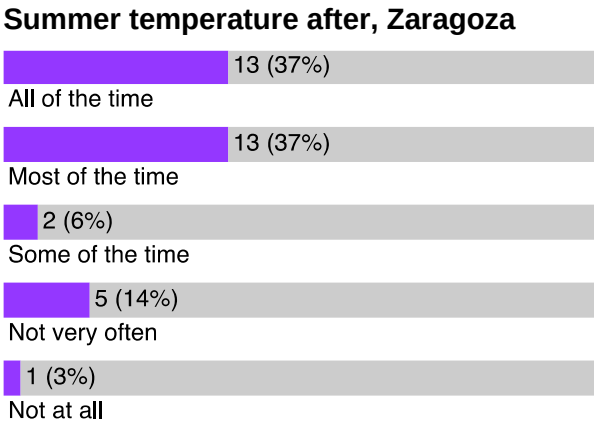

Figure 21 Responses to 'My home was cool enough in summer' number of households, post-installation, Zaragoza

The next time items related to the conditions of respondents' homes prior to and following the installation of BuildHeat. Figure 22 and Figure 23 give the responses for the first of these statements: **'My home was/is draughty'**. Figure 22 provides the pre-installation findings and Figure 23 provides the post-installation findings. Comparison of these figures suggests a decline in the occurrence of draughts within homes. Previously, a minority of residents reported to have experienced draughts 'not at all' (23%), but following the installation of BuildHeat, this proportion has increased to represent a majority of the respondents (80%).

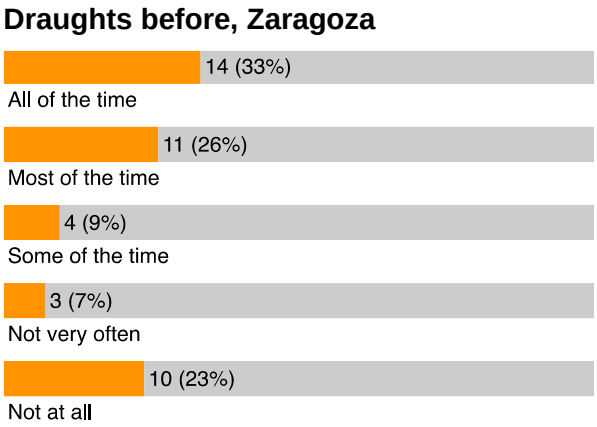

Figure 22 Responses to 'My home was draughty' number of households, pre-installation, Zaragoza

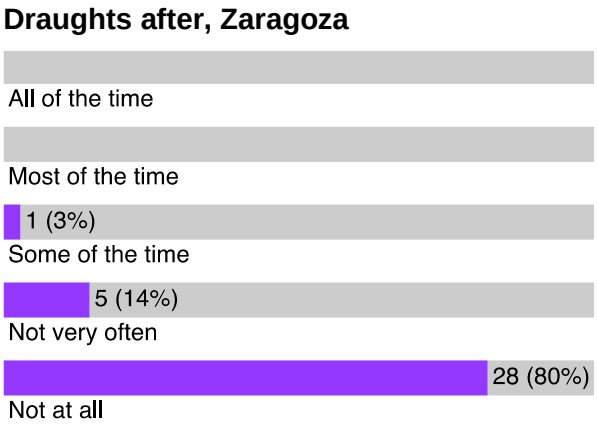

Figure 23 Responses to 'My home is draughty' number of households, post-installation, Zaragoza

Figure 24 and Figure 25 provide the responses for the second of these statements: **'I had/have condensation or mould in my home'**. Figure 24 provides the findings from the pre-installation interview and Figure 25 provides the findings from the post-installation interview. Comparison of these highlights a reduction in instances of condensation and/or mould in households. Before BuildHeat, a majority of respondents reported having experienced condensation or mould at some point (58%), but following the installation of the system, all respondents indicated witnessing no such issues (100%).

