Preventing Overheating

Investigating and reporting on the scale of overheating in England, including common causes and an overview of remediation techniques

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Stuart Wigley	Baily Garner
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This work runs alongside GHA's associated work for the TSB Design for Future Climate investigating flats at One Brighton.

Contents list

Summary

High temperatures in homes are known to cause real problems for occupants. These range from discomfort and mild health effects, to serious health effects[1]. Elderly people and other vulnerable groups are most at risk from these effects, and with an aging population, greater urbanisation and climate change predicted, the risk of overheating needs to be addressed.

This study aims to identify the factors present with known cases of overheating in England, to build a picture of the problem and to highlight the types of dwellings that could be at risk. It also investigates some of the solutions presently used to avoid and tackle overheating.

This investigation approached Environmental Health Officers, housing providers and consultants, through two online surveys. 126 useful responses to the first survey were received, which provided information on 90 of the 185 instances of overheating identified. More detail was obtained on 12 of these instances, in a second survey.

The main findings are as follows:

1. Overheating is a problem in housing

A total of 185 instances of overheating are identified in this study. Nearly half (61) of the 126 survey respondents each identified between 1 and 6 instances of overheating in homes.

While these numbers cannot be considered representative of the situation in England or the UK as a whole, the lack of an effective reporting process suggests that these instances are probably the tip of the iceberg.

A relatively high percentage of the overheating instances revealed by this study occur in two particular housing, the majority of which are in urban locations and occupied during the day:

- Converted flats
- Newly built flats

There are nearly 1 million existing converted flats in England, and new flats are presently built at a rate of around 30,000 per year in the UK. An urgent review should be carried out to assess how many of these flats feature the risk factors identified in this report.

2. The occupants of these homes suffer significant discomfort and disruption

Overheating is a problem that affects everyone using the home, but those specifically at risk are elderly or disabled people and others who are more vulnerable to health effects of higher temperatures, particularly as they are often confined to their homes during the day.

89% of the instances presented here are occupied during the day. Many occupants of the dwellings presented here change the way that they live, or even avoid being in their homes at all during the warmest times. Although their activities do contribute to internal heat gains, occupants are not doing anything that would be considered unusual for a modern lifestyle. However, they do also need support in understanding what they can do to keep comfortable in their homes in warm weather.

3. Urban flats are most at risk of overheating

Urban locations

66 (73%) of the 90 overheating instances, for which information was provided, are in urban locations, and 19 (20%) in suburban locations. Common factors included:

- High density areas
- Hard surfaces and lack of green space
- Noisy roads, security and pollution concerns preventing window opening

Converted flats

27 (30%) of the 90 instances of overheating are in converted flats, and 19 of these are in pre-1919 buildings. Particular problems were identified with:

- Conversions, which divide a previously naturally ventilated house into lots of small spaces, which are often single aspect or in the roof space
- Un-insulated roof spaces
- Either a total lack of windows, or windows that are fixed, or painted shut

The very small units in houses in multiple occupancy (HMOs), and those rented to students, are likely to be at particular risk. It should also be noted that these types of flats are also likely to be uncomfortably cold in the winter and difficult to heat. With close to a million converted flats in England[2], a significant number of flats in older properties may be at risk of overheating.

New flats

43 (48%) of the 90 instances of overheating are in purpose built flats, 28 (30% of the 90) were built post 2000. Improved levels of insulation and airtightness will reduce external heat gains, but will also retain heat, unless an effective ventilation strategy is in place, either through natural or mechanical means. Many of the instances presented here relate to one flat within a large block, where many other flats could also be at risk of overheating. A number of different causes were identified, and most of the instances featured more than one of these problems.

- Locations in high-density areas close to noisy roads and hard surfaces.
- Layouts producing single aspect flats opening onto a central corridor.
- Highly insulated and airtight flats, which are inadequately ventilated.
- Large areas of full-height glazing, often south/ west facing and/or un-shaded.
- Windows that are fixed or have limited opening (often as low as 10% openable area).
- Communal heating and hot water distribution pipes running through flats and/or unventilated corridors.

In the UK, purpose built flats represent more than a third of new housing[3]. New housing is presently built at a rate close to 100,000 units per year[4] (88% of which is built in England), and is predicted to rise. While the numbers of these new flats are small compared to the total dwelling stock, the relatively large numbers reported to this study suggest a significant risk of overheating problems in certain types of new flats.

4. Overheating can be solved and prevented

There are many existing causes that are difficult or impossible to change, such as the location, form and the layout of hot water distribution. In fact one respondent stated that the only solution would be a complete redesign of some types of housing.

However, many overheating problems can be dealt with by reducing heat gains from windows and from hot water distribution, together with providing effective ventilation[5]. It should be possible to include most of these measures in existing maintenance procedures and by providing occupants with guidance on when to shade and close windows as well as when to open them. One effective but more costly solution successfully applied to both converted and purpose built flats is to replace the windows with ones that can be opened effectively.

In some instances, noise, pollution and security issues prevent occupants from opening their windows. In these cases, if a redesign is not on the cards, the only solution may be to install mechanical ventilation, or in extreme cases, comfort cooling.

Other effective solutions include:

- Pre-1919 flats: insulating roofs
- New flats: reducing glazed areas with opaque panels or film; installing mechanical ventilation in flats and corridors.

Most of these problems can be avoided in new developments. There is good guidance available that highlights these issues, and should be carefully considered during the design. However, the overheating checks required for building regulations are not sufficient on their own, to prevent overheating in new homes. Where possible, dynamic thermal modelling can also highlight the risk of overheating, but needs to be used alongside a good understanding of the assumptions and implications, as well as common sense and design skills, in order to be effective.

5. The reporting process needs improvement

One of the most striking results revealed by this study, is that only 47 of 120 respondents stated that they have a process in place for recording and dealing with overheating problems. Additionally, many of the instances identified here were reported to us by individual Environmental Health Officers or housing managers, who were particularly concerned for the well being of the occupants. It is possible that many more complaints of overheating never reach the right person, or go unreported. The processes that are available for dealing with overheating and other hazards are difficult to access for some and considered cumbersome, and at a time of cuts in Local Authority staffing levels, this is likely to become more difficult.

Recommendations

This is a small study, therefore the results cannot be considered representative for the country as a whole. However, from the instances presented here, we would conclude that overheating can be a serious problem for people living in specific types of housing. Many of these homes are in urban areas, and the large majority are flats. With summer temperatures in the UK predicted to rise in coming years due to climate change, instances of these problems are likely to increase. Therefore, housing which is at risk of overheating needs to be identified and measures taken to reduce the risks.

No instances of overheating in unconverted pre-1919 houses were identified. Although houses are not covered in detail in this report, due to the lack of instances presented, it would seem sensible to consider some of the risk factors identified in new flats, when looking at the possibility of overheating in new houses.

Based on the instances presented here, we would conclude that the following dwelling types are at risk of overheating and should be inspected with a view to taking urgent measures:

- Housing for vulnerable people should be prioritised.
- Any flat that has large areas of un-shaded glazing facing south, east or west.
- Any naturally ventilated flat where the windows are not opened, either because:
    - They are sealed
    - They are not fully openable (restricted to prevent falling)
    - Or where security, noise or outdoor pollution concerns prevent occupants from opening windows
- New blocks of flats having a single-aspect, leading from a central corridor, and where heating and hot water is distributed around the building.
- Older buildings that have been converted into small flats or houses of multiple occupancy. Particular attention should be paid to south and west facing flats and those on the top floors or attics.

Any new buildings with these features, which are still at design or construction stages, should also be reviewed and measures taken to avoid future overheating problems.

Additionally, in order to avoid future problems, the design guidance already available should be used and a risk matrix developed to enable this process. A review of the design process and existing policies relating to overheating would help to identify how these instances occur, and what improvements are needed to avoid future problems. Research into solutions applied to housing in hot countries would also be useful.

It is also important to consider policies that encourage measures such as communal heating and high-density development, and the possibility of unexpected consequences in the light of the instances presented here.

1 Introduction

1.1 Sustainable homes

The **Good Homes Alliance** is a group of housing developers, building professionals and other industry supporters whose aim is to close the gap between aspiration and reality by showing how to build and monitor homes, which are sustainable in the broadest sense. Recent priorities have focussed on:

- low energy use
- health and well-being
- proof of performance

The GHA considers the design and construction of good homes in terms of the following physical characteristics:

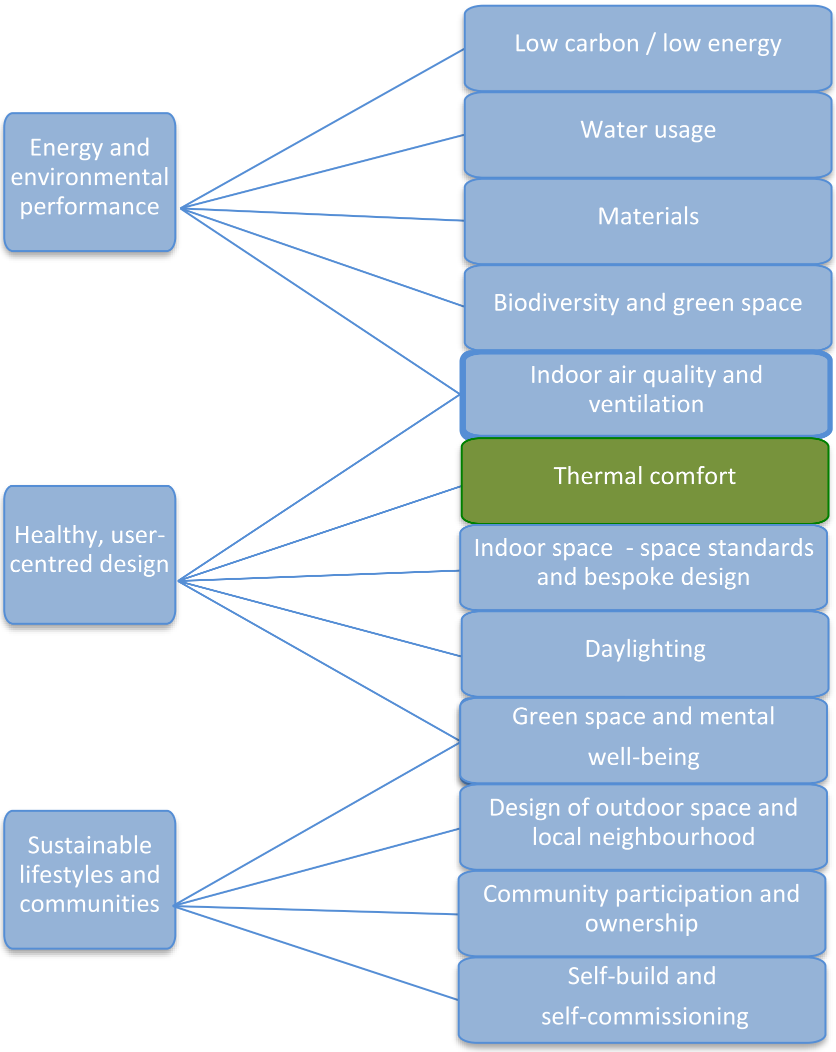

Figure 1 – A Schematic of GHA constituents of a 'good home'.

These characteristics are considered at all stages of the process, through planning, procurement, design, construction, operation and maintenance. Additionally, monitoring and feedback are considered crucial in order to gather evidence and learn what works and what does not.

The focus of the work presented in this report is 'Thermal comfort', specifically instances of overheating in homes. However, it should be remembered that no one aspect can really be considered in isolation. The evidence presented here illustrates how other aspects also influence thermal comfort. Aspects such as the drive for lower energy use, ventilation, space standards, materials, the form and orientation of the building, plus the buildings relationship with the surrounding space and other buildings.

1.2 Healthy homes

Recent years have seen the construction industry focus on reducing energy use in new and existing housing. Building regulations require the building fabric and services to be more energy efficient. Heat lost through the building fabric, is reduced by increasing insulation thickness. Heat lost through uncontrolled ventilation is reduced, by making the envelope more airtight (alongside the provision of a purpose provided ventilation system).

These measures have significantly reduced the predicted energy used for space heating. However, real buildings examined in recent years, have revealed a number of unexpected consequences. These have a significant impact on real energy use, and the healthy, comfortable environment that a home is expected to provide.

These problems are seen in existing homes, refurbished homes and newly built homes. And include:

- More energy used than predicted
- Poor indoor air quality, including damp and mould growth
- Unsatisfactory thermal comfort, both too cold and too warm.

This study examines the issue of overheating experienced in existing, refurbished and new homes in England.

1.3 Overheating and health

The health impacts of overheating have been well documented. The Health Protection Agency describes some of the effects:

> *Mild heat related health effects include dehydration, heat cramps, heat odema, heat syncope and heat rash. Potentially severe health effects include mental health consequences, heat exhaustion and heat stroke*[6].

Vulnerable people are identified as being those who are very young or very old, those who have chronic illnesses, are obese or are on certain types of medication. Additionally, those who live in urban areas and those who are confined to their homes during the day, are identified as being more likely to be exposed to higher temperatures.

Elderly people, particularly those over 75 are less able to cope with higher temperatures. The heatwaves (totaling 53 days) of 2003 have been linked to 700 extra deaths in England and 15,000 in France. Many of these were elderly people who suffered thrombotic stroke and heart failure[7].

Definitions of overheating, and the point at which it becomes a risk to health, are still under discussion. The Health Protection concluded that:

> *… a single temperature threshold is difficult establish due to individual adaptive factors and vulnerabilities.*[8]

1.4 Overheating homes

The temperature within a dwelling is the result of the balance between heat gains and heat losses. In hot weather, heat is gained both from inside the home and from outside.

1.4.1 External heat sources

The sun

- Excessive south and west facing glazing
- Un-insulated roofs
- High areas of hard-surfaces close to the building

Other external heat sources

- Hot air exhausted by cooling systems in other buildings
- Cars, buses and other vehicles

1.4.2 Internal heat sources

- Cooking and appliances
- People and pets
- Heating and hot water distribution systems
- High thermal mass, without an effective night cooling strategy

1.4.3 Inability to cool the dwelling

- Insulated walls and roof
- Airtight building fabric
- Insufficient areas of openable window
- Concerns over security, noise or other preventing window opening
- Insufficient mechanical ventilation
- Or poorly designed, installed or operated mechanical ventilation

In an older building, much of the heat that builds up can be lost through un-insulated walls and roofs as well as draughts, particularly at night when outside temperatures drop. However, with insulation levels and airtightness improving, new homes rely much more for cooling on purpose provided natural or mechanical ventilation.

Insulation will slow down heat transfer, and therefore will reduce heat gains as well as reducing heat loss. An un-insulated space will heat up quickly during the day, and cool down quickly at night if the outside temperature is low enough. A well-insulated space will be less influenced by external heat sources, but large areas of glazing and internal heat sources will contribute to temperature rises, which will be difficult to reduce without a deliberate ventilation or cooling strategy.

This means that in new homes at risk of overheating, windows and mechanical ventilation systems become crucial tools for cooling, and when these are incorrectly designed, installed, or used, overheating can become a significant problem.

Various causes of overheating are identified in this study, and many of the instances presented here demonstrate how overheating often results from more than one of these causes, together with an inability to cool the dwelling sufficiently.

