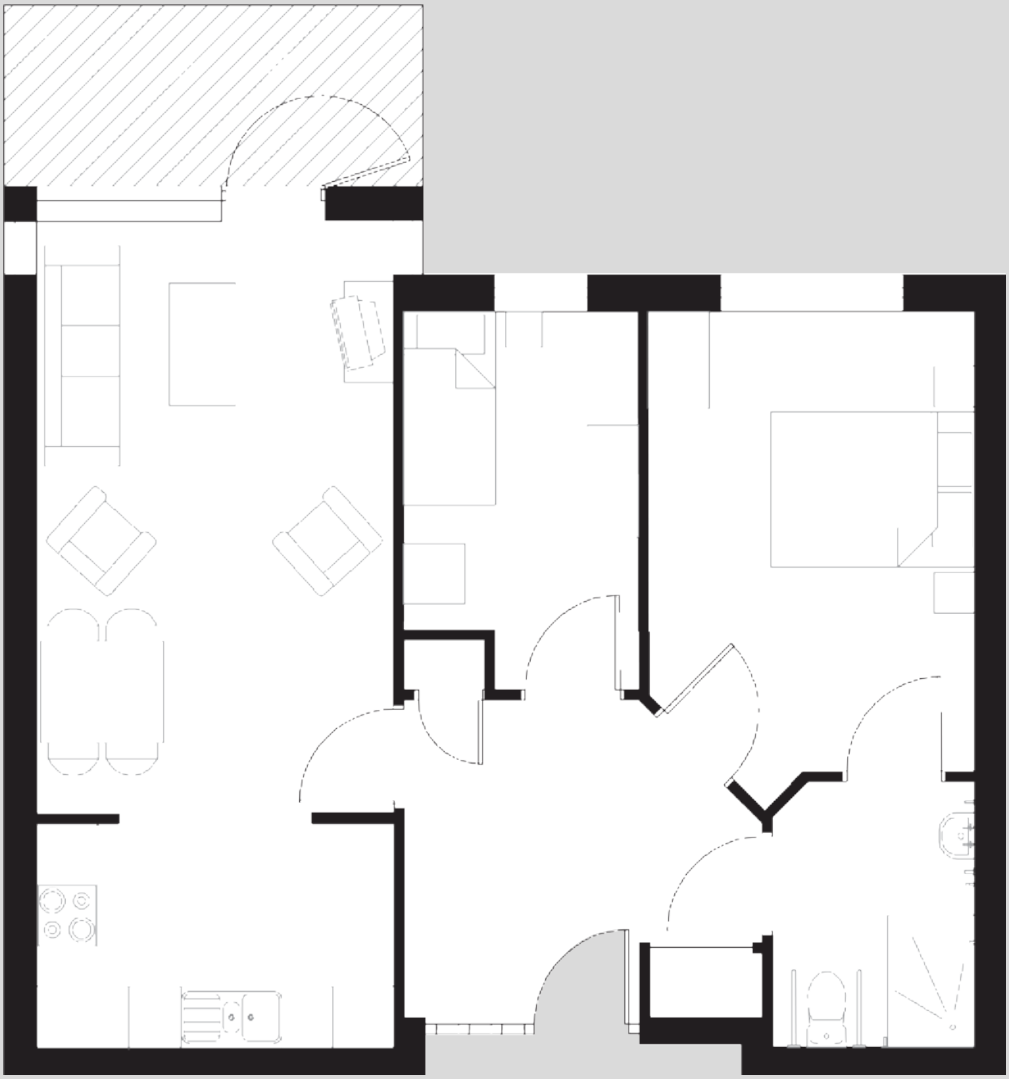
Building Comfort for Older Age

Designing and managing thermal comfort in low carbon housing for older people



Contents

This briefing report summarises research findings and seeks to understand the diversity and dynamics of thermal comfort issues in an ageing society and their implications for current and future energy consumption.

The research project addresses two key forms of social and technological change: the demographic trend of an ageing society and the development of energy-efficient domestic technologies.

Our aim is to understand the implications of these two dimensions, and to identify potential synergies, gaps, and mismatches between them as they relate to the day-to-day experiences of comfort and warmth amongst older people at home.

A Changing Context

Demographic change has multiple implications for housing and energy policy, and for those designing and managing residential spaces. The living experiences of older people are enormously diverse, reflecting differences in physical ability and health, financial resources, aspirations and domestic living situations.