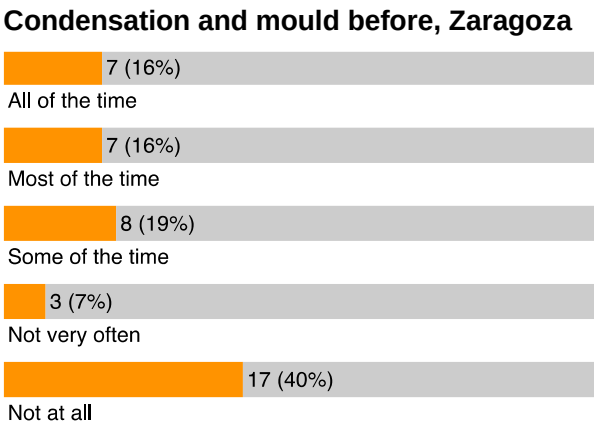

Figure 24 Responses to 'I had condensation or mould in my home' number of households, pre-installation, Zaragoza

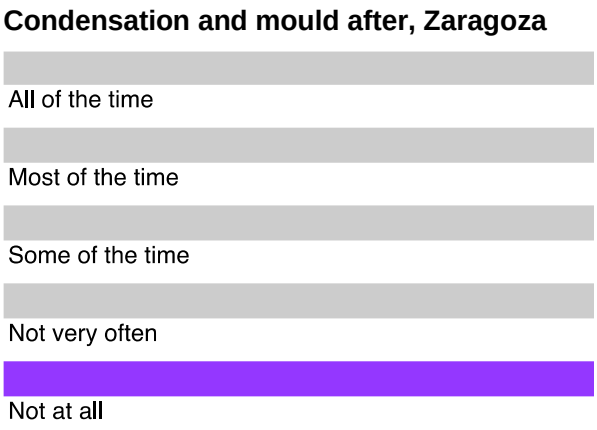

Figure 25 Responses to 'I have condensation or mould in my home' number of households, post-installation, Zaragoza

The next two items related to respondents' perceptions of their energy use prior to the installation of BuildHeat. Figure 26 and Figure 27 provide the responses for the first of these statements: **'I worried/worry about the amount of gas and/or electricity used in my home'**. Figure 26 provides the findings from the pre-installation interview and Figure 27 provides the findings from the post-installation interview. Comparison of these figures suggests a slight decrease in concern about the cost of energy use. Before the installation 91% of respondents described worrying either 'all of the time' or 'most of the time', but this figure fell to 65% following the installation of the system. It should be noted, however, that this still represents a majority of those interviewed.

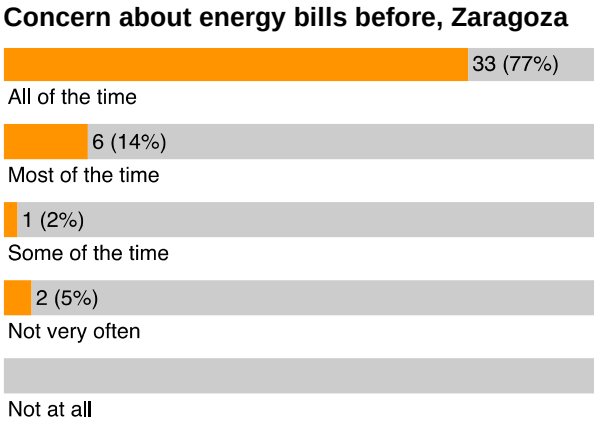

Figure 26 Responses to 'I worried about the amount of gas and/or electricity used in my home' number of households, pre-installation, Zaragoza

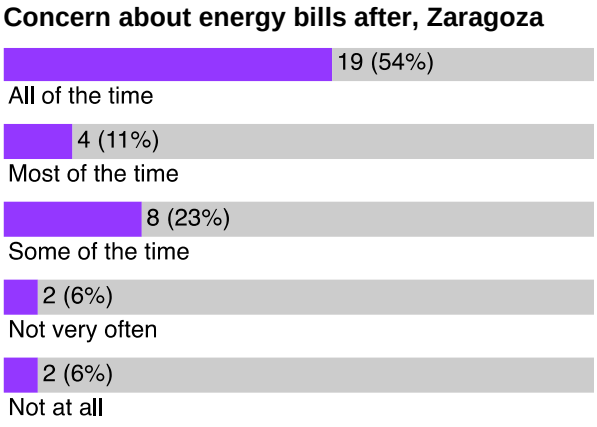

Figure 27 Responses to 'I worry about the amount of gas and/or electricity used in my home' number of households, post-installation, Zaragoza

Figure 28 and Figure 29 give the responses for the second of these statements: **'I tried to be energy-efficient at home'**. Figure 28 provides the findings from the pre-installation interview and Figure 29 provides the findings from the post-installation interview. Comparison of these figures shows a slight decrease in reported efforts to be energy efficient. Prior to BuildHeat, 91% of respondents reported doing this either 'all of the time' or 'most of the time' but this figure has decreased to 74% following its installation.