2 This study

2.1 Background

On the 9th of July 2012 research from National House Building Council (NHBC), Building Research Establishment (BRE), Department for Communities and Local Government (DCLG) and AECOM, was presented at the Good Homes Alliance (GHA) Preventing Overheating event at the Chartered Institute of Environmental Health (CIEH). Prior to the event, the GHA held a call for evidence relating to this issue, which identified a significant level of concern about the occurrence of overheating in homes, both old and new. This call for evidence returned 12 instances of overheating. A further 6 case studies are detailed in the NHBC Foundation's report *Understanding overheating – where to start: an introduction for house builders and designers*. Many of these dwellings are recently built to Building Regs Part L 2002, and beyond, as well as flats in older buildings. The issues raised included a mix of problems, such as:

- Insufficient window openings
- MVHR issues
- Single aspect blocks on busy streets
- Units with communal heating systems
- Excessive solar gains, especially south and west facing glazing

Cases of overheating are dealt with by Environmental Health Officers serving notice under the Housing Act 2004, but as there is no central register, the extent of the problem is unknown. DCLG/AECOM published a review of overheating on the 20th of July 2012; the accompanying Gap analysis indicates that we do not as yet have a good understanding of the scale of the overheating problem. This study attempts to address that gap to some extent, and has run alongside the GHA's TSB funded project; Design for Future Climate Change led by Dr Rachel Capon, as well as current, on-going monitoring work at One Brighton, in partnership with UCL; Temple Avenue with Joseph Rowntree Housing Trust and Leeds Met and Stawell with Oxford Brookes University.

There is a good range of publications and research detailing the causes of overheating in buildings, as well as clear guidance for designers on how it can be avoided (see Appendix C). There is also anecdotal evidence of overheating problems, but no real idea of how widespread or serious they are. This study aims to help build a picture of the problem, and identify the housing types and locations most at risk, hopefully prompting the construction industry and government to take action.

This study aims to identify the factors present with known cases of overheating, and therefore to build a picture of the problem and to highlight the types of dwellings that should be reviewed.

2.2 Preparation

This study was prepared in consultation with a working group consisting of experts with experience and knowledge of overheating as an issue. The individuals involved in providing feedback on the strategy and survey drafts are listed at the start of this report. Some of the issues that were highlighted in these meetings are:

- Scope – A focus on England, instead of the UK was decided, due to the reach of the main contacts. The inclusion of care homes – although housing for the elderly was not targeted, three of the detailed responses were for sheltered housing.
- Occupant surveys – The question of whether occupants should be approached directly with questionnaires was discussed at some length during both meetings. Although the information presented here is reported to us by EHOs, building managers and consultants, the occupants of the dwelling are ultimately the source. Overheating is a problem uniquely experienced by the occupants of the dwellings, and therefore any in depth investigation must include them. It was not found to be possible to include occupant surveys in this study. However, guidance on possible work in this area is presented in the final chapter of this report. It was noted that a questionnaire distributed to occupants by the Homes and Communities Agency (HCA) did not identify any overheating problems. This may have been because these were new homes that people were happy to be in, and the timing was too far from summer.
- Definitions of overheating – It is important to clarify how overheating is defined: by designers, occupants, building managers and environmental health officers. The instances presented in this study were identified mainly due to occupant complaints, or concerned building managers. Therefore there is often no specific definition used for overheating.
- Information – ideally, an in depth study would have access to information from all parties involved: occupant feedback, description of the problems, causes, solution considered and applied, contributory factors, design process, regulations, modelling and assumptions used. This study has only been able to access information from environmental health officers and some housing managers. This provides a picture of the problems and solutions, but is limited in terms of showing how the buildings were designed and built.

Due to the small size of this study, it was not possible to address all of these concerns. However, they do provide a focus for action and future possible research, which is reviewed in chapter 7. Of particular importance for action is the vulnerability of specific occupant groups, and improvements needed to the reporting process.

2.3 Strategy, method and responses

This study is a small-scale investigation into overheating problems in England. By approaching Environmental Health Officers, Housing Associations and members of the Good Homes Alliance, it has been possible to build a picture of some of the common overheating problems experienced in various housing types, together with common causes and solutions. While this cannot provide an assessment of the exact numbers, it does help to inform discussions around the severity of the problem and to help identify homes likely to be at risk, as well as what is being done to reduce existing overheating problems and avoid future problems in converted and new dwellings.

This investigation approached environmental health officers and housing providers, through two online surveys:

1. The first stage survey aimed at a wide audience aimed to build a picture of the size of the problem, and identify some common causes. Results presented in appendix A.

Approached	Method	Responses	Results
• 207 Environmental Health Officers and 400 Local Authorities through CIEH • 1,200 Housing providers, through NHF • 40 GHA members	Online survey with mandatory questions about the respondent, reporting procedure, number of overheating instances encountered.	126 responses: • 77 Environmental Health Officers • 26 housing owners and managers • 9 Local Authorities • 14 consultants	• 47 respondents (37%) have a reporting procedure for overheating • 61 respondents (48%) reported between 1 and 6 instance of overheating, totalling 185 instances
	Optional questions detailing the overheating instances: location, dwelling type, age, tenure, construction, services and occupants.	The optional questions were answered on up to 90 of the 185 instances identified by the mandatory questions.	• 73% in urban locations • 78% flats • 24% pre 1919 and 48% post 2000 • 48% private rented and 43% Housing Association • 68% heavy weight construction • more than half rely on window opening for ventilation • nearly half have communal hot water system • 89% occupied during the day.

Figure 2 – First stage survey method and responses

2. The second stage survey aimed to investigate 12 instances in more depth, exploring the detail behind the problems and the solutions considered. Results presented in Appendix B.

Approached	Method	Responses	Results
12 of the overheating instances selected from those revealed by responses to the first stage survey.	• Online survey, with further questions detailing the 12 instances of overheating, how they were reported, problems experienced by occupants, solutions found.	• Three converted flats in pre 1919 buildings • One disability access post 2000 house • 5 post 2000 purpose built flats • 3 post 2000 purpose built sheltered housing flats	A number of stories revealing common risk factors, solutions considered, lessons learnt and barriers encountered.

Figure 3 – Second stage survey method and responses

While the response numbers cannot be considered representative of the situation in the UK or England as a whole, the lack of an effective reporting process suggests that the instances presented here may well be the tip of the iceberg.

2.4 Limitations

2.4.1 Response rate

The response rate is relatively low, and therefore the results cannot be considered representative, nor can this report fully assess the scale of overheating in the UK. This study does, however, manage to identify the factors present with 90 known cases of overheating in England, and therefore to build a picture of real overheating problems and to highlight the types of dwellings that seem to be most at risk. It also investigates some of the solutions presently used to tackle overheating.

In order to increase the response rate as much as possible, anonymous responses were accepted. The danger with this is that more than one person might report the same instance of overheating, and therefore skew the results. Responses were analysed to compare variables and none of the 90 instances presented here match another exactly.

2.4.2 Measured versus perceived overheating

The instances of overheating presented here are not measured. They are experiences of overheating reported to this study. The difference between perceived overheating and measured overheating is important, as different people with different levels of activity perceive comfort in different ways. Additionally, the presence of air conditioning in many buildings may change expectations of what is a comfortable temperature.

However, while measuring and defining overheating is important for helping to predict risks, real overheating is experienced by people. If they are uncomfortable in their homes because of the heat, there is a problem.

2.4.3 Respondents

The types of households and dwelling types reached by this study have been limited by the types of respondents who answered the surveys. The majority of overheating instances presented here were either private rented homes (48%) or housing association homes (43%). This is most likely due to the sources of respondents being limited to Environmental Health Officers (61%) and housing owners and managers (21%), because of the way that the survey was distributed. As a result, owner occupied dwellings are almost completely unrepresented here, despite comprising 66% of the housing stock[9].

Reports for this study were made not directly by occupants, but via professionals working within housing. This means that the results reflect judgements made by these individuals, and the conclusions that can be drawn in this study are limited by this fact. However, it should be noted that these are professionals with experience in this area and their expertise should add weight to these reports of overheating instances.

Most of the instances of overheating presented here are in homes occupied during the day (89%). It is possible that overheating may not have been considered a problem, if they had been unoccupied during the day. While occupants do not cause overheating, the way that they use their homes can influence temperature and comfort within the home at different times. Some people are better able to respond or adapt to this than others.

It should also be noted that many potential respondents (professionals working in housing) may have been prevented from responding at all, due to fears of reputational risk. With the existing reporting process, it seems likely that many instances of overheating are never reported, or do not reach the right person. Those renting privately are often unwilling to report problems which may threaten their lease. And for private housing there is no real complaint route other than back to the builder. Therefore it seems possible that many more instances of overheating remain unreported at various levels.

Additionally, several respondents to the first stage indicated that they had experienced more instances than they were reporting to us.

> *While I am reporting one example in this survey, all the complaints are of a similar nature.*
>
> *There are more examples than this, but they represent houses in the same schemes.*

However, those that have provided details to this study will have their own reasons for responding. Whether these reasons are professional integrity, concern for the occupants, curiosity or some other, they might have influenced the responses presented here to some extent.

The following chapters present the information gathered from the results of both stages and discuss the implications, detailing:

- The overheating problems found (Ch 3)
- The types of dwellings affected (Ch 4)
- The common risk factors identified (Ch 5)
- Measures taken to avoid and solve overheating (Ch 6)
- Implications for the reporting process (Ch 7)

3 Overheating in homes

3.1 The nature of the problem

Residents report problems with overheating because they are uncomfortable in their homes. Many occupants described in the instances presented here, found it difficult to use certain rooms, or to sleep at night. In extreme cases they even avoided being in their homes at certain times of the day in hot weather.

> *One occupant keeps a close eye on the weather forecast and makes arrangements to stay away at the weekends in sunny weather.*
>
> *Another family avoid cooking as much as possible.*

Elderly people, those with a disability, and families with young children, are often confined to their homes for much of the day. These are the people most likely to experience overheating, with 89% of the instances presented here relating to dwellings occupied during the day. These are also the people who are most vulnerable to the effects of higher temperatures, particularly when there is little relief.

In order to make their homes more comfortable, occupants often find temporary solutions of their own, such as using curtains for shading, fans or air conditioning, or avoiding certain rooms during the summer months.

> *In a block of sheltered flats some residents open their main flat door to increase ventilation, but the corridors are too hot due to horizontal heating distribution pipes.*

In older properties overheating is almost always experienced alongside problems with cold in the winter months.

> *All problem attic flats are the same as the one highlighted and have required enforcement action to remedy - they also suffer excess cold and often dampness and mould due to condensation problems.*

3.2 The numbers

In all, 185 instances were identified by around half of the 126 individuals who responded to the first survey. More detailed information was provided on 90 of these instances, but some questions were only answered on as few as 30 instances. More detail is presented in Appendix A, but in summary (based on between 30 and 90 instances, depending on whether the question was answered):

- 73% of instances are in urban locations and 21% suburban
- 78% are flats, half of which are on the top floor, and three quarters mid-block
- 48% of instances were built post 2000, and 24% pre 1919
- 48% are private rented properties and 43% housing association properties
- Only 47 responded to the question on glazing orientation, but 70% of those who did have some south facing glazing

- Nearly half have a communal heating system, and a quarter communal heating
- 55% rely on window opening for ventilation, 20% on extract ventilation, and the rest on mechanical, MVHR or some other form of ventilation
- None of the instances have air conditioning, while in only 9 instances fans are used
- 77% are heavy weight construction and 23% lightweight
- Nearly half have elderly occupants, and half have young children living in the home, while 89% have occupants who are at home during the day

3.3 The stories

A range of different overheating situations is described in the responses to the first stage survey, along with what some respondents think is the cause.

Older properties, which had been converted into homes:

- *The bedsit had low ceiling that was not effectively insulated so it was very warm in the summer and very cold in the winter.*
- *A 1960s concrete construction shopping centre with flats over. Extreme problems with excess cold and heat; 2 exposed walls, exposed flat roof and part exposed floor.*
- *A 1960s flat in the town centre with un-insulated flat roof. Problems with south facing frontage, so heat gain from windows and roof.*
- *This flat was part of a converted church with a south facing elevation and no openable windows.*
- *Problems are invariably student flats in old conversions of 19th century properties - ie poorly insulated attics. Often these flats are not self-contained and are part of an HMO.*
- *Ground floor was a shop, with a metal shutter to the front. Now being used as a flat without building regulation consent or planning approval.*
- *A house in multiple occupation (house shared by students) in a mews terrace. The top floor letting lies within the loft space within an un-insulated mansard roof. No provision had been made for a window to ventilate the room directly to external air. This room opens onto a rooftop conservatory, which has a very large glazed area that would gain heat considerably during the summer. The building is south facing, which would maximise heat gain from the sun.*
- *A 2nd / 3rd floor maisonette in a small purpose built apartment building. The 3rd floor had been added on in the 1950's as an artist's studio. The roof is constructed of corrugated tin and there is little thermal insulation. The window mechanism does not work so there is no ventilation and a large section of the front wall is glazed.*
- *Both properties included skylight windows and were bedrooms in the roof (attic rooms). Each property was let as a bedsit in a 3 storey HMO*

And newer housing:

- *The building is SIPs built in 2008 with high performance double glazing to EcoHomes but also used as a trial for Code Level 3. Traditional design no solar shading etc.*
- *Flat located directly above boiler house providing a district hot water/heating system to some 300 properties inadequately insulated/ventilated/cooled.*
- *2002 built RSL owned block of flats of non traditional construction. Poor means for controllable ventilation with only french doors to all rooms on ground floor and no secure windows and well-insulated walls not allowing heat to dissipate.*
- *While I am reporting one example in this survey, all the complaints are of a similar nature and type. They usually occur in high-rise properties, which get their heating requirements via a district heating design. We often get enquiries about over-heating but as many as people saying they are cold as well.*
- *In all the cases we encountered overheating was caused by excessive heat/poor ventilation in corridors, stairwells and communal areas*

Some housing specifically for elderly residents:

- *I have experienced similar problems, throughout my career at a number of HA providers, all relating to sheltered or schemes specifically for the elderly.*
- *All three cases have housed elderly in sheltered tenures (due to the fact the sheltered schemes have less natural ventilation, the customers reluctance to use any (windows) their medical conditions have a big impact & their life styles)*

And views of the causes:

- *In our experience the primary issue is the extent of un-insulated sloping ceiling area, which allows the room to suffer excessive solar gain.*
- *Non-opening windows big problem.*
- *Main living room ventilated by door rather than window.*
- *Roof light the only ventilation into the room.*
- *There were virtually no windows openings on a converted shop premises with the whole front wall glazed.*
- *The main bedroom was in a converted roof space, which had no windows.*
- *Lack of adequate insulation to hot flow and return pipes. Lack of temp controls on communal boilers. Lack of background vents in windowless corridors.*

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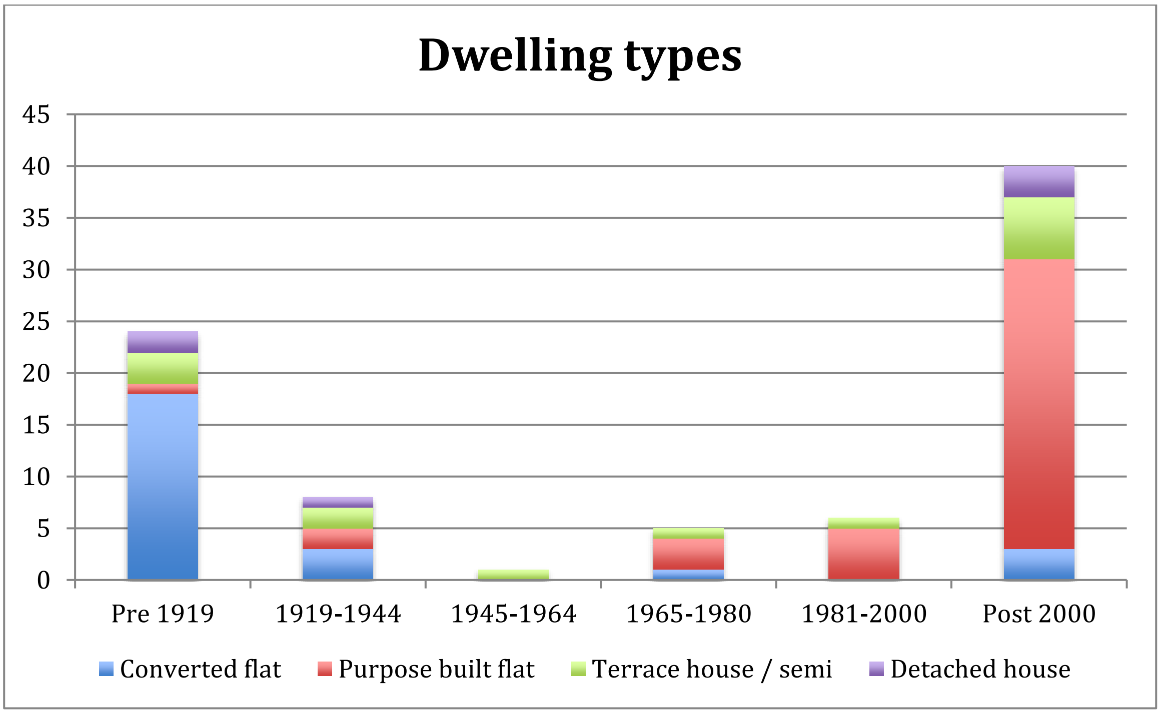
4 The types of dwellings affected

Of the 185 instances of overheating identified in the first stage, 84 provided enough information to build a picture of some of the types of housing that are experiencing overheating problems.