Some older people are in good health and are active. They are improving their homes, adopting new sustainable technologies and leading full and mobile lives. Others live comparatively sedentary lives and spend more of their time at home. Those that live in poorer quality, energy inefficient houses or have restricted incomes can suffer from the effects of fuel poverty.

Older people with greater health problems may need to move into different living arrangements (such as extra care housing and care homes) where comfort is managed in very different ways.

Vulnerabilities related to thermal comfort can become serious and are complex. Being too cold or too hot presents physical risks, as changes such as lower metabolic rates and poor blood circulation become important. Sight loss is also an important issue, and one with implications for how controls and visual information are designed with older people in mind. Some individuals with dementia can find it difficult to use thermostats and timers, and to communicate thermal discomfort to carers. It can also introduce risks, such as not recognising the danger of hot surfaces.

UNDERSTANDING COMFORT

This study of thermal comfort has explored this diversity of experience. Rather than assuming that engineering approaches which control the temperature of buildings are sufficient, the researchers recognised that comfort is the result of a combination of factors, including levels of physical activity, the extent to which occupants can exercise control over heating and cooling systems, and the cultural and social underpinnings of how comfort is experienced and managed in everyday life. The researchers also paid attention to the ways in which older people adapt their activities to maintain comfort; whether opening windows and blinds, changing clothing, or modifying their food and drink intake.

THE ROLE OF PRACTITIONERS

Designers, building managers and other practitioners are increasingly being called upon to accommodate the diverse needs of older people and the ways in which their experiences of thermal comfort affect their health and quality of life. The situation becomes more complex with the increasing emphasis on energy efficiency and low carbon heating technologies. New technologies can allow for significant energy savings but they also create new operational demands and change the way that occupants maintain comfortable conditions. Evaluating how new technologies fit into the diversity of living arrangements of older people and how their needs are provided for is therefore increasingly important.

Houses

The majority of UK residents live in houses. Privately owned housing and, to a lesser extent, rented housing, offers the greatest degree of independence and control for occupants. However, when people age there are challenges in maintaining heating technologies and paying energy bills. Houses present energy efficiency challenges, particularly those that have heritage value, solid wall construction, out-dated components (boilers, windows), or are too large for older occupants. On the other hand, factors such as the availability of roof and garden space provide opportunities for incorporating renewable energy technologies such as photovoltaic panels, ground source heat pumps, and biomass boilers.

Feeding a wood-burning stove requires strenuous physical activity that might be challenging for some people

New technologies can create conditions for drying clothes

Occupants of privately owned housing often have the freedom to reconfigure their homes, but physical impairments may restrict the extent to which they can do this. Biomass boilers may be an attractive option, for example, yet older people can experience difficulties carrying heavy supplies of pellets, lifting them in the hopper, and being dependent upon informal, and potentially precarious, local fuel supply networks. Households on relatively low incomes may have a restricted range of affordable insulation options available to them. Where homes are rented, occupants may be limited in terms of any physical alterations to the building and heating system.

If, following an energy upgrade, thermally-inefficient spaces become comfortable and usable all year round and throughout the day, families may spread activities throughout the house, rather than staying together in the warmest room on colder evenings. This is referred to as 'spatial rebound' and is partly due to the dispersal of technologies and comfortable areas throughout the house. This can negate the energy and cost savings from energy efficiency upgrades but can improve the quality of life for occupants.

In some cases, boilers and pipework can raise temperatures and decrease humidity in rooms and people may be able to dry clothes and shoes. Whilst potentially useful, this may upset the delicate balance of temperature and humidity and lead to problems with condensation. The unintended consequences of new technologies are frequently overlooked in decision-making processes.

Comfort is about more than temperature. Visual elements and other sensory features, such as the glow of a fireplace (even 'fake' fires) and the smell of the wood burning stove, provide both a physical gathering space and a psychological sense of warmth. For instance, it is common for a wood-burning stove to be a focus for social occasions even when other forms of heating are available.

'...we've got a very different attitude to it because [the new heating system is] not costing the same as the other heating system... we're not daft, we know we've paid for it up front, big time, but that's psychologically different isn't it.'

A householder reflects on the relatively cheap running costs of a new heating system

'I used to get very cold sitting there, but now I don't, it's much more comfortable to spend time there than it was because the whole house is more or less the same temperature now.'