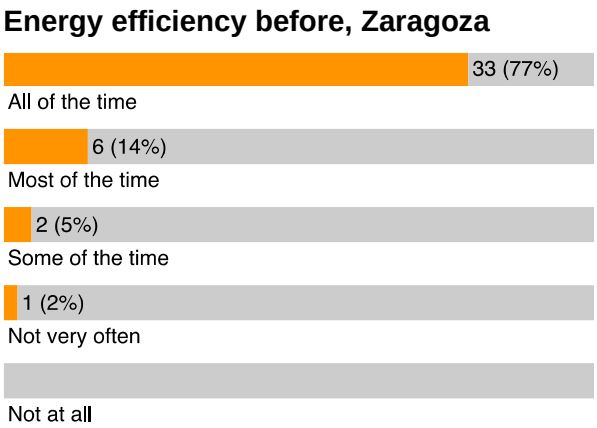

Figure 28 Responses to 'I tried to be energy-efficient at home' number of households, pre-installation, Zaragoza

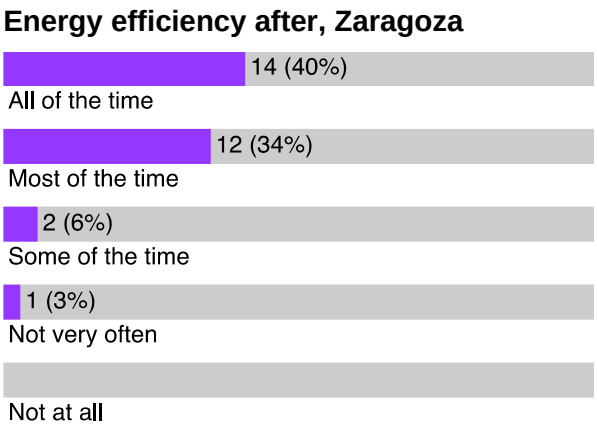

Figure 29 Responses to 'I try to be energy-efficient at home' number of households, post-installation, Zaragoza

6.2.3 Comfort and Energy Practices Post-BuildHeat

Figure 30 represents general attitudes towards the changes represented by the installation of the BuildHeat system. It provides the responses to the statement: **'In general, how do you feel about the changes made as part of the BuildHeat system?'**. The responses available related to degree of happiness: 'Very unhappy', 'slightly unhappy', 'neutral', 'slightly happy', 'very happy'. It shows that the majority of respondents reported being either 'very happy' or 'slightly happy' (69%). It should be noted, however, that a significant proportion did report feeling 'very unhappy' (14%).

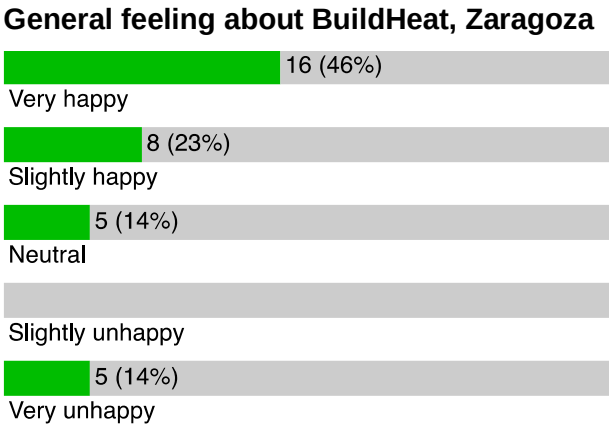

Figure 30 Responses to 'In general, how do you feel about the changes made as part of the BuildHeat system?' number of households, Zaragoza

The paper questionnaires used as part of the interview provided the opportunity for respondents to provide additional comments. It should be noted that the comments presented forthwith are not direct quotations from residents. Rather, the comments were noted by the staff member conducting the interview and then translated into Spanish by the University of Salford team. The majority of these comments reflect the broad trend indicated in the charts. This is towards overall satisfaction with the BuildHeat system, feeling warmer in the winter, feeling cooling in the summer, as well as observing some benefits to health and in terms of the way they make use of their space in the home. There are, however, instances whereby respondents have expressed concerns about some elements of the system.