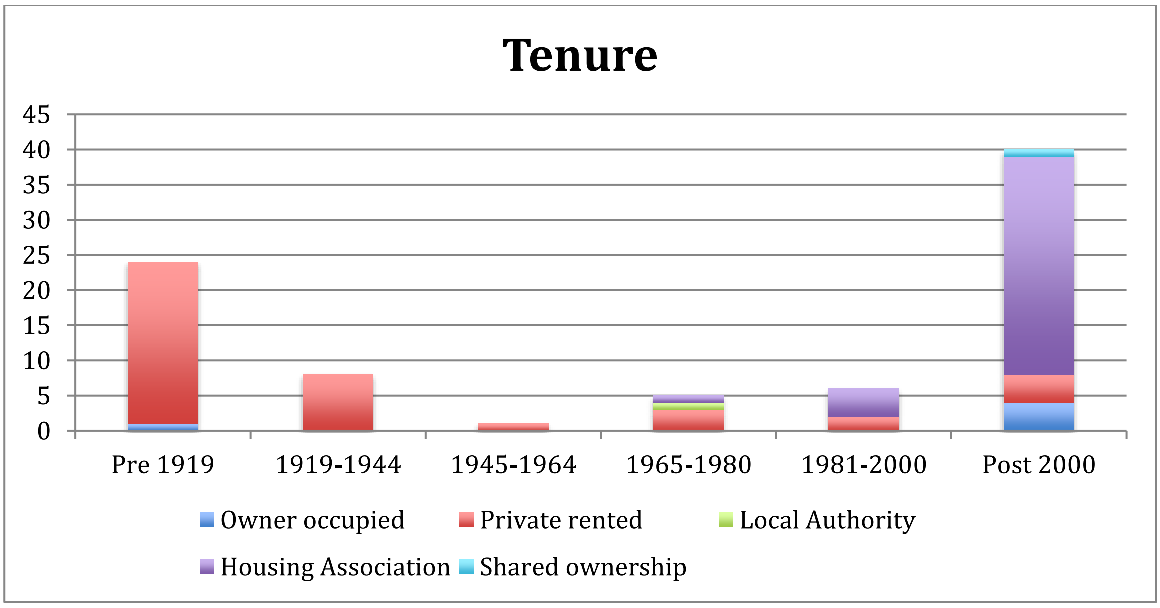
4.1 Dwelling types

The majority of the instances reported in this survey and presented here are flats, mostly in converted pre-1919 buildings, or in purpose build blocks built after 2000.



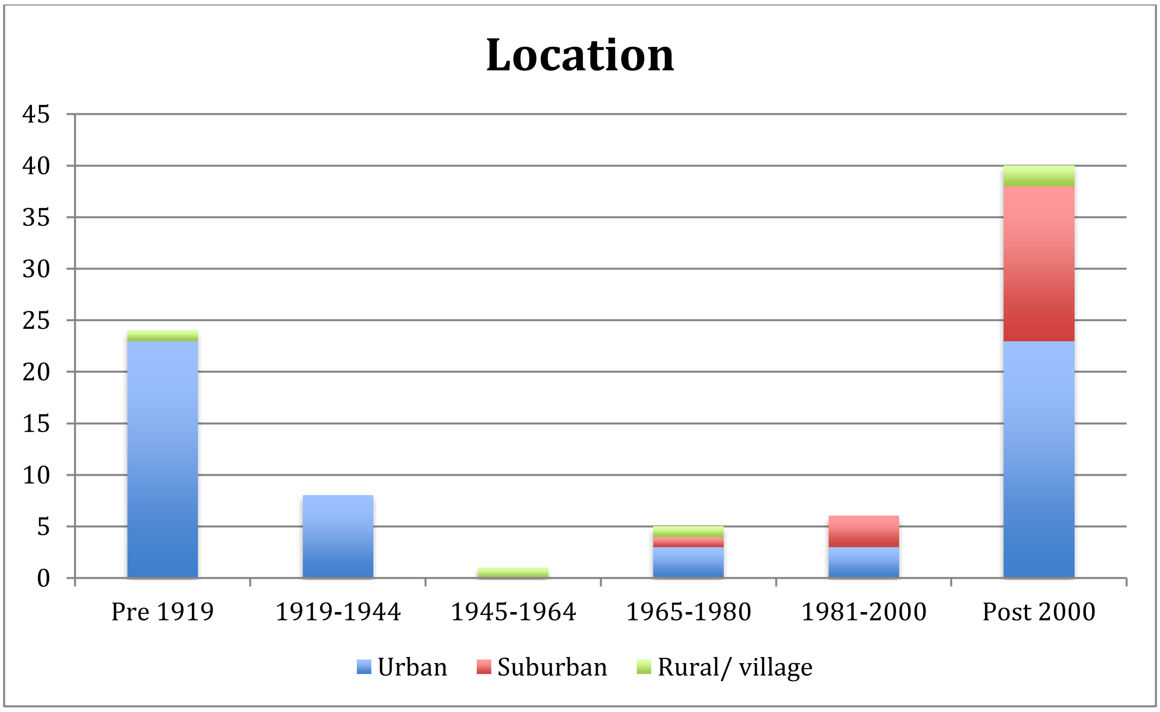
4.2 Tenure

Most of the pre-1919 converted flats are privately rented, while the majority of the post 2000 purpose built flats are owned by Housing Associations.



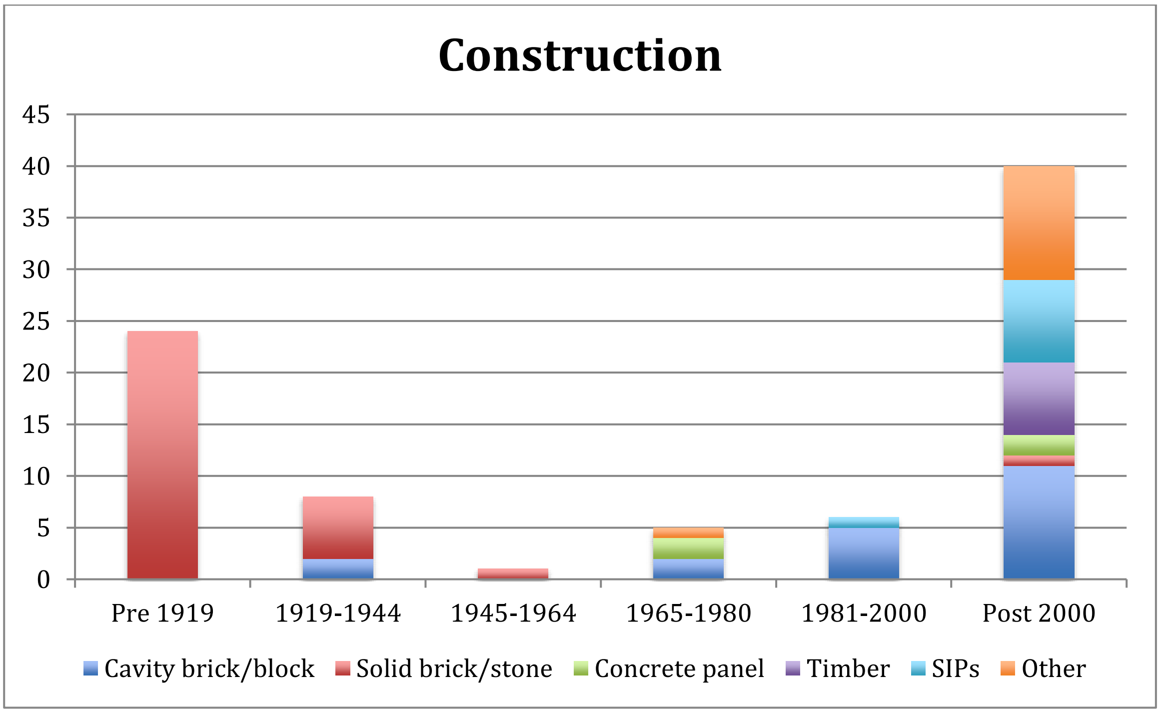
4.3 Location

Almost all of the instances highlighted by the first stage survey are located in urban and suburban areas.



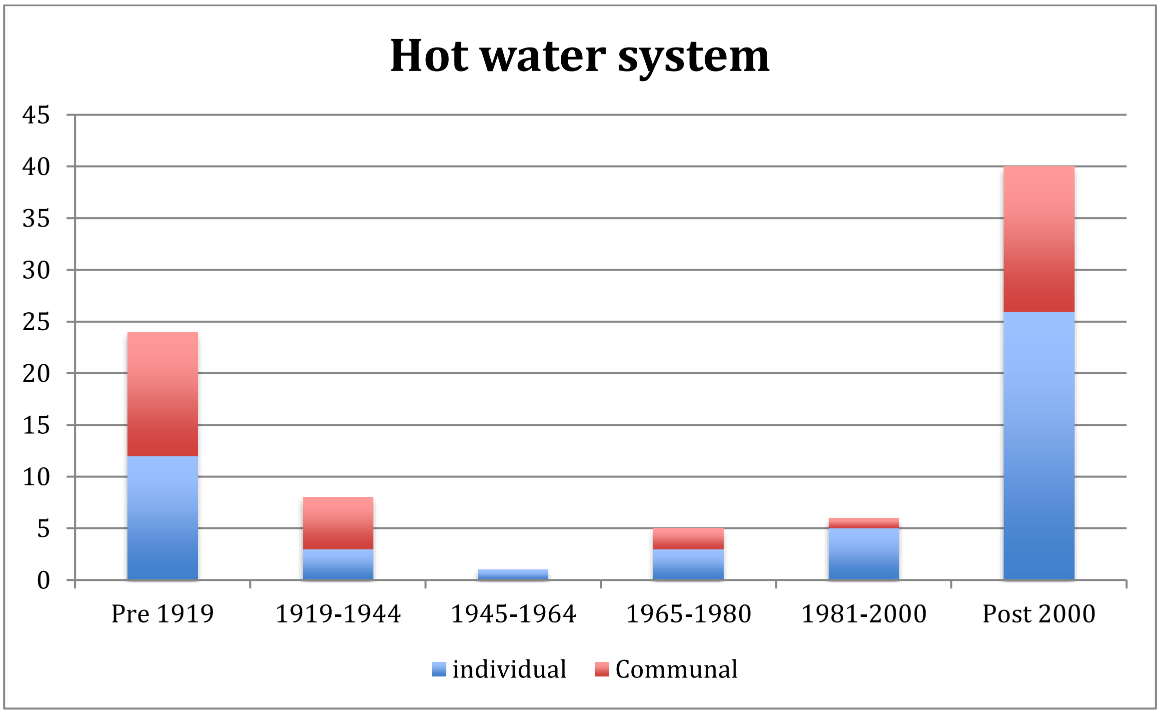
4.4 Construction

While all of the pre-1919 dwelling are solid brick or stone, a range of methods were used for the other dwellings.



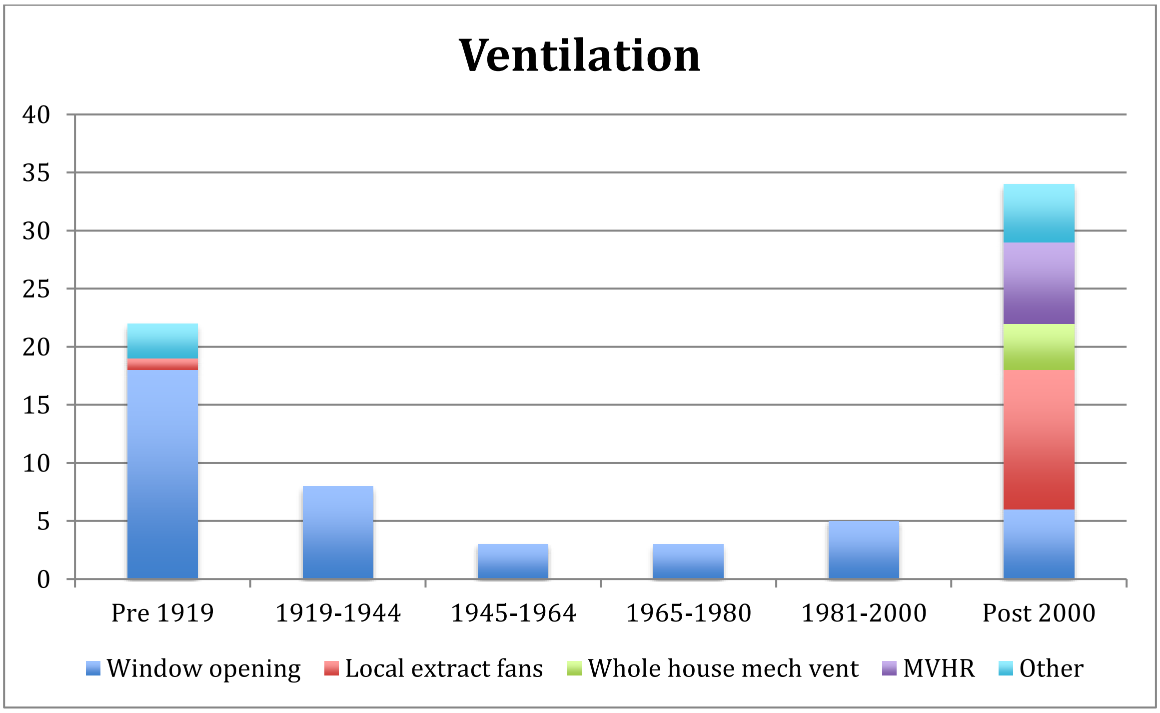
4.5 Hot water systems

A large number of the dwellings identified have a communal hot water system.



4.6 Ventilation

The older dwellings are almost all rely on ventilation provided by opening windows, whereas the dwellings built post 2000 use a variety of methods.



4.7 The problem with small flats

This study has identified a notably larger number of problems in small flats than in other dwelling types. It seems there are a number of issues causing these types of dwellings to have particular problems with overheating:

- Overcrowded small spaces - with proportionally high numbers of occupants, appliances etc generating heat within the home.
- Converted flats in older properties, which have been subdivided in such a way that there is no longer any opportunity for effective ventilation.
- New blocks of flats, which are small, well-insulated and under-ventilated.

None of the activities carried out in these dwellings are anything that would not be considered a normal part of a modern lifestyle. Although they have an impact, internal heat gains from people, cooking, televisions, computers, games consoles etc within the dwelling do not on their own cause the overheating problems described in these instances. Heat will be generated within the home, which will build up more quickly if it is small, well-insulated and airtight.

Around 18% of the housing stock in England is a flat or maisonette, and flats have increased from representing 20% of new build homes in 2000 to almost half in 2010[10]. Additionally, one-person households are predicted to increase at a greater rate than other household types, many of who are expected to be elderly. So it is important to ensure that these new homes are comfortable and healthy places to live.

New homes in the UK are getting smaller, and are the smallest in Western Europe[11]. The very small units provided for student accommodation and care homes, may also be at particular risk of overheating and require further investigation.

Further work needs to be carried out to correlate design assumptions with real buildings, and the impact that they have on the design and ventilation required for small flats.