A householder describes how having a more uniform temperature across the house has influenced how she uses available space

'It's not ideal where [the heat pump] is... but the fan in the ceiling helps to make it work more effectively. But the outside part, if you put it on our drive, you wouldn't be able to get a car in the garage... If you put it outside, you wouldn't be able to walk in the door to the conservatory.'

A householder recounts the difficulty of finding a suitable location for his heat pump

RECOMMENDATIONS

Adopt a context sensitive approach to ensure that energy savings are realised. This should take into account the different ways in which occupants adopt and use energy efficient technologies.

Consider the impact of low carbon heating on how different spaces may be used after an upgrade. This may mean that projected cost savings are offset by changing living patterns and increased comfort levels.

Consider the daily and long-term maintenance and operating requirements and who will provide these. Some technologies, such as biomass boilers, might not be appropriate for older occupants because of the physical effort needed to run and maintain them.

Consider the many ways that comfort is achieved in houses. This might provide opportunities for lower cost options that do not involve significant disruption or the adoption of new comfort practices. This includes lighting, colours, air movement, and other textures, sounds and smells.

The warm glow, and fresh smell, of a fire can be as important as its warming effect

Roof space can be used for solar hot water panels

Flats and Apartments

In multiple occupancy housing, such as apartments and flats, residents sometimes have less control over their comfort conditions due to the presence of centrally controlled heating systems and fewer perimeter walls. On the other hand, the compactness of these buildings provides energy efficiency gains and occupants can share comfort strategies by talking with their neighbours and the building manager.

Our case study in Grenoble, France, identified potential challenges in designing and managing energy efficient apartment buildings, and making them suitable for the diverse needs of older people. Here, the occupants complained that they could not get their flats to a high enough temperature during the winter months because the default setting for the central heating system was too low and could only be changed by a technician. The lack of control led to numerous complaints and a general feeling of dissatisfaction amongst the occupants.

Controlling the temperature was also complicated by multiple interfaces that were difficult for the occupants to understand. The building manager was frequently called in to adjust the settings for particular residents because he knew how to operate the system. In effect, the manager acted as an intermediary between the design intentions and the everyday use of the building.

Design decisions can also create problems with maintaining comfort. In the Grenoble case study, uninsulated hot water pipes were embedded in concrete slabs of the super-insulated building. This resulted in the inadvertent heating of landings and apartment floors. Whilst beneficial in the winter, this was problematic in the hotter summer months due to overheating.

The case study apartments in Grenoble

Inside the apartment building

Temperature, light and ventilation controls in flats

‘We do a pre-regulation at the boiler level, it is a little higher so that people can choose how far they go. But at home, it is not a regulator they have but just a small valve. They can never go beyond what is provided centrally.’

A representative of a district heating provider describes the level of centralisation of control in some installations

‘You see these things, they’re the devices for regulating the heating. You need to be a rocket scientist to understand something like that. I’m a hairdresser. You see what I mean? Even the building manager, poor guy, he tried but he wasn’t able to regulate it properly.’

An apartment occupant reflects on the challenge of understanding the technicalities of managing the heating system

RECOMMENDATIONS

A proactive approach to ensuring that users are able to easily and effectively use controls is needed. Estate agents have an important role in communicating information and guidance and accessible user manuals are vital.

Building managers are crucial yet often overlooked. Where they are in place, they should be trained to understand the intentions of designers and provide advice and guidance to occupants.

Engineering and architectural teams have an important role to play in optimising the efficiency and effectiveness of heating systems. They should take the opportunity to better coordinate their design efforts, particularly when utilising new technologies.

Extra Care Housing

Extra care housing provides older people with individual dwellings, communal facilities and care support, and has received extensive funding in the UK in recent years. When the state has contributed to the capital costs of an extra care housing scheme, there has generally been a requirement for that scheme to comply with particular energy ratings within the Code for Sustainable Homes. This requirement has been one of the principal drivers for the uptake of low carbon heating and insulation technologies in extra care housing.

Many occupants living in recently built energy-efficient extra care housing schemes appreciate the lower energy bills when compared with their previous homes. They are unlikely to experience feeling cold, in comparison to occupants of older schemes who often experience cold during winter months. Instead, it is becoming increasingly common for energy-efficient schemes to overheat due to high levels of thermal insulation. This problem is compounded by design features such as heated corridors and restricted window opening. This can cause discomfort and lead to occupants leaving windows open during the winter to reduce excessive heat, resulting in increased energy consumption.