In order to better understand their attitudes, householders were asked a set of questions about their comfort and energy-related practices since the installation of the BuildHeat system. These items required householders to reflect on changes occurring as a result of the installation of the system. The first two items related to the temperature of residents' properties, the answer options being: 'much colder, 'slightly colder', 'about the same temperature', 'slightly warmer', 'much warmer'. Figure 31 gives the responses for the first of these statements: **'Compared to before BuildHeat, in the winter is your apartment…'**. It shows that the majority of respondents felt that their home is now either 'much warmer' or slightly warmer' (88%). Figure 32 gives the responses for the second of these statements: **'Compared to before BuildHeat, in the summer is your apartment…?'**. It shows that the majority of respondents felt that their home is now either 'slightly cooler' or 'much cooler' (91%).

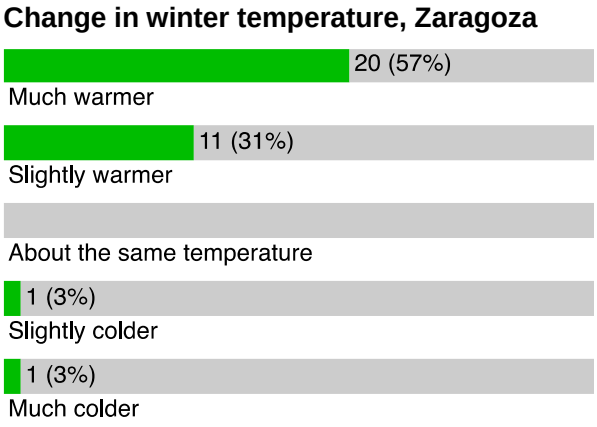

Figure 31 Responses to 'Compared to before BuildHeat, in the winter is your apartment...' number of households, Zaragoza

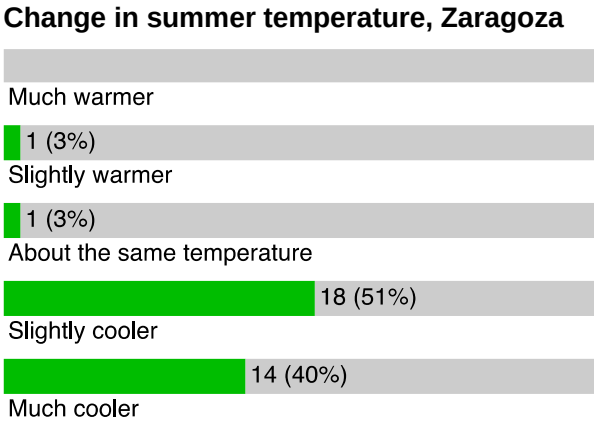

Figure 32 Responses to 'Compared to before BuildHeat, in the summer is your apartment...' number of households, Zaragoza

The next item related to respondents' perceptions of the ease of use of the new system. Figure 33 gives the responses to the statement: **'Compared to before BuildHeat, is the process of controlling the temperature in your apartment…?'**. The answer options responded to ease of use: 'Much more difficult', 'slightly more difficult', 'about the same', 'slightly easier', 'much easier'. It shows that the majority of respondents felt that the process of controlling the temperature of their home is now 'much easier' or 'slightly easier' (62%).