5 Common risk factors

The second stage survey focused mainly on the types of dwellings which had presented the most common problems in the first stage: pre-1919 converted flats, and post 2000 purpose built flats, most of which are located in urban areas. The density of new developments has increased in England from 25 dwellings per hectare (d/h) in 2000 to 43 d/h in 2009. The increase has been from 56 d/h to 121 d/h in London, where 92% of new homes are flats.

The risk factors described here for each type of flat commonly features in the 90 instances detailed by the first stage, and the 12 instances described further by the second stage.

5.1 Converted flats in pre 1919 buildings

Three instances of this type were examined.

5.1.1 Form and orientation

- Conversions of buildings previously used as houses, shops, or industrial.
- Division of space into small, single aspect unventilated rooms
- Common use of un-insulated and unventilated loft spaces

5.1.2 Fabric

- Un-insulated roofs
- Large areas of glazed wall, roof, or conservatory.
- Windows painted shut
- Single glazing
- Fixed (unopenable) glazing

5.1.3 Services

- Heating and hot water systems which are difficult to control or faulty
- Communal heating and hot water systems

5.1.4 Location

- Located in urban areas
- Close to the noise and pollution of busy roads
- Close to hard surfaces, absorbing and radiating heat

5.2 Post 2000 purpose built flats

Eight instances of this type of flat were examined.

5.2.1 Form and orientation

- Large areas of south facing glazing

- Single aspect flats leading from central corridor
- Use of winter gardens

5.2.2 Fabric

- Very well insulated
- Very airtight
- Large areas of glazing
- Use of glazed doors (not providing secure ventilation)
- Fixed windows (unopenable)
- Window opening restricted

5.2.3 Services

- Communal heating and hot water distribution pipes running through flats and corridors
- Heating systems, particularly underfloor, which are difficult to control
- Ventilation systems that are not understood by occupants
- Ventilation systems that are badly designed (such as intake and extract located next to each other on south face)
- Ventilation systems that are faulty

5.2.4 Location

- Urban locations
- High density developments
- Noise and security fears preventing window opening

Any dwellings with these features could be at risk of overheating, and many of the instances presented here have more than one of these features. Therefore, existing housing, plus those dwellings in construction and at design stage should all be reviewed. It is important to identify the dwellings most at risk and take action to avoid and solve any possible future overheating problems.

6 Avoiding and solving overheating problems

Most overheating problems are easily avoided with good, informed design skills. However, once problems are built into a new development or conversion, reducing overheating can be challenging. Research[12] carried out into the implications of climate change for overheating in English suburban housing suggests that:

> *The most effective (passive) package for tackling future overheating tends to combine fabric improvements and internal heat gain reduction.*

The measures listed here are those that have been applied successfully in one or more of the 12 instances detailed in Appendix B. While some of the measures suggested here have a high cost, others can be carried out easily and quickly, ideally integrated into an existing maintenance programme.

6.1 General strategies used

Some measures are relevant for any type of dwelling that is experiencing overheating:

- Reducing external heat gains
    - Reducing large areas of glazing (applying solar film or inserting opaque panels)
    - Shading south, west and east facing glazing (internal blinds, or external shading)
- Reducing internal heat gains
    - Avoiding densely occupied dwellings (people and appliances)
- Cooling
    - Providing adequate secure ventilation (opening windows, mechanical ventilation)

6.2 Occupants and behaviour

While occupants are not responsible for overheating problems, they are the ones that suffer the discomfort, and need to be informed about things that they can do to keep comfortable. For instance, opening windows during the hottest parts of the day may not be the best solution, as letting in warm air from outside could actually increase overheating. People in hotter countries keep both shutters and windows closed until the sun and heat of the day has subsided. However, existing UK urban housing design does not always offer these opportunities, and may need to adapt in response to rising temperatures.

A number of measures can be taken by occupants:

- Keeping windows and curtains/ blinds closed during the day
- Opening windows during the night
- Using efficient appliances, and using them less often

However, even these simple measures may be difficult for some occupants to carry out. Some occupants with specific needs are particularly badly served by their homes. In particular, the elderly residents in the sheltered housing and the occupant of the house designed specifically for a person with a disability. The designers of these housing types have assumed that they will not be able to reach or open windows, and as a result fitted windows with only small areas that open, creating homes which are impossible to ventilate. It is important that occupants who have specific needs, are served both by good design and by effective management of their homes.

6.3 Converted flats

There are close to one million converted flats in England[13], and converted flats are more likely to fail the decent homes standard for than other types of dwelling (47%)[14]. The most common problems with the instances of this type of dwelling reported here, seem to be un-insulated roofs and unopenable windows. Successful solutions for most of these should be reasonably straightforward:

- Insulating roofs
- Repairing or replacing windows so that can be opened effectively
- Installation of extract ventilation to kitchens and bathrooms
- Ensuring that conversions subdivide the space in such a way that allows sufficient natural ventilation to continue. Cross ventilation is more effective than single aspect.

Barriers - Even when the overheating problems are identified and the solutions found, significant barriers remain preventing these measures from being implemented. As well as the costs of such measures, conservation issues relating to older buildings can halt any progress, and occupants may be put off by the disruption of building work.

6.4 New flats

Around one third of new build homes in England are flats[15]. This is after an increase from 20% in 2000 to nearly half in 2010.

- Replacing unopenable windows with ones that open effectively
- Blocking lower areas of full height glazing with opaque panels
- Solar film applied to windows
- Installation of bespoke ventilation systems
- Installation of vertical mechanical ventilation from corridors to roof
- Caretaker opening corridor windows every morning to ventilate common areas
- Coffee mornings with residents to help them to understand how the building works

Barriers – It appears that aesthetic concerns have created some of the problems with the façade in the first place, and this remains a barrier. Adding panels or film to windows will have an impact on the look of the building, as well as reduce the quality of light in the flats. Replacing windows with different ones will have implications for planning as well as cost, but may be the only effective solution in some instances. It should be noted that any additional ventilation systems must be well designed and installed, and the risk of noise avoided.

Additionally, some residents may be put off by the upheaval of major work to their home:

> *There is a lack of take up from elderly residents (they would rather suffer than agree a major refurbishment).*

6.5 Improving design

Careful consideration of the impact that design decisions will have on conditions within the home is crucial. In one extreme case (example 5), which resulted in an almost complete lack of ventilation:

> *The architect did not want opening lights, as it "would have spoiled the aesthetics of the building lines" (although the only unobstructed view was from the car park directly opposite).*

However, many of the housing providers and consultants responding here with details of overheating and the solutions they have found, have used this experience to inform future designs.

> *As a result of this knowledge we are trying to look at schemes in design stage to "design out" problems.*

Most of the problems identified by this study can be avoided in new developments. There is good guidance available (see Appendix C) that highlights these issues, and should be carefully considered during the design. The hierarchy of measures suggested in the London Plan chapter 5 gives priority to passive measures and recommends comfort cooling only as a last resort.

6.5.1 Design modelling

Where possible, modelling can identify risks of overheating, but needs to be used alongside a good understanding of the assumptions and implications as well as good design skills, in order to be effective.

For new homes, overheating risks can be evaluated by modelling and inform the design of the building and the ventilation system. Modelling tools including the SAP (tool used for building regulations compliance) and more sophisticated dynamic thermal modelling tools, rely on assumptions about the building and how it will be used, in order to predict likely heat gains and overheating risks. These assumptions can include factors such as occupancy profiles, numbers and types of appliances. But there is limited guidance on which inputs to use for overheating assessments in domestic buildings, and the modelling may not necessarily match what actually happens in a small flat.

Modelling is not expected to accurately predict the real performance of a building. SAP is not a design tool, it is used to test compliance with building regulations under a set of template conditions. However, even a simple test can produce the wrong result. If the SAP results reveal an overheating risk, it can be solved by telling the model that all the windows will be wide open all of the time. However, the model will not know if the road outside is too noisy, polluted or dangerous for the occupants to leave the windows open. The person using the model will need to make that judgement.

Design tools such as dynamic thermal modelling software are more sophisticated than SAP and intended to inform design by exploring how the building might perform under different conditions and over time (and using CIBSE future climate data sets). It is possible to set every single aspect down to an hourly level; how the building is used by occupants, and how the outside climate changes, these will change all the time. So the building will need to be designed so that it can adapt in order to remain comfortable. Again, these design measures need to be considered by a designer with real understanding of the implications of their decisions, in order for them to be effective in the real performance of a building, and the real experience of its occupants.

Using modelling to predict how comfortable the building will be is quite different to using it to predict energy demand, although much of the same information is used. If energy modelling is inaccurate, the building may use more or less energy than predicted, and cost more or less to run. If comfort modelling is inaccurate, serious problems can arise for the occupants' health and wellbeing.

Modelling has also been useful for researchers looking into possible future impacts of climate change on overheating in homes in England, and impacts of various adaptation measures[16].

6.6 Policy

A full policy review is needed in order to understand how existing policy allows these instances of overheating to occur, particularly in new buildings. Either there are insufficient policy measures in place, or they are not being complied with, for whatever reason. There may be opportunities within building regulations and planning processes to improve this. For instance, it could be possible to check that overheating risks have been sufficiently considered in the design of a building, by including a requirement in planning applications.

If design modelling is to be used for checks, it is important that measures are taken to ensure that it is used effectively. Members of the working group for this study have suggested that it would be useful to have a rigorous national test, using template internal conditions profiles for assessing overheating in the same way that there are template internal conditions profiles for Part L assessments. All consultants are under pressure to show that schemes work, particularly if they have been brought on late and the design is finalised. Having a standard test would avoid the temptation of using favourable profiles to get the building to pass.

7 Reporting overheating

Only 47 (39%) of 120 (non-consultant) responses to the first stage survey indicated that they have a procedure in place for recording and dealing with overheating problems within homes.

Many of the problems presented here are being dealt with because individual environmental health officers or housing managers are concerned and want to improve conditions for occupants. It is possible that many more instances of overheating are not reported at all, or are reported to someone who doesn't know how to deal with them.

> *The Housing Act is quite a cumbersome piece of legislation to use. Enforcement procedures under the act should be streamlined and simplified. Local Authorities have undergone unprecedented cuts to their budgets in recent years. At my own LA this has resulted in about a third of our enforcement staff. This makes it much harder for the LA to respond quickly and effectively to complaints of this nature.* (Respondent detailing example 3)

7.1 How these problems were reported

Responses to the second stage survey described how the overheating was identified in various different ways:

- Tenant complaint to housing manager
- Tenant complaint to Council
- Health professionals raising concerns about occupants
- Dedicated Housing Association green team inspecting properties
- Poor reputation of the building and tenancy refusals
- Identified during inspections carried out for other reasons

The evidence gathered ranges from detailed inspections and the inspector's experience, to temperature monitoring and occupant reports of discomfort.

In some instances such as examples 2 & 3, problems were only revealed during an inspection that was carried out for other reasons. This indicates that instances of overheating do go unreported, and there may be many others, which are not being dealt with.

One respondent stated:

> *During an interview after 12 months defects the resident remarked that it did get very hot in the hot weather during the first summer. When I asked how hot they just pointed to a thermometer they had and said 'off the scale'.*

The time to take action on the problems once identified range from 8 weeks to 8 years. Enforcement action or the threat of it from Environmental Health Officers is sometimes necessary to push things forward. In some cases the council also provided grant funding to assist the owners with the necessary work.

7.2 The role of the occupant

For occupants to report a problem with their home, they must first know who to contact, and consider what might be done as a result. Tenants of private landlords, particularly those with a Six-month short hold tenancy, may be less likely to complain for fear of eviction. And some landlords try to evict tenants who wish to enforce their legal rights to repair[17]. Tenants may not know that they can report problems to their local council's environmental health officer in confidence.

Occupants of housing association or local authority housing should also be able to report problems directly to their landlords, or contact environmental health officers.

Owner occupiers are under represented by this study. However, it can be assumed that some of those living in converted flats could have similar problems with overheating, and that they are usually able to improve the property and deal with the problems themselves. However, those owning new flats in large blocks are often less able to make changes to them, and may be reliant on a building manager.

Buyers of new flats will need to be aware of the risk factors identified by this study. This will allow them to investigate whether their new home may overheat in the future, or whether any measures have been taken to reduce these risks.

7.3 The role of Environmental Health Officers

Under the Housing Act 2004, local authority Environmental Health Officers (EHOs) use a risk assessment approach called the Housing Health and Safety Rating System[18] (HHSRS) to look at the condition of properties. This identifies deficiencies that could lead to possible hazards and generates a score, based on how serious the outcomes would be and how likely they are to occur. Category 1 hazards banded A-C are considered serious, and Category 2 hazards banded D-J are ones that officers do not consider serious.

The HHSRS Guidance identifies 29 potential health and safety hazards, divided into four groups:

A. Physiological requirements:

Damp and mould growth; Excess cold; ***Excess heat;*** Asbestos and MMF; Biocides; Carbon monoxide and fuel combustion products; Lead; Radiation; Uncombusted fuel gas; Volatile organic compounds.

B. Psychological requirements:

Crowding and space; Entry by intruders; Lighting; Noise.

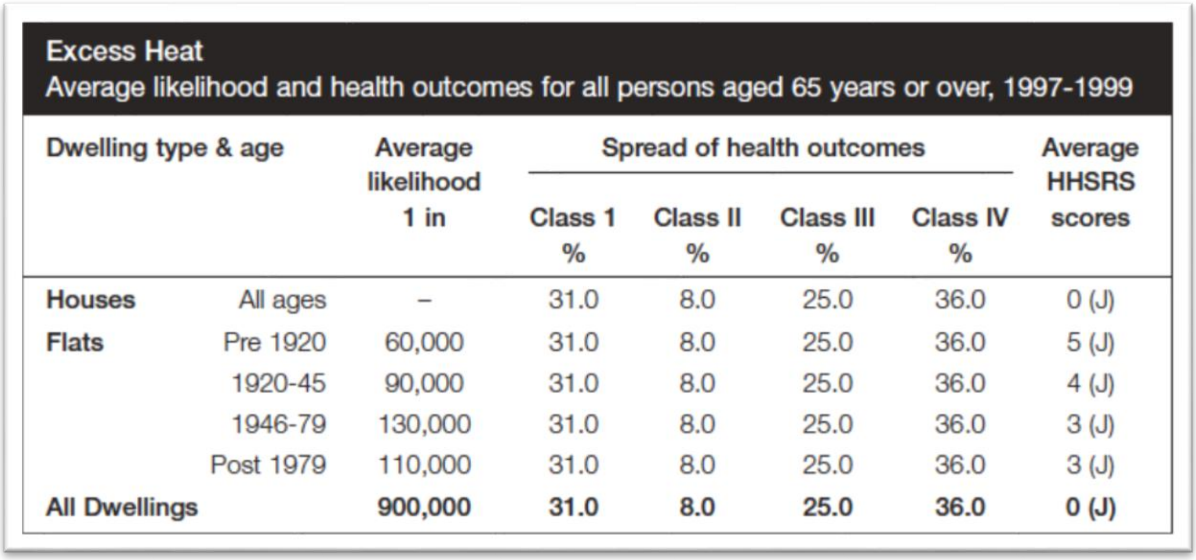
C. Protection against infection:

Domestic hygiene, pests and refuse; Food safety; Personal hygiene, sanitation and drainage; Water supply.

D. Protection against accidents:

Falls associated with baths etc; Falling on level surfaces etc; Falling on stairs etc; Falling between levels; Electrical hazards; Fire; Flames, hot surfaces etc; Collision and entrapment; Explosions; Position and operability of amenities etc; structural collapse and falling elements.

The estimated average HHSRS scores for 'Excess heat' relate to the most vulnerable occupants aged 65 and over.