Some occupants have difficulty using heating controls. Those with sight loss, for example, have difficulties reading the markings on thermostats or timers while others are more familiar with the Fahrenheit than the Celsius scale. Occupants with mild dementia sometimes have difficulty remembering how to change their heating systems from one season to another or they are confused over how to adjust the settings. In such cases they sometimes rely on family members or carers to operate their heating system. Heating controls in corridors can be a source of disagreement, and are used by some residents to obtain 'free heat' for their apartment (by turning up corridor thermostats and turning down apartment thermostats) despite their neighbours' complaints that the corridors are too warm.

Safety features on windows can restrict the ability to keep dwellings cool in hot weather

Reducing solar gain by drawing the shades closed during the day is a simple way to keep cool in summer months

‘It gets far too hot, and even though it’s cold outside, the sweat pours off me.’

A resident of extra care housing recounts her experience of discomfort caused by overheating

‘I have the fans on and if it’s not windy I have the balcony door open, that’s all you can do.’

An occupant describes his approach to moderating temperature

A white-on-white temperature control that has been modified by a user with sight loss

RECOMMENDATIONS

Possible design solutions identified to address the problem of overheating in extra care housing include

- **not heating corridors, except near entrances and large areas of glazing;**
- **introducing mechanical ventilation into corridors to alleviate problems caused by the lack of through-ventilation in single aspect dwellings;**
- **taking steps to prevent excessive solar gain;**
- **minimising excessive heat loads by using traditional forms of construction (rather than timber frame) to ensure buildings have a high thermal mass;**
- **using thermal modelling at the design stage to identify potential problems with overheating.**

Control interfaces, such as thermostats and timers, should be carefully designed or chosen to ensure that they are suitable for older people with diminished physical and mental capacities.

Scheme managers can be key to ensuring that occupants are comfortable. Managers should be trained to improve their understanding of how a building's designers intended comfortable conditions to be maintained. The manager can be the key to ensuring that occupants are comfortable.

Care Homes

Care homes are an institutional form of living space for older people and have staff who are responsible for the running of the home and who share the indoor spaces with residents. There are some similarities between care homes and extra care housing but the former have a higher degree of shared spaces in their layouts and also centrally managed heating systems. In contrast to extra care housing, in which occupants have their own apartment or bungalow and, crucially, their own front door, it is normal in care homes for there to be more collectively occupied and used space and for carers to have routine access to residents' bedrooms.

Management of thermal comfort in care homes is largely the responsibility of staff rather than residents and is not limited to technological approaches. Daily routines include the operation of temperature controls, opening of windows, provision of hot food and drinks, the use of blankets and dressing appropriately in warmer or cooler clothing.

Care homes are hybrid indoor environments – part long-term residence, part communal space, part working environment – and this can create tensions between staff and residents. They are also largely private businesses and vary considerably in organisational size. The adoption and use of new technologies is influenced by these distinctive characteristics.

In providing a professional care service, the reliability and performance of equipment is paramount since the provision of warmth is a critical part of providing effective care. Occupants of care homes are expected by staff to have higher health care needs and to 'feel the cold'. Demand for heat is usually continuous throughout the day and night and typically throughout the building. Some devices that are common in houses and flats (such as portable heaters or hot water bottles) are seen as too risky for use in a care home setting.

New energy technologies can enhance the quality of care. For example, underfloor heating allows for space to be used flexibly and removes some physical risks such as hot radiators. Other technologies can introduce reliability problems and difficulties in terms of operating and maintaining systems effectively. In some instances, a 'green' image provides a market advantage to a particular care home due to lower operating costs and improved comfort conditions.

A care home information board including weather forecast

‘And if I thought for any reason that it was too cold, then I would obviously report it to the person in charge to say, ‘this is unacceptable’.’

A senior carer indicates the high level of priority given to avoiding cold conditions for residents

‘You’ve got residents sitting around that can become quite cold, quite chilly. It might be a fine summer’s day, we’re working, rushing around and we’re really quite hot. So you’ve got the two people in the same building. How do you get it right?’

A staff member reflects on differing ways in which staff and residents experience indoor temperatures

‘Safety-wise, we wouldn’t use hot water bottles. Because...in order for it to benefit somebody, you have to put boiling water in it, then you wrap a towel round it anyway. And it would be too risky, with older people, who’ve got very often fragile skin anyway.’