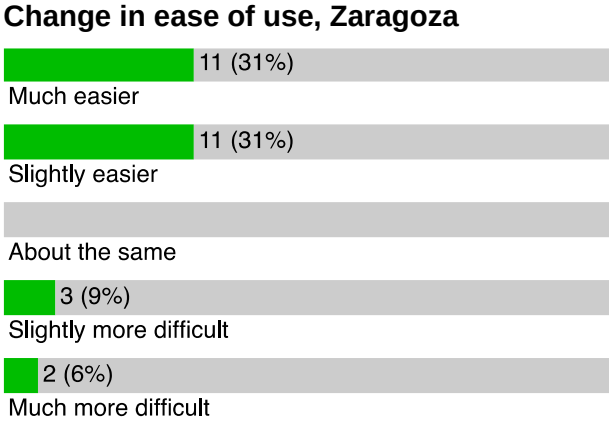

Figure 33 Responses to 'Compared to before BuildHeat, is the process of controlling the temperature in your apartment...' number of households, Zaragoza

Figure 34 and Figure 35 give the responses related to perceptions of energy use. Figure 34 provides the responses to the statement: **'Since BuildHeat, has your awareness of your energy use…?'**. The responses available related to degree of such awareness: 'Decreased greatly', decreased somewhat', 'remained the same', increased somewhat', 'increased greatly'. It shows that a majority of respondents' awareness of their energy use has now either 'increased somewhat' or 'increased greatly' (54%).

Figure 35 gives the responses for the second of these statements: **'Compared to before BuildHeat, does your heating cost to run…?'.** The available responses related to the relative cost of energy use: 'Much less', slightly less', 'about the same', 'slightly more', 'much more'. It shows that 34% of respondents believed that their respondents felt that the cost of their energy is now either 'slightly less' or 'much less'. Only a small minority believed that the cost is now 'slightly more' (6%).

The pre-installation questionnaire reveals that 15 of respondents relied on some form of additional heating prior to the installation of BuildHeat, which represents a majority of the sample (57%). These mostly included 'something portable', such as heaters, radiators, or heated towel rails. Other examples provided included hot air heaters, electric heaters, and butane heaters.

It is noteworthy that despite reporting the home to now be a more comfortable temperature during the winter months, 30 (86%) residents reported still utilising some form of additional heating, which represents a larger majority than evident in the pre-installation survey. The additional sources of heat included electric fires and heaters, butane heaters, electric radiators, accumulators, and one individual referred to an air heater. Within the comments provided by such individuals, however, is the indication that the use of such equipment is not necessarily indicative of an inadequacy of the BuildHeat system but could represent a preference for localised heat at certain times and for particular activities. One resident describes how they use additional heating to only heat the room that they are currently using ('When I am in the sitting room resting, I turn on a butane heater, as well as when I'm in the bathroom showering'). Furthermore, among those not currently making use of additional heating sources directly referred to this as being a result of the changes brought about by the BuildHeat system *('you can feel the change for the better, it is much better… because we no longer use the electric fire nor ventilator'*).

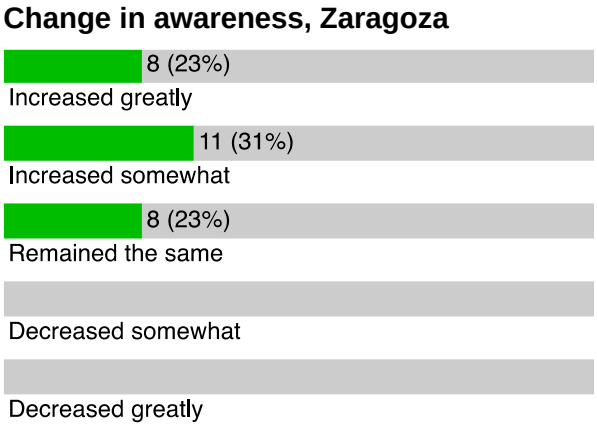

Figure 34 Responses to 'Since BuildHeat, has your awareness of your energy use...' number of households, Zaragoza

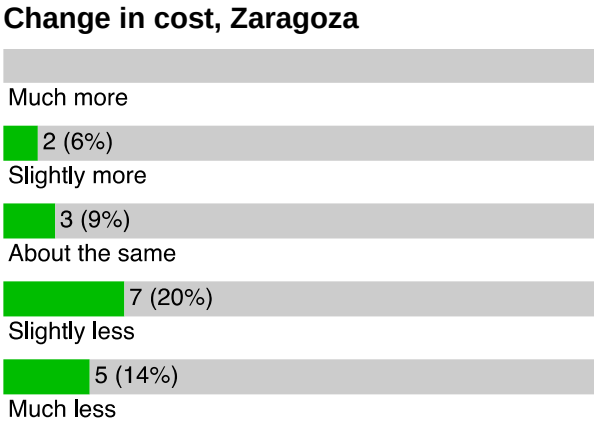

Figure 35 Responses to ''Compared to before BuildHeat, does your heating system cost to run...?' number of households, Zaragoza