Excess Heat
Average likelihood and health outcomes for all persons aged 65 years or over, 1997-1999

Dwelling type & age		Average likelihood 1 in	Spread of health outcomes				Average HHSRS scores
			Class 1 %	Class II %	Class III %	Class IV %	
Houses	All ages	–	31.0	8.0	25.0	36.0	0 (J)
Flats	Pre 1920	60,000	31.0	8.0	25.0	36.0	5 (J)
	1920-45	90,000	31.0	8.0	25.0	36.0	4 (J)
	1946-79	130,000	31.0	8.0	25.0	36.0	3 (J)
	Post 1979	110,000	31.0	8.0	25.0	36.0	3 (J)
All Dwellings		**900,000**	**31.0**	**8.0**	**25.0**	**36.0**	**0 (J)**

Figure 4 - Excess Heat (Table source: DCLG, HHSRS Operating Guidance, p.63)

The estimated scores presented in the table above, are considered by assuming that 'the living and sleeping areas of 5% of converted flats are immediately under the roof' and that 'there is no risk from heat associated with houses'[19]. There are no direct indicators for heat vulnerable dwellings, and a weak evidence base for the statistics used for the HHSRS. Therefore, considering the high number of newly built flats identified by this survey, and temperature rises expected due to future climate change, the scores for likelihood and health outcomes of excess heat may need reviewing.

7.4 Comfort standards

Occupants of private rented and Local Authority properties are most likely to approach EHOs when they experience overheating. However, many Housing Associations consider the HHSRS evaluation of overheating to be fairly subjective, and prefer cases to be dealt with before the EHO gets involved. The difficulty is defining what constitutes overheating in a domestic setting, where different people perceive comfort in different ways, and specific groups are more vulnerable to the health effects.

While definitions of overheating in mechanically ventilated buildings relate to the number of hours a particular temperature is exceeded and does not differ with external temperatures, there is no clear definition of overheating in naturally ventilated buildings[20].

Source	Temperature	Criteria
CIBSE, 2005	Living areas 28°C Bedrooms 25°C	Should not be exceeded for more than 1% of occupied hours
ASHRAE	35°C	Point of danger to human health, but can be lower depending on humidity level and vulnerability of individuals.
UK Heat wave Plan	26°C	Should not be exceeded in residential or nursing homes and in rooms where vulnerable people spend their time.

Figure 5 – Table illustrating varied temperature thresholds

> *Comfort is not a precise concept and the conditions that will deliver comfort also change in a complex way.*[21]

While a clear definition of overheating is necessary for informing the design of new buildings and refurbishments, it will not just be the numbers that are reported. The experiences of people living in these homes, and how their lives and health are affected by discomfort, will inevitably drive the reporting of overheating.

7.5 Changes needed

In order for overheating problems to be identified and dealt with more effectively, a number of improvements can be made:

- All organisations responsible for managing housing could include checks for overheating risk within inspection procedures, informed by a knowledge of the occupants.
- Local authorities could raise awareness of this as an important health and safety issue, particularly for vulnerable people.
- Occupants of all types of housing could be made aware of the risks, what they can do to help themselves and who to get further help from.

8 Conclusion and recommendations

8.1 Conclusions

This is a small and limited study, therefore the results cannot be considered representative for the country as a whole. However, from the evidence presented here, we would conclude that:

1. Only a limited number of overheating instances are actually reported and dealt with, therefore it is likely that the numbers are higher than suggested by this study.
2. Converted flats are a particular problem, and many more (mostly private rented) probably remain unreported.
3. Overheating in newly designed and built blocks of flats is also a problem, and the instances presented here should serve as a warning. Policies, which push high-density development and communal heating, should be questioned in light of this evidence.
4. Elderly, disabled and other vulnerable occupants are most likely to be exposed to overheating, when confined to their homes during the day. These people should be prioritised in any future measures.

With summer temperatures in the UK predicted to rise in coming years, discomfort and health impacts for occupants are likely to increase. Therefore, housing which is at risk of overheating needs to be identified and measures taken to reduce the risks.

8.1.1 The problems

Nearly half (61) of the 126 survey respondents each identified between 1 and 6 instances of overheating in homes, totalling 185 instances of overheating identified by this study.

Problems with high temperatures in homes cause discomfort and disruption for the occupants, particularly those who are elderly, have a disability or are confined to the home during the day. Most of the instances of overheating identified here are flats in urban locations, and are occupied during the day. Although this is a limited study, we would conclude that overheating is a problem in UK housing, and there are specific problems with two dwelling types:

1. Converted flats in older buildings (27 of the 90 instances for which information was provided)
2. Newly built flats in large developments (28 of the 90), including those provided as care home accommodation.

This study identified a number of risk factors associated with dwellings experiencing overheating, many of which feature more than one of these:

- High density locations close to noisy roads
- Hard surfaces and lack of green space
- Noisy roads and security concerns preventing window opening.

- Conversions, which divide a previously naturally ventilated house into lots of small spaces, which are often single aspect or in the roof space.
- Un-insulated roof spaces.
- Windows, which are fixed, have limited opening (often as low as 10% openable area) or are painted shut.
- Layouts producing single aspect flats opening onto a central corridor.
- Highly insulated and airtight flats, which are inadequately ventilated.
- Large areas of full-height glazing, often south or west facing and/or un-shaded.
- Communal heating and hot water distribution pipes running through flats and/or unventilated corridors.

With close to a million converted flats in England[22], a significant number of older properties could be at risk of overheating. In the UK, purpose built flats[23] represent more than a third of new housing, which presently stands at a rate close to 100,000 units per year[24] (88% in England), and is predicted to rise. While the numbers are small compared to the total dwelling stock, the relatively large numbers reported to this study suggest a worrying risk of overheating problems in specific types of new flats.

8.1.2 The solutions

One effective solution successfully applied to both converted and purpose built flats is to replace the windows with ones that can be opened effectively and securely.

In some instances, noise, pollution and security issues prevent window opening. In these cases, if a redesign is not on the cards, the only solution may be to install mechanical ventilation, or in extreme cases, comfort cooling.

Other effective solutions include:

- Pre-1919 flats: insulating roofs, shading glazing.
- New flats: reducing or shading glazed areas; installing mechanical ventilation in flats and corridors.

8.1.3 The reporting process

One of the most striking results is that only 47 of the 126 respondents stated that they have a process in place for recording and dealing with overheating problems. Additionally, many of the instances identified here were reported to this study by individual Environmental Health Officers or housing managers, who were particularly concerned for the well being of the occupants. It is possible that many more complaints of overheating never reach the right person, or go unreported. The processes that are available for dealing with overheating and other hazards are considered difficult to access cumbersome, and at a time of cuts in Local Authority staffing levels, it will be challenging to increase reports.

8.2 Recommendations

Based on the instances presented here, we would conclude that the following dwelling types are at risk of overheating and should be inspected with a view to taking urgent measures:

- Housing for vulnerable people should be prioritised.
- Any flat that has large areas of un-shaded glazing facing south, east or west.
- Any naturally ventilated flat where the windows are not opened, either because:
    - They are sealed or not fully openable
    - Or where security or noise concerns prevent occupants from opening windows
- New blocks of flats having a single-aspect, leading from a central corridor, and where heating and hot water is distributed around the building.
- Older buildings that have been converted into flats or houses of multiple occupancy. Particular attention should be paid to south facing dwellings and those on the top floors.

8.2.1 The design and planning process

Although not a requirement, in order to avoid future problems, the design guidance already available should always be used.

Additionally, any new buildings with the risk factors identified in this study, which are still at design or construction stages, should be reviewed and measures taken to avoid future overheating problems. Where possible, modelling can highlight the risk of overheating, but needs to be used alongside a good understanding of the assumptions and implications, as well as common sense and design skills, in order to be effective.

The ‘performance gap’ has emerged in recent years as a serious issue for the construction industry. Work by the GHA[25] [26] and others has revealed that many new buildings use more energy than predicted as well as providing poor indoor air quality and thermal comfort. This is thought to be due to three problems:

- Inadequate design and modelling
- Poor standards of construction, installation and commissioning
- Lack of support for users of the building

Identifying which of these is responsible for overheating in housing will be an important part of preventing further problems. For instance, is overheating in corridors of block of flats due to the way that the building was designed, how the systems were installed (poorly insulated pipework) or how the building is managed? Or could it be all three?

All of these issues have implications for how new buildings are procured by housing associations and others. There would appear to be a need for specifications and tender documents to highlight to contractors that there are risks to overheating and that this need to be carefully considered in their design and construction proposals. A risk matrix might be developed that can be applied to a site to identify the risks of overheating inherent in the proposed development.

Although a full policy review is needed in order to understand how existing policy allows these instances of overheating to occur, there are policy measures that could be considered in the light of this study. The planning process can be used to check that overheating risks have been considered, by requiring this issue is addressed as part of a planning application. And HMO licence applications could also consider overheating risk.

It is also important to consider the role of policies, which encourage measures such as communal heating and high-density development, and the possibility of unexpected consequences in the light of the instances presented here.

8.2.2 The reporting process

In order for overheating problems to be identified and dealt with more effectively, a number of improvements can be made:

- All organisations responsible for managing housing could include checks for overheating risk within inspection procedures.
- Local authorities could raise awareness of this as an important health and safety issue, particularly for vulnerable people.
- Occupants of all types of housing could be made aware of the risks, what they can do to help themselves and who to get further help from.

8.3 Further research needed

This small study is limited in a number of ways. Although a good response to the first stage survey was received, the numbers cannot be considered representative or evaluate the size of the problem in the UK. What it does do is help to build a picture of the types of problems and dwellings that are reported and solutions found. However, any in depth investigation into overheating needs to gather evidence directly from occupants of a wider range of dwelling types. Additionally, the design process that has led to these problems is not investigated.

- A larger statistical study gathering evidence from a wider sample would provide a clearer picture of the situation.
- An assessment of how widespread the risk factors are should be undertaken.
- The development of a risk matrix relating to overheating (and possibly other issues) would be useful to inform the procurement process and identify risk in new developments.
- It may be useful to add a question on this issue to the Housing Condition Survey.

8.3.1 Occupant surveys

In order to build a complete picture of overheating problems it is crucial to contact occupants, and gather evidence of the conditions they are living in.

- It would be most useful to survey occupants during or soon after the summer months, so that the issues are fresh in their minds.
- Tenants of private rentals and social housing, as well as owner-occupiers should all be surveyed, in order to build a representative picture. Private tenants need to be reassured that they can report problems in confidence, and shouldn't risk retaliatory eviction.
- Ideally, responses from occupants regarding their perceptions should be calibrated with measured temperatures.
- Tenants should be provided with advice about reporting to the building owner/manager or environmental health officer, and expectations for a solution.
- Surveys could specifically target areas where problems have already come to the surface.

Possible sources and contacts for reaching occupants: Warranty organisations such as NHBC; DCLG tenants panel; HPA Heatwave Plan is based on helping the vulnerable, identified through GP's, carers and social workers; Consumer associations such as Which; NASBA self build association; University accommodation departments; Citizen Advice bureaus; Specialists such as BSRIA and independent building performance consultants; Solicitors specialising in housing issues; Housing Law Practitioners Associations; RICS; Shelter.

8.3.2 Other dwelling types

This study has focussed in particular on converted flats in existing buildings and new flats in large blocks. A number of other dwelling types require further study, in order to identify those at risk.

- Sheltered housing has been covered to some extent by this study, but due to the vulnerability of residents and reliance on management, a separate study should be carried out specifically targeting housing for elderly and other vulnerable residents.
- Student accommodation has been identified as requiring further study. Many of the converted flats presented to this study are occupied by students, and new student accommodation appears is often similar in layout to the blocks identified in this study.
- It should be noted that no instances of overheating in unconverted pre-1919 houses were identified. Houses are not covered in detail in this report, due to the lack of instances presented and it seems that houses appear to present less of a risk. However, it would seem sensible to consider some of the risk factors identified in new flats, when looking at the possibility of overheating in new houses. For instance, increasing insulation and airtightness without providing sufficient ventilation is likely to cause air quality problems as well as overheating.
- Refurbishments have also not been specifically covered in this study, but again, it seems possible that there could be risks of overheating in the future. Although extra insulation will prevent overheating in some instances, thermal mass and effective ventilation may be reduced in the process.

- 1960's flats have been identified as at risk of overheating by other studies, but the numbers reported to this study seem to be small.

8.3.3 Other measures

The measures presented here are those that have been applied or considered in the instances reported to the study. A number of other measures merit further investigation:

- Research, which modeled adaptation measures to respond to future climate change[27], found that: *For all homes modelled, user-controlled shading proved to be the most effective adaptation.* No instance using these measures or external shading, were found in this study. Further work is needed looking at how architectural adaptation measures (such as simple external shutters, decorative security grates for openings) used in hotter countries might be suitable for urban housing in the UK.
- Measures relating to the surroundings of urban housing also require investigation:
    - The role of micro-climate in tackling overheating, including the use of planting and water to cool areas around urban housing.
    - Measures to reduce the noise and pollution, which prevent window opening in housing reliant on natural ventilation. For example, traffic speed reductions, sound barriers and road surface materials, encouraging electric vehicle use.

8.3.4 Reporting process

The HHSRS uses no direct indicators for heat vulnerable dwellings, and there is a weak evidence base for the statistics used for overheating risk. Therefore, considering the high number of newly built flats identified by this survey, and temperature rises expected due to future climate change, the scores for likelihood and health outcomes of excess heat may need reviewing.

8.3.5 Design process

This study does not investigate the design process that has led to the problems identified here. Questions are raised about the design process, and why new flats in particular are experiencing problems with overheating. A comprehensive review of relevant policy should also be undertaken and to analyse how designs have addressed regulations and guidance on overheating, and how effective it has been.

- Developers and design teams who have been involved in the new developments could be contacted, and the design process investigated. How were decisions made? Why wasn't overheating risk addressed?
- Work needs to be carried out to correlate design assumptions (occupancy, appliance use and efficiency) with real buildings, particularly for small flats.
- With dwelling size shrinking and occupant and appliance density increasing, overheating should be included in the investigations and discussions around dwelling size and space standards.

- It is also important to carry out a review of planning policies and building regulations influencing some of the design decisions which indirectly have led to overheating problems in some of these instances; policies that drive measures such as communal heating, high density building forms and orientation.

Appendix A – First stage results

First stage survey

The first stage consisted of an online survey, with the link distributed to Environmental Health Officers through the CIEH networks, and to Housing Associations and other professionals, through the National Housing Federation and Good Homes Alliance contacts.

In order to increase the response rate, this survey allowed the respondent to provide as little or as much information as they wanted to.

1. The respondents

126 useful reposes to the survey were received. 61% of these were from Environmental Health Officers, which skewed the results somewhat towards the private rented sector. The results do not provide a representative picture of the problem nationally, but does provide some useful information about the types of buildings that are overheating, and how this can be tackled.

1.1 The respondents

A building owner	A building manager	An Environmental Health Officer	Architect/ designer	Consultant	Contractor	Local Authority	Gov or other body	Other
14	12	77	3	4	2	9	3	2

1.2 The type of location of the majority of housing dealt with by the respondents (more than one type can be indicated)

City centre	Other urban centre	Suburban residential	Rural residential	Village centre	Hamlet / isolated
47	51	55	31	8	4

1.3 The tenure of the majority of housing dealt with by the respondents (more than one type can be indicated)

Owner occupied	Private rented	Local authority	Housing association	Shared ownership
23	82	10	42	10

1.4 Whether there is a procedure for recording and dealing with overheating problems within homes (consultants excluded)

Yes	No	Unknown/ No answer
47	53	20

2. The instances of overheating

After the initial compulsory questions, many of the respondents did not answer the optional questions that followed, or did not know the answer.

2.1 The number of instances of overheating drawn to their attention in the past 3 years

1	2	3	4	5	6	More than 6	None	Unknown
15	16	11	2	5	1	11	55	10

48% of the respondents indicated that they had between 1 and more than 6 instances of overheating drawn to their attention over the past 3 years. In all, **185** instances of overheating were identified by this survey.

Varying amounts of information were provided on between 50 and 90 per cent these instances.

2.2 Location of instances

City centre	Other urban centre	Suburban residential	Rural residential	Village centre	Hamlet / isolated	Unknown/ No answer
35	31	19	4	1	0	95

73% of the instances for which information was provided are in urban, and 21% in suburban locations.