A manager expresses concern for the safety implications of comfort practices

RECOMMENDATIONS

In managing thermal comfort in care homes, the wide range of occupants should be considered. This includes carers and other staff as well as residents with varied needs.

Given the importance of keeping residents warm and safe as an effective care service, new technologies and thermal comfort regimes need to minimise unreliability and physical risks.

The adoption of new technologies in care homes should be understood in terms of both infrastructure and operational context.

Care staff should be trained on the many ways in which the thermal needs and expectations of residents can be achieved, keeping them safe (which includes avoiding overheating in the summer) whilst maintaining their autonomy and dignity.

A typical modern care home building

A notice suggesting disagreement over operation of the heating system

Complicating Comfort: The policy challenges of housing older people

THE VULNERABLE USER

Implicit in the concept of specialist housing is the notion of the 'special occupant'. There is an observable tendency to design for the most vulnerable, at the risk of disregarding the comfort requirements of more active older people. This can result in design that does not adequately reflect the diversity of experiences and conditions of older people.

There is, for example, a commonly held perception that the priority should always be the avoidance of cold conditions. Whilst this is clearly important, the researchers found that older people can find indoor spaces at times uncomfortably warm. Building features related to vulnerability, such as restrictions on window opening, can make it difficult for occupants to moderate temperatures during hot weather.

The issue of overheating will be increasingly important in the UK with climate change projections suggesting that extreme temperature and weather events will become commonplace in future years.

CONTROL AND MEDIATION

How users interact with and control technology to set temperatures and other parameters is an important aspect of any heating system. With user interfaces often determined early in design processes, and by people with responsibility for safety and building operation rather than comfort and energy efficiency, it is important to consider their likely impact on occupant comfort and their sense of autonomy and control over their lives.

As identified in extra care housing, controls can be very difficult to use, particularly for those older people with dementia or sight loss. Dementia is challenging for carers because older people may be unable to clearly communicate concerns about comfort. In care homes, controls are sometimes concealed so that people with dementia do not inadvertently adjust them. In the French case study, restricting temperature controls in private living spaces with the implied aim of energy efficiency caused dissatisfaction amongst occupants.

Comfort is not simply the responsibility of the occupant; it involves conversations with building managers and owners, installers, and design team members. Having clear controls and an understanding of how comfort conditions are intended to be maintained in buildings can go a long way in creating liveable environments.

A RANGE OF APPROACHES

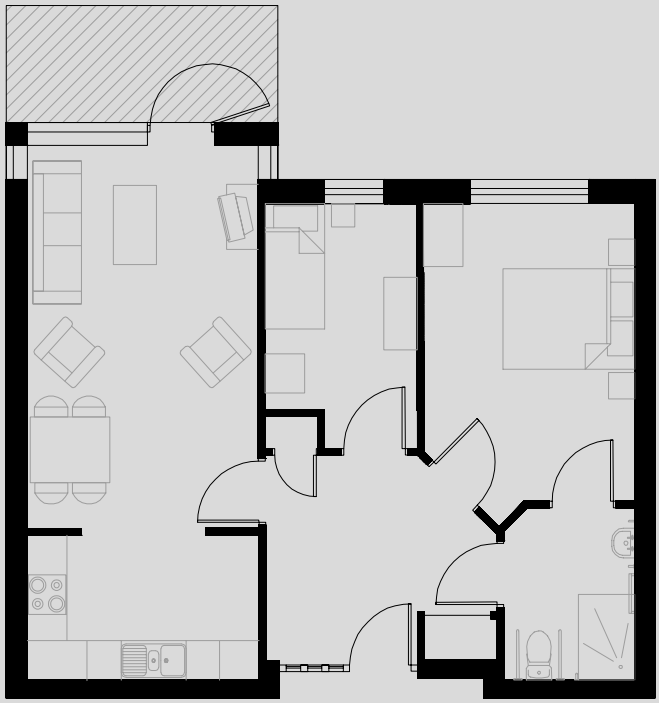
Technologies are not used uniformly over the year. In some private household examples, the researchers found that fuels such as oil, wood and coal were being used in the winter but were replaced with electric immersion heaters in milder months. Some appliances, such as portable heaters, have a supplementary role and provide either additional heat or a backup in case of failure. Comfort is an on-going negotiation rather than a constant condition.