Figure 36 and Figure 37 give the responses related to health and heating/cooling practices. Figure 36 provides the responses to the statement: **'Compared to before BuildHeat, is your overall health…?'**. The responses available related to perceptions of a change in health condition: 'Much worse', 'slightly worse', 'about the same', 'slightly better', 'much better'. It shows that over half of the respondents felt that their health is now either 'slightly better' or much better' (51%). Many felt that their health is now 'about the same' (40%), and a number felt that it is now 'slightly worse' or much worse' (9%).

Figure 37 gives the responses for the statement: **'Compared to before BuildHeat, does the temperature of your apartment affect what you do at home…?'.** The available responses related to perceived changes in frequency in the need to engage in additional heating/cooling practices: 'Much less often', slightly less often', 'about the same', 'slightly more often', 'much more often'. It shows that a significant proportion feel that the temperature of their home influences their behaviour either 'slightly more often' or 'much more often' (37%).

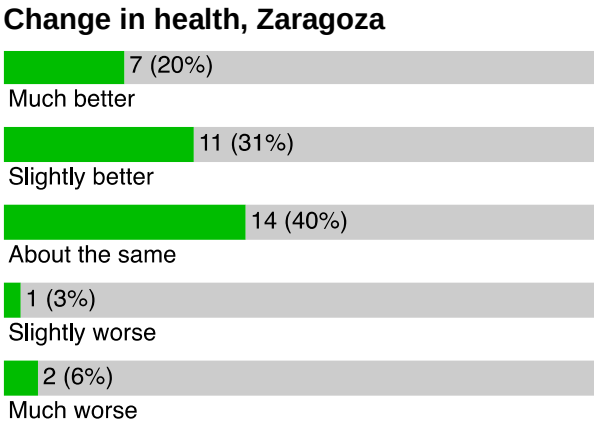

Figure 36 Responses to ''Compared to before BuildHeat, is your overall health...?' number of households, Zaragoza

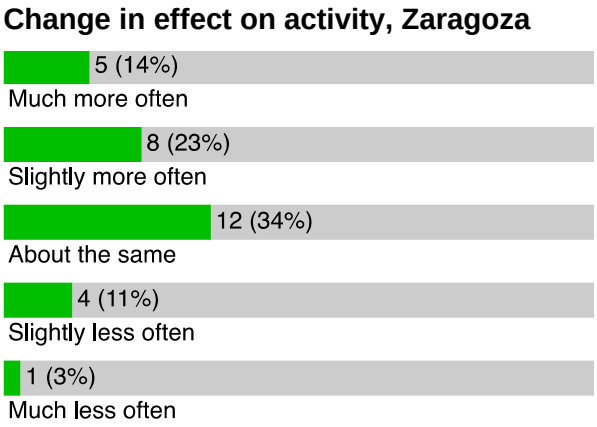

Figure 37 Responses to 'Compared to before BuildHeat, does the temperature of your apartment affect what you do at home...?' number of households, Zaragoza

In terms of the comments relating specifically to health, there were references to becoming ill less frequently ('*I usually get a lot of colds, but this year I haven't even got a vaccination'; 'Every year I am admitted with pneumonia, this year I wasn't'*). Conversely, a reference was also made to some continuing issues with cold temperatures within properties ('*Sometimes, as I suffer from my bones (arthritis) when I am in the sitting room resting, I turn on a butane heater, as well as when I'm in the bathroom showing'*). It should be noted, however, that this person also mentioned that they rarely use their heating system, implying that this is not something they experience every day.

There were many comments that indicated greater freedom to use more of the home as a result of the newly installed system. For example, no longer having the need to gather in the warmest room during the winter and being able to use bedrooms that had previously been too cold. One respondent described how people in their household were now able to use multiple showers at the same time, whereas the hot water capacity had previously limited this.

The residents also made reference to factors that could be described as teething issues, as the final touches are applied as part of the installation. These include doors not closing tightly and some periods of unreliability with the system. One occupant described having to call to ask for assistance as the 'danger' light was displaying on the unit. A further comment received from some of the households was that the machine itself can be noisy and that this can be disturbing.