2.3 Dwelling type

Semi-detached	Detached	Bungalow	Converted flat	Purpose built flat, low rise	Purpose built flat, high rise	End terrace	Mid terrace	Unknown/ No answer
3	5	1	27	29	14	5	6	95

78% of the instances, for which information was provided, are flats.

2.4 Flat floor

Ground floor	Middle floor	Top floor	Not a flat	Unknown/ No answer
14	20	32	2	117

Around half of the flats identified are on the top floor.

2.5 Flat position

Mid- block	End block	Not a flat	Unknown/ No answer
41	14	11	119

Three quarters of flats identified are mid block.

2.6 Year of construction

Pre 1919	1919-1944	1945-1964	1965-1980	1981-1990	1991-2000	Post 2000	Unknown/ No answer
24	8	1	5	1	5	40	101

24% of instances for which details were provided, were constructed before 1919, and 48% after 2000.

2.7 Tenure

Owner occupied	Private rented	Local authority	Housing association	Shared ownership	Unknown/ No answer
5	42	1	38	2	97

48% of the instances for which details were provided, are private rented properties. 43% are housing association properties.

2.8 Glazing orientation

South only	East only	South and North	South and East	South and West	North and East	North and West	East and West	South & East & West	Unknown/ No answer
12	1	10	3	6	2	2	9	2	138

Only 25% of respondents provided an answer. Of those, 70% had at least some south facing glazing.

2.9 Heating system

Boiler	Room heater	Storage radiators	Warm air system	Communal	Other systems	Unknown/ No answer
42	4	8	2	21	3	105

More than half of the instances for which information was provided have boilers, and a quarter communal heating.

2.10 Hot water system

Individual system	Communal system	Other systems	Unknown/ No answer
42	36	0	107

Just under half of the instances for which information was provided have a communal hot water system.

2.11 Ventilation

Window opening	Local extract fans	Whole house mechanical ventilation	Mechanical ventilation with heat recovery	Other	Unknown/ No answer
43	16	4	7	9	106

More than half of the instances for which information was provided rely on widow opening for ventilation.

2.12 Cooling

Air conditioning	Fans	Other	None	Unknown/ No answer
0	9	1	67	108

Only 10 instances state that they have some form of cooling, and none state that they use air conditioning.

2.13 Construction

Brick and block cavity walls	Solid brick or stone	Concrete panel	Timber frame	Structural insulated panels (SIPs)	Other	Unknown/ No answer
23	27	4	7	9	10	105

68% of instances for which information was provided are constructed with heavy weight materials.

2.14 Age of refurbishment measures

2.14.1 Draughtproofing

Under 2 years	2-5 years	5-10 years	10-15 years	15-30 years	Over 30 years	None carried out	Unknown/ No answer
5	6	5	1	0	2	20	146

2.14.2 Loft insulation

Under 2 years	2-5 years	5-10 years	10-15 years	15-30 years	Over 30 years	None carried out	Unknown/ No answer
3	6	4	2	1	1	21	147

2.14.3 Wall insulation

Under 2 years	2-5 years	5-10 years	10-15 years	15-30 years	Over 30 years	None carried out	Unknown/ No answer
2	4	5	1	0	0	29	144

2.14.4 Double glazing

Under 2 years	2-5 years	5-10 years	10-15 years	15-30 years	Over 30 years	None carried out	Unknown/ No answer
5	4	6	5	1	1	20	143

2.14.5 Other

Under 2 years	2-5 years	5-10 years	10-15 years	15-30 years	Over 30 years	None carried out	Unknown/ No answer
2	1	1	1	0	0	19	161

2.15 Occupants

Are there young children living in the home?			Are there people over 60 living in the home?			Are there people in the home during the day?		
Yes	No	Unknown/ No answer	Yes	No	Unknown/ No answer	Yes	No	Unknown/ No answer
32	41	112	28	44	113	65	8	112

Of the instances where information was provided, 44% have young children, 39% have people over 60 and 89% have people in the home during the day.

2.16 Information availability

For each case of overheating, do you have access to the following details?					
The highest temperature?	**How long it was too hot for?**	**Which rooms were too hot?**	**Comments from the occupants?**	**The cause of the overheating problem?**	**Any solutions that have been found?**
24	17	52	42	40	33

Only 33 instances had information on causes and solutions. Those agreeing to further contact were followed up for stage 2, and 12 instances were selected based on their availability for responses to a further stage of questioning.

2.17 Further contact (for second stage)

38 respondents indicated that they would be willing to be contacted for further information on the instances that they had identified. 19 Environmental Health Officers, and 19 others (Housing providers and consultants). Some of these did not provide contact details, and others had not identified instances of overheating. 12 respondents were approached, focusing on those representing the most common housing types experiencing overheating. Additionally, those instances where measures had been developed and applied to solve overheating problems, were also prioritised.

Appendix B - Second stage results

Second stage survey

Twelve of the responses from the first stage were followed up for more detail on the instances that had been identified. This was done through another online survey, identified through consultation with the respondents as the most popular form of enquiry.

Example 1 – Converted flat above shop

THE PROBLEM

Timing	May to September 10.30am – 8pm
Which rooms	All, though south facing rooms are the worst
Observed cause	Large south-facing windows and insufficient ventilation
Vulnerable occupants	Elderly woman
Effects	Disturbed sleep
Temporary measures	Placed thick dark curtains in south-facing windows

THE DWELLING

Dwelling type	Converted flat, previously part of a shop
Location	Urban
Tenure	Private rented
Year	Pre-1919
Position	1st floor, above shop

Floor area	40m^2
Construction	Brick
Floors	Timber – un-insulated
Walls	Glazing, timber and brick – un-insulated
Ceiling	Plasterboard
Windows	Single glazed, 98% not openable
Surroundings	Buildings, busy road and hard surfaces
Estimated noise level	High

THE SYSTEMS

Heating & hot water	Electric storage and electric immersion
Ventilation	Limited window opening

THE OCCUPANTS

Occupants	One elderly woman, home all day
Activities	Cooking and television, often
Window opening	Day and night (but limited)
Window concerns	Noise, smells and air pollution from outside
Ease of use	Heating system not easy, but ventilation is

THE SOLUTIONS

Reducing internal heat gains	None
Reducing heat gains from outside	Heavy curtains on south-facing windows
Cooling the dwelling	Very little
Additional recommendations	The provision of larger opening windows; Passive ventilation; Reduction in glazed areas. As this w as in a conservation area changing its appearance would be difficult

Avoidance suggestions	Make sure there are sufficient opening windows; Greater relaxation on listed buildings

THE REPORTING

Source	Complaint to Council from tenant
Evidence	Temperature taken in Summer
Finding a solution	Owner contacted to improve ventilation
Time from occupant report to the solution	9 months

Example 2 – Converted first floor flat

THE PROBLEM

Timing	Summer 2007
Which rooms	All rooms
Observed cause	Faulty heating system and inadequate ventilation
Vulnerable occupants	N/A
Effects	N/A
Temporary measures	Unknown

THE DWELLING

Dwelling type	Converted flat
Location	Urban
Tenure	Private rented
Year	Pre-1919
Position	1st floor, end block
Floor area	Unknown
Construction	Solid brick or stone
Floors	Timber – un-insulated
Walls	Solid wall – un-insulated
Ceiling	Plaster – un-insulated
Windows	Single glazed timber frame
Surroundings	Low-rise buildings and hard surfaces
Estimated noise level	Low

THE SYSTEMS

Heating & hot water	Combi boiler in kitchen
Ventilation	Window opening

THE OCCUPANTS

Occupants	One adult, two children
Activities	Unknown
Window opening	Unable to open windows
Window concerns	Unable to open windows
Ease of use	Heating system easy to use, but heating had to be on to provide hot water (fault). Cannot ventilate the property (windows painted shut)

THE SOLUTIONS

Reducing internal heat gains	Repairs to heating and hot water system, so that heating doesn't have to be on to provide hot water
Reducing heat gains from outside	N/A
Cooling the dwelling	Repairs to windows, which were painted shut, so that they can be opened and provide ventilation; Extract ventilation provided to kitchen and bathroom
Additional recommendations	N/A
Avoidance suggestions	N/A

THE REPORTING

Source	Complaint from tenant reporting issue with heating/hot water (not windows). The windows were discovered during the subsequent HHSRS inspection.
Evidence	Inspection
Finding a solution	Enforcement action against landlord
Time from occupant report to the solution	10 months

Example 3 – Converted top floor flat

THE PROBLEM

Timing	Summer 2009 & 2010
Which rooms	Loft converted into a bed sitting room
Observed cause	This w as a room in a converted loft space which had no window s and no means of ventilation. The roof was not insulated. On the eastern side it was partitioned off from a rooftop conservatory by large glazed patio doors. The conservatory w as glazed at the flanks (but also could not be ventilated as it had no openable window s) and roofed over with corrugated plastic sheeting.
Vulnerable occupants	The tenant was a student and did have the use of a shared living room on the 1st floor but nonetheless had to spend much of her time in this unventilated space.
Effects	Difficulty sleeping and relaxing
Temporary measures	Not known

THE DWELLING

Dwelling type	Converted flat
Location	Urban

Tenure	Private rented
Year	Pre 1919
Position	Top floor
Floor area	Unknown
Construction	Solid brick or stone
Floors	Timber suspended
Walls	Solid brick
Ceiling	Plasterboard
Windows	None – only large glazed doors to unventilated conservatory.
Surroundings	Mainly low and medium-rise buildings and hard surfaces, and minimal green space.
Estimated noise level	Medium

THE SYSTEMS

Heating & hot water	Communal boiler
Ventilation	None

THE OCCUPANTS

Occupants	Student
Activities	Cooking and television often, and computer continuously
Window opening	No windows
Window concerns	No windows
Ease of use	Heating system easy to use.

THE SOLUTIONS

Reducing internal heat gains	None
Reducing heat gains from outside	Insulation fitted to roof
Cooling the dwelling	Dormer windows fitted to provide ventilation.

Additional recommendations	None
Avoidance suggestions	Provision of through ventilation in conversions and new blocks of flats, preferably through dual aspect.

THE REPORTING

Source	Full inspection required under Part 2 of the Housing Act 2004, for multiple occupancy house. This did not come to the Councils attention via a complaint from the tenant.
Evidence	Physical inspection of the property
Finding a solution	The council served a statutory notice under Part 1 of the Housing Act 2004, and provided grant aid to assist the owner with the works.
Time from occupant report to the solution	2 years
Suggestions	The Housing Act 2004 is quite a cumbersome piece of legislation to use. Enforcement procedures under the Act should be streamlined and simplified, Local authorities have undergone unprecedented cuts to their budgets in recent years. At my own local authority this has resulted in about a third of our enforcement staff. This makes it much harder for the local authority to respond quickly and effectively to complaints of this nature.

Example 4 – New build end terrace, wheelchair -accessible house

THE PROBLEM

Timing	Late spring to late autumn Mid day onwards, all night
Which rooms	South facing rooms and all rooms upstairs
Observed cause	Large southern aspect, insufficient roof insulation (due to complex roof form), only lower half of windows openable, insufficient thermal mass.
Vulnerable occupants	Adult with MS and heart condition, children
Effects	Avoiding use of rooms, children missing school due to lack of sleep.
Temporary measures	Window opening, ceiling fans, portable air conditioning.

THE DWELLING

Dwelling type	End-terrace two-storey house
Location	Suburban
Tenure	Housing Association
Year	Post 2000
Position	N/A
Floor area	90m^2
Construction	Bick and block cavity
Floors	Insulated concrete ground floor
Walls	Brick outer, insulated timber inner

Ceiling	Plasterboard, with sloping ceiling section in roof. The sloping bit is hard to access and appears uninsulated
Windows	d/g top hung double casements 30% (bottom half only) is openable – wheelchair accessible; the rest of the development has windows that open top and bottom
Surroundings	High proportion of green space to east and hard surfaces in development landscaping
Estimated noise level	Low

THE SYSTEMS

Heating & hot water	Boiler in airing cupboard
Ventilation	Window opening

THE OCCUPANTS

Occupants	One adult and 2 children
Activities	Cooking – often Television – often Computers - often
Window opening	Only on shaded walls during the day Only first floor during the night
Window concerns	Break-ins and pests
Ease of use	Average

THE SOLUTIONS

Reducing internal heat gains	Change halogen lights for LEDs – small improvement
Reducing heat gains from outside	Plans to add external shading, insulation to sloping ceiling, solar glazing film, and possible extra internal thermal mass.
Cooling the dwelling	Currently using mobile A/C to protect occupant health, potential for increased through-roof ventilation

Additional recommendations	Increase window-opening area and night-time purge ventilation securely.
Avoidance suggestions	Use more thermal mass in construction, think about window heights when considering night ventilation, provide external shading devices for unobstructed s. facing windows

THE REPORTING

Source	Resident contact
Evidence	Logged temperatures, surface temperatures, occupant comments, inspection.
Finding a solution	Not found yet
Time from occupant report to the solution	Action taken the next day, but the complete solution has not been applied yet
Improvements to process	This was only discovered and dealt with because of a dedicated ‘Green Team’ of informed people dealing with energy and comfort. This is unusual.

Example 5 – New build high-rise flat

THE PROBLEM

Timing	Late spring, summer and early autumn. From 10am onwards and into the evening.
Which rooms	All rooms
Observed cause	Large areas of south facing glazing, plus insufficient and flawed ventilation
Vulnerable occupants	None
Effects	Occupant unable to sleep or use the flat properly in sunny weather. He had taken to keeping a very close eye on the weather forecast and if it forecast for a sunny weekend, would make arrangements to stay aw at for the weekend. He had tried leaving the doors ajar but then had concerns about security.
Temporary measures	Electrical fans but as the air was so warm, this proved ineffective and as a result, sought the involvement of Private Sector Housing HMO Team.

THE DWELLING

Dwelling type	High rise purpose built flat
Location	City centre
Tenure	Shared ownership
Year	2004
Position	3rd & 4th floors, mid block
Floor area	80m^2
Construction	Brick and block cavity walls
Floors	Tiled concrete slab
Walls	Insulated clinker block internally, external, glass and insulated steel
Ceiling	Insulated and plastered concrete
Windows	Double glazed, not openable
Surroundings	Tall and medium-rise buildings, busy road, tram line and hard surfaces. No green spaces.
Estimated noise level	High

THE SYSTEMS

Heating & hot water	Individual boiler, well insulated pipes.
Ventilation	Local extract fans - 100mm extraction with unintentional heat recovery due to poor siting of vent and intake. Located on south facing elevation. Operation was woefully poor.

THE OCCUPANTS

Occupants	1 male, 32. Home for lunch.
Activities	Unknown
Window opening	Windows not openable
Window concerns	Windows not openable
Ease of use	Heating system and ventilation easy to use.

THE SOLUTIONS

Reducing internal heat gains	N/A
Reducing heat gains from outside	External shades fitted.
Cooling the dwelling	Existing windows replaced with openable ones, and now able to ventilate more effectively.
Additional recommendations	Air conditioning would be very useful, though not environmentally friendly.
Avoidance suggestions	Some newer buildings now seem to over engineer the insulation as a Knee jerk reaction to higher Building Regulation demands. More common sense rather than a wish to stay clear of building inspectors would help.

THE REPORTING

Source	Request for service from the occupant
Evidence	Temperature loggers were installed and a high of 36 degrees centigrade was recorded.
Finding a solution	Negotiation and threat of enforcement action

Time from occupant report to the solution	8 weeks
Other comments	The architect did not want opening lights as it "would have spoiled the aesthetics of the building lines" (although the only unobstructed view was from the shopping centre car park directly opposite).

Example 6 – New build sheltered flats

THE PROBLEM

Timing	Spring, summer, autumn Daytime
Which rooms	Living room and bedrooms
Observed cause	Solar gain from windows, plus lack of ventilation due to limited areas of openable windows
Vulnerable occupants	People between 55-85
Effects	Discomfort
Temporary measures	Some residents open the main flat door to increase ventilation, but the corridors are also overheated due to heating distribution pipes.