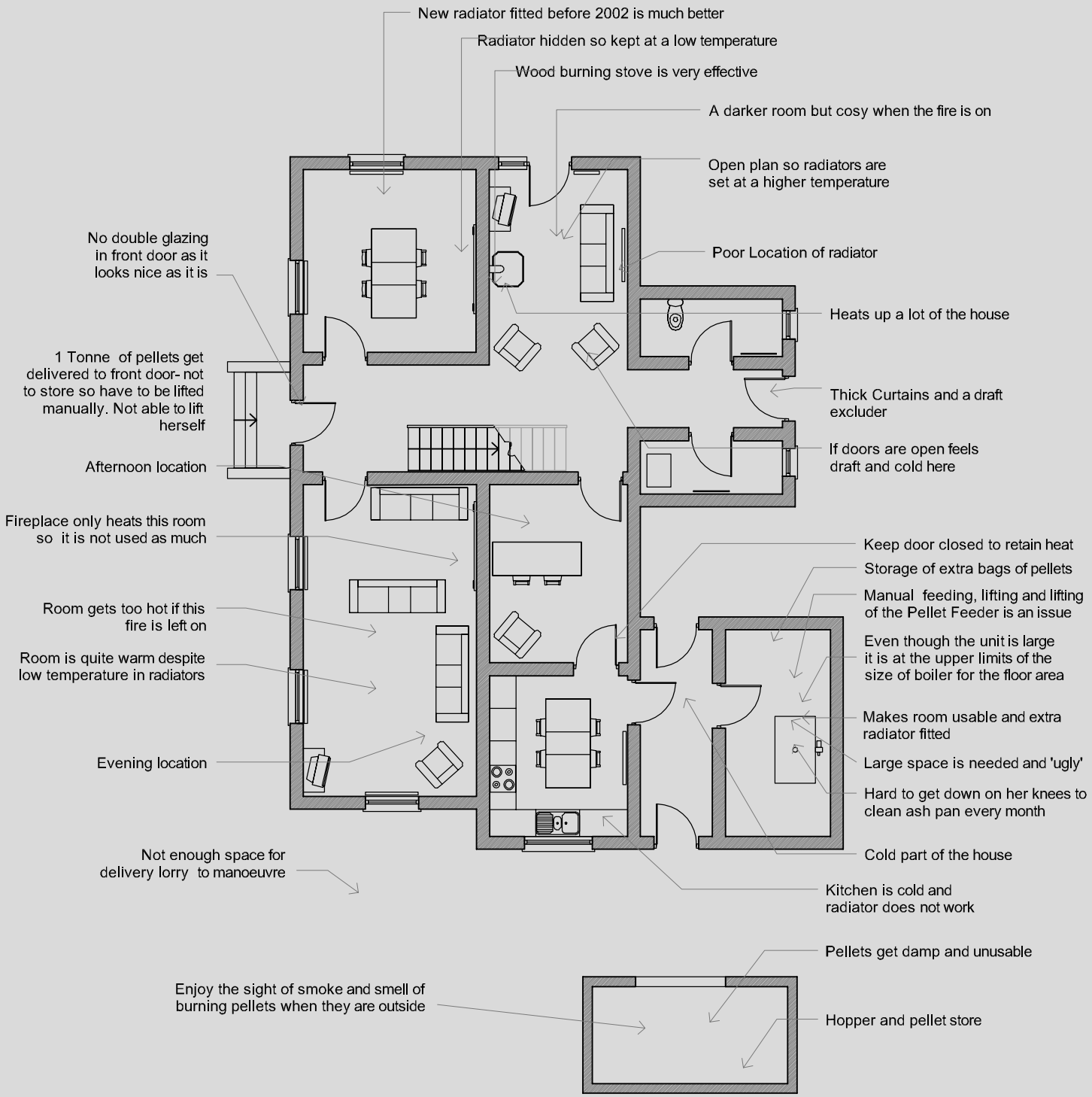
Technology is only one element in approaches to managing comfort, which can include opening and closing windows, going for walks or moving to another part of a building that has a more comfortable temperature.

SENSES AND SPACE

Temperature is only one factor in determining comfort; other issues play a role too. Occupants experienced the dispersed warmth of underfloor heating differently to the more visible and concentrated heating that comes from a radiator. Other sensory elements, such as the sound of ventilation and the smell of fresh air, are important too. Interviewees mentioned that the glow of a fireplace provided a social focus, something to gather around with friends and family, as well as a psychological sense of warmth.