6.2.4 Summary - Zaragoza

Reflecting on the full picture provided by both the quantitative and qualitative data, the Zaragoza retrofit appears to have been well received by the affected residents. Figures indicate a high rate of satisfaction and reports of warmer winter and cooler summer temperatures.

Taking winter temperatures as an example, the results consistently reflect low levels of winter comfort (Figure 18), being replaced by higher levels (Figure 19), and occupants then reporting this as an improvement (Figure 31). Whilst some respondents say that their homes are 'slightly' rather than 'much' warmer, it should be noted that such answers are subject to individual subjective and contextual factors such as what occupants perceive to be 'warm enough', and how satisfied they were prior to the installation of the new heating system. For example, if they were largely satisfied before then 'slightly' warmer may represent a very comfortable state. What is noteworthy, is that irrespective of such factors, the majority of responses indicate a trend towards increased satisfaction. Occupants also identify some health benefits and point to increased comfort in the home and to more of the space being at a comfortable temperature. There are still, however, remaining issues and some dissatisfaction and it is important that those occupants who are still experiencing these issues are helped through technical repairs or provided further advice and support. Notwithstanding these concerns, the overall trend is that occupants view the changes positively and report changes towards increased comfort and decreased stress.

7 Conclusions

Conclusions drawn through comparison of the findings generated from residents Zaragoza and Salford should be treated with caution. The demographic information collected highlights differences in household composition. Furthermore, whilst both areas experience colder winter temperatures, the Zaragoza climate means that those apartments are much more prone to overheating in the summer. Whilst the local climate and the composition of the households are quite different across the two case studies, there are some commonalities. They are all, for instance, social housing tenants and a greater number of them are unemployed than the general population. Unemployment tends to correlate with limited finances and spending more time within the home.

With these factors in mind, the findings highlight the extent to which home heating and cooling systems can affect quality of life in terms of not only of temperature and energy affordability but also related factors such as health and utilisation of indoor space. In the Salford case study, the charts reveal a situation in which respondents have found it challenging to stay warm in the winter and are concerned about how much they are spending on energy bills. Figures 9-16 indicate that these concerns endure and that, although some residents are broadly happy with the new system, the majority hold concerns over temperature-related comfort and energy bills, which are reportedly impacting upon their health and causing financial stress.

In the pre-installation survey conducted in Zaragoza, respondents expressed concern that it was difficult to keep warm in the winter, that homes were draughty and that it was difficult to keep them cool in the summer. When speaking to the respondents after the retrofit, it is evident that the new system has been positively received. For the majority of households, temperatures are now generally higher in the winter and lower in the summer and the incidence of condensation and mould has been substantially reduced. Respondents reported being less concerned about their energy bills and stated that it is now easier to control the temperature of their home. Respondents also identified some apparent health benefits. Although these trends represent the experience of the majority, some residents do still report negative issues and associated health impacts. Nearly two-thirds still report being concerned about the amount of gas or electricity being used in their home – a figure that is lower than before, but one that still represents a majority of respondents. It is reassuring, however, that most respondents report spending less money on energy. It is also noteworthy that despite the positive attitudes towards the new system, many respondents continue to use some form of additional heating such as electric heaters and butane units. Comments provided seem to suggest that this may be reflect engrained of heating habits rather than any problems or inadequacy of the newly installed system, although such issues cannot be ruled out.

Another interesting outcome is that in both locations, respondents report a greater awareness of their ‘energy use’. Salford respondents implied that this related to their experiences of disruption during installation, teething issues for which they needed to request support from the housing provider and heating engineers, the difficulties they had found in getting the best out of the system, and their concerns over increasing costs. Several interviewees also referred to conversations with other residents of Albion Tower and implied that the new systems and their experiences of it was the subject of discussion. It is therefore unsurprising that they have become more aware of energy use. In Zaragoza, with respondents expressing fewer concerns about the system, there is less reason to think that awareness is a result of problematic experiences, although this will have been the case for some occupants. The housing provider conducted engagement activities throughout the project and has been interacting with the residents as the different stages of the retrofit were installed, and this is also likely to have boosted awareness of energy use.