THE DWELLING

Dwelling type	Purpose built flat Low-rise blocks
Location	Suburban
Tenure	Housing Association
Year	Post 2000
Position	Various flats in two similar blocks
Floor area	80m^2
Construction	Unknown
Floors	Concrete/ polystyrene insulation
Walls	Timber frame, brickwork external face
Ceiling	Plasterboard, glass fibre insulation above
Windows	Double glazed UPVC 10% openable, 90% not openable
Surroundings	High proportion of low-rise buildings, medium green space and low proportion of hard surfaces. Busy road within 5-10m.
Estimated noise level	Medium

THE SYSTEMS

Heating & hot water	Central plant room, distribution pipes in corridors, underfloor heating in each flat.
Ventilation	Limited window opening, plus bathroom and kitchen extracts

THE OCCUPANTS

Occupants	Various, aged from 55 to 85 yrs.
Activities	Cooking – Often; Television – Continuously; Computers - Occasionally
Window opening	Yes, day and night, but area is insufficient to provide adequate ventilation.
Window concerns	Some concerns about noise, break-ins and pests etc.
Ease of use	The underfloor heating is difficult to control and confusing fro the residents. The ventilation is easy to use, but inadequate.

THE SOLUTIONS

Reducing internal heat gains	Educating residents on how to control their heating and hot water system.
Reducing heat gains from outside	Solar reflective film on the windows. This seems to have worked, but residents don't like the reduced daylight. It also doesn't look great from the outside.
Cooling the dwelling	The caretaker now opens the windows at either end of the corridors to allow through ventilation to the building. This has reduced overheating in the communal areas.
Other measures taken	Vertical mechanical ventilation ducts from the corridors to the roof – top floor residents now complain about the fan noise, and fire grills are required between compartments.
Additional recommendations	External solar shading
Avoidance suggestions	Consider orientation at initial design stage; use traditional construction rather than timber frame; provide through ventilation in flats; use radiators rather then underfloor heating; windows with larger openable areas and solar shading.

THE REPORTING

Source	Resident complaints – some have refused tenancies because of the reputation of the development.
Evidence	Logged temperatures, occupant comments and inspection.
Finding a solution	Recommendations from building surveyors and heating engineers.
Time from occupant report to the solution	3 years
Improvements to process	Learning from experience, and doing it better next time.

Example 7 – Purpose built - sheltered flats

THE PROBLEM

Timing	Jun/July/August Day and night
Which rooms	All
Observed cause	Centrally controlled communal heating and hot water, timed in a way that does not match lifestyles of the residents. Residents less willing and able to control the system, or open windows.
Vulnerable occupants	Elderly residents, mainly women.
Effects	Uncomfortable living conditions and poor sleeping patterns
Temporary measures	Provision of temporary air conditioning units and drink machines

THE DWELLING

Dwelling type	Purpose built low-rise flat - sheltered
Location	City centre
Tenure	Housing association & Shared ownership
Year	Unknown
Position	Ground floor
Floor area	Varies
Construction	Brick and block cavity walls
Floors	uninsulated
Walls	Insulated
Ceiling	Insulated
Windows	Double glazed – 90% openable
Surroundings	Reasonably built up area, roads and trees.
Estimated noise level	Medium

THE SYSTEMS

Heating & hot water	Communal heating and hot water. Insulated pipes running through flats, adding to heat gains, even wen the system is off.
Ventilation	Windows and extract fans to kitchen and bathrooms.

THE OCCUPANTS

Occupants	Over 55's at home during the day
Activities	Often using cooking and television, occasionally computers
Window opening	Not during the day, and some residents do during the night
Window concerns	Often concerned about noise, smells, pollution and people breaking in.
Ease of use	The residents do not find the heating system easy to understand, and there is very limited control. The ventilation system is not used because of concerns about draughts.

THE SOLUTIONS

Reducing internal heat gains	Wardens hold coffee mornings with residents and health visitors, to encourage better practice. Very little physical refurbishment is carried out due to limited budget and unwillingness of residents to live with the upheaval.
Reducing heat gains from outside	None
Cooling the dwelling	Opening communal windows, and provision of drinks machines.
Additional recommendations	Complete redesign of the schemes, but unlikely because of drive to reduce costs.
Avoidance suggestions	Better design guidance, plus a central standard and more powers for planners to consider overheating as part of any planning application.

THE REPORTING

Source	Reports from scheme wardens and housing teams
Evidence	Team meeting and concerns raised by health professionals
Finding a solution	No solution found yet
Time from occupant report to the solution	N/A

Example 8 – sheltered housing

THE PROBLEM

Timing	The problem occurs in the communal corridors all year round and is worse in the daytime.
Which rooms	All corridors
Observed cause	Excessive heat and poor ventilation in corridors, stairwells and communal areas. These corridors are long and T shaped with only one window at one end of the corridor at each floor. The window is only openable about 100mm (fitted with restrictor).
Vulnerable occupants	Elderly residents and staff
Effects	Uncomfortable conditions in the circulation areas
Temporary measures	None

THE DWELLING

Dwelling type	Purpose built low-rise flats
Location	Urban
Tenure	Housing Association
Year	Post 2000
Position	Corridors on all floors
Floor area	100m long
Construction	Brick and block cavity walls
Floors	Carpet, insulated
Walls	Plaster finish, insulated
Ceiling	Ceiling tiles with ceiling void for services
Windows	Double glazed – 15% openable
Surroundings	Semi built up area with green spaces, hard surfaces and low-rise buildings.
Estimated noise level	Medium

THE SYSTEMS

Heating & hot water	The hot water pipes and heating pipes run through the ceiling void over the ground floor corridor, then run through risers between each flat. The pipes

	are insulated but not the joints.
Ventilation	No mechanical ventilation in the corridors, and very limited window opening.

THE OCCUPANTS

Occupants	Average age 50-70, 1.5 people in each flat, mostly at home in the day.
Activities	Cooking and computers occasionally and television often
Window opening	Open windows in the day (when it feels too hot).
Window concerns	Sometimes concerned about noise and insects/ animals entering.
Ease of use	N/A

THE SOLUTIONS

Reducing internal heat gains	In all corridors reduce the numbers of light fittings and fit LED lighting to all remaining fittings
Reducing heat gains from outside	N/A
Cooling the dwelling	Apply a bespoke passive ventilation system with mechanical fresh air intake assistance to cool corridors. As the free air flow area through the open-able area of the windows are not sufficient due to the windows opening restrictors, the three fire stair cases at each end of the corridors have been “borrowed” to generate the better buoyance effect by holding back the fire doors with smoke detectors. The corridor windows and windows at top floor at each fire stair case would be grouped up and open in steps by temperature control in order to best cool each corridor areas.
Additional recommendations	For corridors in communal areas, it is worth to considering the length in order to better benefit from passive ventilation through open-able windows. Control solar gain by considering glazing area and orientation. It is important to make sure heating and hot water pipework, including joints, are insulated. Lighting can also contribute large amount internal gains. Apply these recommendations to buildings in design now and implement on others in the future.
Avoidance suggestions	Overheating in communal areas, e.g. corridors, in residential blocks It is not considered at design stage and there is no legal requirement to do so from Building Regulations. It is only identified as a problem after occupation. Therefore, it is worth considering this issue at design stage to avoid potential overheating in communal areas and corridors.

THE REPORTING

Source	The overheating issue was reported by clients and occupants.
Evidence	Occupant comments, working staff reported/ inspected, and logged temperatures.
Finding a solution	Carrying out dynamic thermal modelling.
Time from occupant report to the solution	About 3 years
Additional comments	This Case Study details an overheating issue that occurred in the corridors of a care home. It had been a problem for approximately 3 years since the building was constructed. The issue was reported by staff working there and residents. The temperature could reach over 30 degrees inside even in cooler months. Dynamic thermal modelling was carried out to establish the causes and work out the solutions with mechanical and electrical engineers. The building has been improved with the mitigation solutions and since then obtained positive feedback from residents and staff. Installed temperature loggers will record the temperatures over a trial period.

Example 9 – New build ground floor flat

THE PROBLEM

Timing	June – August 2009 11am – 5pm plus stuffy nights
Which rooms	South facing lounge and bedroom
Observed cause	Insecure and inadequate window opening
Vulnerable occupants	Child under 10yrs
Effects	Unable to use lounge; Child’s sleep disturbed
Temporary measures	Curtains drawn during the day

THE DWELLING

Dwelling type	Purpose built Flat, low rise block
Location	City Centre
Tenure	Housing Association
Year	Post 2000
Position	Ground floor, end block
Floor area	$60m^2$
Construction	Brick and block cavity

Floors	Insulated concrete slab
Walls	Insulated cavity
Ceiling	Plasterboard and skim
Windows	South facing Double-glazed, no trickle vents, no restrictors. 66% openable, 34% not openable
Surroundings	Low-rise buildings, hard surfaces and busy road.
Estimated noise level	Medium

THE SYSTEMS

Heating & hot water	Non-condensing combination boiler Un-insulated distribution pipework
Ventilation	Window opening, internal kitchen and bathroom with extracts fans

THE OCCUPANTS

Occupants	1 adult, at home; 1 child part-time
Activities	Cooking – often Television – often Computers - often
Window opening	Not in south facing lounge (glazed doors) or bedroom, as they open onto publicly accessed area.
Window concerns	Noise and break-ins
Ease of use	Heating system – yes Ventilation - yes

THE SOLUTIONS

Reducing internal heat gains	None
Reducing heat gains from outside	None

Cooling the dwelling	Provision of new window to lounge, as an alternative to the glazed door Opening restrictors to new lounge window and bedroom window Trickle vents to new lounge window and bedroom window Passive ventilators within partition walls or doors to improve air movement through the flat.
Additional recommendations	Shutters or lined curtains to south facing glazing
Avoidance suggestions	Regulations – Do not allow external doors for ventilation Design – Fit window restrictors to all windows accessible from outside, for security reasons.

THE REPORTING

Source	Complaint from the occupant
Evidence	Physical inspection of the flat by EHO and assessment of the excess heat hazard under the HHSRS; Interview with occupant; experience of EHO during August inspection.
Finding a solution	EHO experience, and assessment of practical and reasonable improvements..
Time from occupant report to application of solution	8 months

Example 10 – New build low-rise flats (multiple) – unoccupied

THE PROBLEM

Timing	July to October, 10am onwards
Which rooms	Corridors to flats especially but also whole flats, particularly on the south side where there's no external passive shading from balconies above as elsewhere in the building.
Observed cause	Long internal corridors with areas enclosed by fire doors and no access to natural ventilation and no windows. Many flats on the south side have no brise-soleil or passive shading. Some flats have shading from the balconies above. Heat intensifies as you go up the building noticeably. There's much more concrete and masonry and shelter from other buildings at lower level.
Vulnerable occupants	Not occupied yet, but visiting housing managers have complained about the problem already.
Effects	Temperatures of 28C, when it’s 19-21C outside
Temporary measures	Opening windows is all they can do - there is no cooling facility on the centralised system.

THE DWELLING

Dwelling type	Purpose built low-rise flats
Location	Urban

Tenure	Housing Association
Year	Post 2000
Position	Top five floors
Floor area	Whole building
Construction	Structural Insulated Panels (SIPs)
Floors	Concrete
Walls	Steel frame studwork internally, concrete columns with masonry infill for external walls highly insulated
Ceiling	plasterboard, waffle board to corridor ceilings
Windows	Plastic double glazed – 10% openable
Surroundings	In a densely developed area next to a river.
Estimated noise level	Medium

THE SYSTEMS

Heating & hot water	Centralised heating system - plant in the basement, lagged pipework running throughout the building and in corridors.
Ventilation	Decentralised fans in the wet areas with humidistat overruns. There is also a resident operated boost switch in the kitchen. We've been careful about ensuring each one is tested and certificated (Clerks of Works briefed).

THE OCCUPANTS

Occupants	Not occupied yet
Activities	N/A
Window opening	N/A
Window concerns	N/A
Ease of use	N/A

THE SOLUTIONS

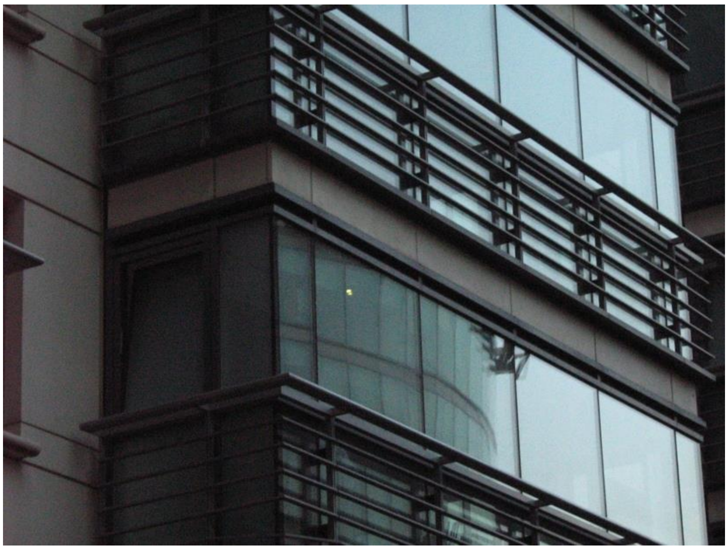
Reducing internal heat gains	Investigating a system that works by evacuating excessive heat through the fire safety smoke removal ducts.
Reducing heat gains	None yet

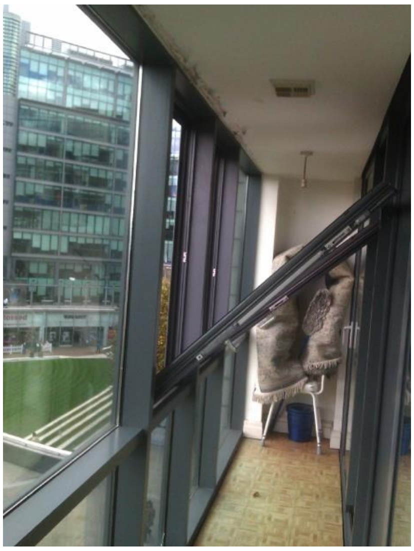
from outside	
Cooling the dwelling	None yet
Additional recommendations	May need to consider a lot of external passive shades. And perhaps some external planting screens encouraged or installed on balconies.
Avoidance suggestions	Passive shading – surprising that the architects didn't employ this. A solar aspect modelling analysis at design stage with consideration of windows.

THE REPORTING

Source	Visits by housing managers who reported back.
Evidence	Temperatures in the flats are visible on the heating programmers. These temperatures can be remotely checked. The corridors are noticeably stifling.
Finding a solution	Still investigating
Time from occupant report to the solution	N/A

Example 11 – New build high-rise flat





THE PROBLEM

Timing	Every May – September since built in 2002, Peak temperatures in mid-late afternoon and little opportunity for night cooling.
Which rooms	In the single aspect, south facing living room and bedroom, opening onto the winter gardens.
Observed cause	Social Housing on first two floors of two twelve-storey blocks. Remaining 10 upper floors have combined heating and cooling systems. The external envelope including the window design for both sectors is identical. South facing winter gardens have no means of dumping heat built up in the day - not an issue for private flats with access to cooling. The flats are single aspect and the living rooms/kitchens are approximately 9m deep. In fact it has come to light that cooling load calculations were carried out by the developer at the time for all of the flats irrespective of whether they were eventually fitted with cooling or not so there was evidence to the trained eye of an overheating problem at the time of construction.
Vulnerable occupants	Both tenants have health problems that make them more vulnerable to overheating
Effects	Interrupted sleep, the heat is overpowering because there is no air coming in, having chemo makes it worse. It is worse when cooking but you have to eat.
Temporary measures	Using limited ventilation, fans, portable air con unit. One tenant overrode restrictors on windows in winter garden - still not effective, and health and safety risk due to weight of casements.