As thermal efficiency increases, occupants may be less concerned about leaving doors open and keeping heating on in underused rooms. This has implications for energy consumption, and for how the seasons are experienced, implying a more uniform, less time-dependent experience of thermal comfort.




New radiator fitted before 2002 is much better
Radiator hidden so kept at a low temperature
Wood burning stove is very effective
A darker room but cosy when the fire is on
Open plan so radiators are set at a higher temperature
No double glazing in front door as it looks nice as it is
Poor Location of radiator
Heats up a lot of the house
1 Tonne of pellets get delivered to front door- not to store so have to be lifted manually. Not able to lift herself
Thick Curtains and a draft excluder
If doors are open feels draft and cold here
Afternoon location
Fireplace only heats this room so it is not used as much
Keep door closed to retain heat
Storage of extra bags of pellets
Manual feeding, lifting and lifting of the Pellet Feeder is an issue
Room gets too hot if this fire is left on
Even though the unit is large it is at the upper limits of the size of boiler for the floor area
Room is quite warm despite low temperature in radiators
Makes room usable and extra radiator fitted
Evening location
Large space is needed and 'ugly'
Hard to get down on her knees to clean ash pan every month
Not enough space for delivery lorry to manoeuvre
Cold part of the house
Kitchen is cold and radiator does not work
Pellets get damp and unusable
Enjoy the sight of smoke and smell of burning pellets when they are outside
Hopper and pellet store

A Socio-Technical Approach to Comfort

This plan (left) depicts a house that was built over a hundred years ago and has seen many changes, both in terms of physical adaptations and inhabitants. This example provides a socio-technical lens through which to view our themes (pages 12-13). It is derived from an actual case study from this research project.

A socio-technical approach recognises that society and technology co-evolve. Whilst a system may appear to be technologically rational, it may not meet the needs or expectations of users. Rather than simply assuming that people use energy, it understands that energy consumption intersects with everyday life through diverse and culturally mediated practices such as heating and cooling.

In this home, the **user**, perhaps an older person, faces challenges in manually stocking and lifting the pellet feeder, getting down on her hands and knees to clean the ash pan, or experiencing discomfort in an overheated room. Space limitations mean that pellets are delivered to the front door but have to be carried round to the back of the house. A **range of approaches** to thermal comfort can be seen, including the wood-burning stove, radiators, and a fire, alongside more informal methods such as thick curtains and a draft excluder. There is a relationship between **comfort and the senses**: the occupant enjoys the sight of smoke and the smell of burning pellets when she is outside and has decided not to double-glaze the front door because it detracts from the aesthetic value of the house. The plan also illustrates the ways in which experiences of comfort can influence the **use of space** in the house: the kitchen can be cold, but the front room can be made cosy with the wood-burning stove. The use of technologies has co-evolved with the layout of the house: for example, the furniture in the front room obscures the radiator and so it is little used.

This example shows that comfort is highly dependent on the physical attributes of the house as well as the preferences, knowledge, and capabilities of the occupants.

About this Project

The findings in this briefing are derived from the project 'Conditioning Demand: Older People, Diversity and Thermal Experience'. The project was funded by EPSRC, ECLEER, and EDF and is part of the 'People, Energy, Buildings' collaborative research programme.

Between 2011 and 2013, the research team looked at energy consumption and thermal comfort in domestic settings in the UK and France. In a changing technological and demographic context, the aim was to understand the implications of these trends and how they relate to domestic thermal experiences amongst older people.

The team studied care homes, extra care housing developments, multi-occupancy houses, and single-occupancy houses. For each category at least half of the sites chosen had taken steps to increase energy efficiency or use low-carbon heating technologies while the other half had conventional technologies.

A range of methods was used to study comfort. Quantitative data included SAP ratings of buildings. Photos and buildings plans enabled visual and spatial analysis. Interviews with occupants, designers, building managers and care home staff enabled the team to get a thorough understanding of day-to-day experiences of thermal comfort.

The outcomes of the project are relevant to a range of stakeholders including NGOs, community organisations, and the general public by elucidating the multiple factors that shape thermal experience. The findings are relevant to a diverse array of academic disciplines, including sociology, architecture, urban planning, engineering, science and technology studies, geography and environmental psychology.

PROJECT WEBSITE
www.sed.manchester.ac.uk/research/marc/conditioningdemand

The photos and illustrations in this briefing have been selected from both the fieldwork and a stock photo library.

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