THE DWELLING

Dwelling type	Purpose built flat, low-rise
Location	City centre
Tenure	Housing Association
Year	Post 2000
Position	First floor
Floor area	81m^2
Construction	Structural Insulated Panels (SIPs)
Floors	Concrete
Walls	External curtain walling
Ceiling	Concrete with suspended plasterboard ceiling
Windows	Double-glazed, low e. Only 2nd bedroom window is fully openable. Majority of winter garden windows are not openable, 2 bottom hung sashes open inward approximately 175mm.
Surroundings	Densely developed area next to water, train station, hard surfaces and roads.
Estimated noise level	Medium, but varies on each face of the building. Restaurants, roads, rail traffic etc.

THE SYSTEMS

Heating & hot water	Hot water system pipes above suspended ceiling. Heating electric storage heaters
Ventilation	Intermittent extract in bathroom (internal) kitchen supplied with cooker hood but set in recirculation mode (same for all social housing flats). Sound attenuated passive trickle vents in ceilings to habitable rooms appear not effective

THE OCCUPANTS

Occupants	Single person and daughter
Activities	Often use cooking and television
Window opening	Open windows day and night, but with no effect.
Window concerns	Sometimes concerned about noise.

Ease of use	Rarely have to use the heating, and thinks that the ventilation system doesn’t work.

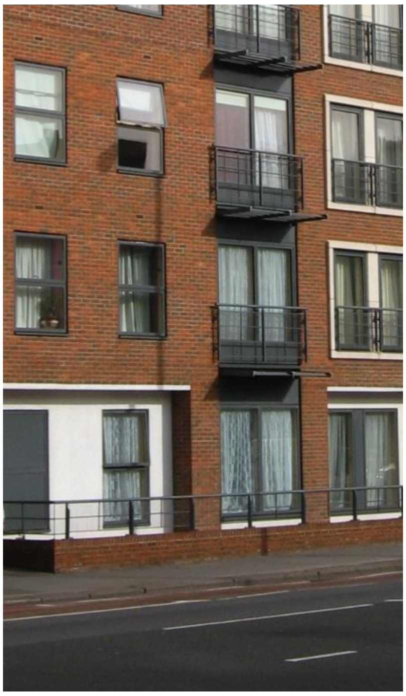
THE SOLUTIONS

Reducing internal heat gains	No works as yet carried out but see below
Reducing heat gains from outside	No works as yet carried out but see below
Cooling the dwelling	No works as yet carried out but see below
Additional recommendations	Provide a total of 4no fully openable windows in the winter garden, to allow heat built up in summer months to be ‘dumped’. This is a standard feature in the winter garden design which was overlooked at the time. Overheating risk was not generally anticipated as a problem and focus was more on providing a buffer against environmental noise and capturing beneficial heat gain in winter.
Avoidance suggestions	At the design stage essentially follow the principles set out in Energy Efficiency Best Practice Guide 'Reducing overheating - a Designer's Guide’. Comfort cooling should be the last resort. Apart from environmental considerations, comfort cooling is inappropriate in housing for lower income households due to running coats

THE REPORTING

Source	Complaints from residents
Evidence	Occupants comments, inspection, temperature logging in other dwellings, pilot study on estate carried out by the BRE
Finding a solution	Specific solution confirmed as an option in a report commissioned by the Building Owner (not the RSL) in response to formal representations from Environmental Health in May 2013 prior to taking enforcement action under the Housing Act 2000 to deal with the Category 1 Excess Heat Hazard
Time from occupant report to the solution	First complaint from tenant August 2011, still unresolved

Example 12 – New build low-rise flats (multiple)



THE PROBLEM

Timing	April – Sept; Temperature peaking mid afternoon.
Which rooms	All rooms - Average indoor temperatures in all rooms throughout the monitoring period (16.9 – 22.9.2006) exceed 25oC, the trigger point identified in the guidance where 'mortality increases and there is an increase in strokes'. Overnight bedroom temperatures (between 00.00 and 6.30am) are a particular cause for concern where the daily average for this period ranges between 25.2 and 28.0 and vary between only 1.0oC and 1.7oC below the maximum temperature reached the preceding day. This demonstrates there is very limited cooling during the night-time period.
Observed cause	Large areas of un-shaded south-facing glazing. Lack of window opening, due to location on busy road.
Vulnerable occupants	All tenants suffered. One person is housebound and suffers with depression so particularly vulnerable. Showed clinical signs of dehydration
Effects	Everyone experiences lack of sleep, both due to heat and noise/fumes if they opened windows. Ground floor tenant's pillow is 15 feet away from trunk road, no barrier with pavement. Tenant's handbook says windows only to be taken off restrictors for cleaning. Night-time cooling impossible. One tenant picked her kids up from school in summer and took them to the park till about 7.30 when temperatures outside began to fall. They avoided cooked meals during hot weather.

Temporary measures	One flat had one side (kitchen) window which was left open all day even though on ground floor. A couple of tenants installed their own ceiling fans (one was told by doctor there was a risk to her baby if left on at night). Ground floor tenant tried portable air con unit but limited effectiveness as had to open window for vent. The L/L provided portable units during summer months while works in design phase)

THE DWELLING

Dwelling type	Purpose built flat, low-rise
Location	City centre
Tenure	Housing Association
Year	Post 2000
Position	Ground, first, second floors (each flat single storey)
Floor area	1 bed: 46m2, 2 bed: 59m2, 3 Bed: 90m2
Construction	Brick and block cavity walls
Floors	Concrete
Walls	Brick with plasterboard lining
Ceiling	Concrete with plasterboard sub-ceiling
Windows	Double glazed. Living room: fully openable French casements (on restrictors), bedrooms: fully openable (BUT severely restricted ability to open due to noise and pollution).
Surroundings	Buildings, busy road and hard surfaces. Slabs just below ground floor window sills measured at 56°C on one occasion. When BRE did monitoring modified the Summer Design Year file to account for high temperature of structure affecting temperature of summer ventilation air.
Estimated noise level	High, day and night.

THE SYSTEMS

Heating & hot water	Heating: storage radiators, hot water: Individual Pulsacoil thermal store.
Ventilation	Intermittent extract in internal kitchens and bathrooms (on testing did not meet Building regs, in some cases not connected to external vents).

THE OCCUPANTS

Occupants	Varied among the 6 flats: families with children, Single pensioner, three households with members with disabilities (one house bound) 2/6 working households.
Activities	All activities average for households. As mentioned above cooking was restricted due to conditions in summer
Window opening	Windows are opened sometimes during the day but noise and pollution limit this. You cannot hear the TV at a reasonable volume with the window open. Sleeping difficult with window open at night due to high level of noise 24/7 (confirmed by reference to 'noise map' for the area)
Window concerns	Noise – often. Air pollution – often. Pollen – D/K (unlikely) Kids falling – not mentioned as a factor. Crime – often (ground floor) Insects – often.
Ease of use	Heating system: average for storage radiators (on peak/off peak and controls not well understood by all) Ventilation, how to use not an issue, lack of control is.
Additional comments	The occupants of the dwelling well understood the impact of living in these conditions. The problem was that for many years no one took it seriously – due to lack of belief that this was an issue in UK. Tendency with landlords (as with condensation) to over emphasise tenant lifestyle as the cause of problems rather than defective buildings. There was nothing any of these households were doing that was not a reasonable part of a modern lifestyle – hence build should accommodate this.

THE SOLUTIONS

Reducing internal heat gains	No specific measures to reduce internal gains – not seen as excessive.
Reducing heat gains from outside	Reduction in some widow areas, solar shading, solar film. First measure put in place was solar film most tenants found some improvement but definitely not the whole story. Film chosen to balance solar and light reduction. Concern about losing some window area (bottom panels of full height bedroom glazing replaced with opaque panels) but seem to have been accepted.
Cooling the dwelling	Bespoke ventilation system ducting cooler air from the North facing courtyard elevation into hallways and extracting hot air from living rooms/bedrooms. Separate continuous and boost fans in wet rooms. Teething problems with this. Input fan (on continuous low level) relies on being activated by sensing

pressure difference when tenants turn up living room extract fans. Does not appear input fan can sense this – BRE carrying out monitoring. Appears solution has been found - yet to be implemented.

Additional recommendations Only other feasible measure was comfort cooling which was opposed by Landlord as setting a precedent and Council as expensive to run (most families on low income), and environmentally unsustainable. The tenants felt for a long time that the only thing that would work would be air conditioning and some thought they wouldn't mind paying more because they rarely used their heating in the winter.

Avoidance suggestions Take notice of guidance that is already in existence eg CE129, although more specific thought needs to go into the urban environment. Hierarchy of measures as suggested in 'London Plan (?)' giving priority to passive measures, comfort cooling last resort. Warming standard as part of local development plan where developer has to demonstrate a strategy to avoid overheating. One developed in Westminster requires developer to undertake dynamic thermal modelling. OK for 'high end' developers but very expensive, need something affordable for the rest. As a general rule the simpler the better. Have regard to counter indications of measures for beneficial heat gain in winter (mentioned in GLA report adapting for Climate Change) – we got in this mess by not having due regard the other way round. Education of all professionals to recognise and deal with the issue. Don't let developers get away with 'it's all the fault of the extreme climate change lobby' perfectly possible to have homes that are warm in winter and not ovens in summer – learn from other countries, both in the developed and developing world, the latter where they have had experience of much higher temperatures for literally thousands of years and where there is less acceptance that we have anything to learn from them. Resist marketing drives of mechanical ventilation lobby that increasingly the solution is ever more sophisticated (and expensive) mechanical systems. Penalise comfort cooling more in the Building regulations.

THE REPORTING

Source Complaints from residents to Environmental Health of overheating

Evidence The most impressive 'evidence' was the resident's stories of what it was like to live there. The first time I visited I was a little sceptical of 'overheating' being an issue in this country – spent most of my professional life advocating for something to be done about cold. I recall that also was the case with the RSL technical manager who first visited the block. Having listened to the tenants he became a strong and persistent advocate for finding a solution. We also did temperature monitoring.

Finding a solution

BRE used this example in a pilot study they undertook in 2006/7, funded by the Energy Savings Trust) into avoiding overheating in urban dwellings (BRE Client Report 234742, 2007). On the basis of our evidence and the contents of this report we concluded reluctantly that the only solution for these dwellings was installation of comfort cooling and we served notice on the RSL 'owner' requiring this in one of the ground floor flats. Legally we had to serve on them because of the nature of the lease, although as in many of the cases involving RSL accommodation provided via s106 planning agreements, we sympathised with their predicament of being landed with a problem that was not primarily of their making.

After protracted negotiations that came to a dead end the RSL agreed to work with us on an alternative solution to air conditioning for the whole elevation (the six flats). They employed the BRE to carry out dynamic thermal modelling for various options of remedial works (a combination of reducing impact of solar gain and increased night-time ventilation. One of the difficulties was answering the designer's question 'how cool does it have to be?' The CIBSE guidance is not readily transferable to the domestic sector (eg Guide A) and the Housing Health and Safety Rating System only refers to health risks starting at above 25oC. The BRE report looked at limiting the number of consecutive night time hours where temperatures exceeded 24oC (temp recognised in Guide A where there is a 'risk of interference with sleep' and hence a recognised health impact and consecutive hours generally where the dwelling temperature exceeded 25oC based on the HHSRS Guidance. We concluded that straight application of the CIBSE trigger points for living rooms and bedrooms of 28oC and 26oC respectively for 1% of occupied hours was not sufficient in guarding against future instances of heat related ill health.

The RSL engaged two 'specialist' companies to design the solar reduction and ventilation aspects of the solution. Our Housing Act notices were varied accordingly. Works were finally complete on site in April of this year; detailed monitoring is being carried out by the BRE. Depending on positive results from this the Council will revoke the notices served on the RSL

Time from occupant report to the solution

8 years

Additional comments

The length of time it took was in part due to the fact that this was 'a first' for those of us working with the new Housing Act in the Council and for the RSL. Lessons learnt included 'get it right at the design stage' because dealing with the consequences remedially is a nightmare, most significantly for the people that have to live with it.

Appendix C - Other research and publications relating to overheating

Design guidance

CE129 Energy Efficiency Best Practice in Housing: Reducing overheating – a designers guide Energy Saving Trust, March 2005

Design for Future Climate: opportunities for adaptation in the built environment Bill Gething, TSB, June 2010

Understanding overheating – where to start: An introduction for house builders and designers Guide NHBC Foundation, Richards Partington Architects, July 2012

Guidance on climate change and overheating

Health Effects of Climate Change in the UK 2012: Current evidence, recommendations and research gaps Sotiris Vardoulakis and Claire Heaviside (editors), HPA, Sept 2012

London's Changing Climate: In sickness and in health London Climate Change Partnership, March 2011

The London Plan 2011: Spatial development strategy for Greater London - chapter five: London's response to climate change Greater London Authority, July 2011

The National Adaptation Programme: making the country resilient to a changing climate DEFRA, July 2013

TM52 The Limits of Thermal Comfort: Avoiding Overheating in European Buildings NEW 2013 CIBSE, 2013

UK Climate Change Risk Assessment: Government Report DEFRA, Jan 2012

Research

Blowing Hot and Cold at Home: workshop report HPA, London March 25th 2011

Control of Overheating in Well-Insulated Housing Malcolm Orme, John Palmer, Steve Irving, FaberMaunsell Ltd,

Investigation into Overheating in Homes: Analysis of Gaps and Recommendations DCLG, AECOM, July 2012

Investigation into Overheating in Homes: Literature Review DCLG, AECOM, July 2012

Overheating and Health: a review into the physiological response to heat and identification of indoor heat thresholds Health Protection Agency, March 2011

Overheating in new homes: A review of the evidence NHBC Foundation, Nov 2012

Housing Health and Safety Rating System

Good Housing Leads to Good Health: a toolkit for environmental health practitioners CIEH, BRE, Sept 2008

Housing Health and Safety Rating System: Guidance for Landlords and Property Related Professionals DCLG, May 2006

Housing Health and Safety Rating System: Operating ODPM, Feb 2006

Housing and thermal comfort background

Adaptive Thermal Comfort: Principles and Practice Fergus Nicol, Michael Humphreys and Susan Roaf, Routledge, 2012

Housing, climate and comfort Evans M, Architectural Press, 1980

Quality Counts 2011/12 – Results of the quality assurance and impact visits: affordable homes programme 2011-12 HCA, July 2013

Links

The Good Homes Alliance

http://www.goodhomes.org.uk

Network for Comfort and Energy Use in Buildings (NCEUB)

http://nceub.commoncense.info/

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[1] Health Protection Agency, *Overheating and Health: a review into the physiological response to heat and identification of indoor heat thresholds* (March 2011)

[2] DCLG, *English Housing Survey, Stock Profile* (2011)

[3] NHBC, *Housing Supply Update* (Nov 2013)

[4] NHBC, *Housing Supply Update* (Nov 2013)

[5] Energy Saving Trust *CE129 Energy Efficiency Best Practice in Housing: Reducing overheating – a designers guide* (March 2005)

[6] Health Protection Agency, *Overheating and Health: a review into the physiological response to heat and identification of indoor heat thresholds* (March 2011)

[7] Professor James Goodwin PhD *Heat, Health and the Older Population* Presentation at GHA event, July 2012 http://www.goodhomes.org.uk/downloads/events/James%20Goodwin%20Age%20UK_Overheating.pdf

[8] Health Protection Agency, *Overheating and Health: a review into the physiological response to heat and identification of indoor heat thresholds* (March 2011) p.6

[9] DCLG, *English Housing Survey: HOMES 2010,* p.9

[10] DCLG, *Housing and Planning Statistics, 2010*

[11] RIBA, *The Case for Space: The size of England's new homes*, Sept 2011

[12] Rajat Gupta and Matt Gregg. *Preventing the overheating of English suburban homes in a warming climate Building Research Information*, 2013, Vol. 41, No 3, 281-300 (Taylor & Francis, 2013) http://dx.doi.org/10.1080/09613218.2013.772043

[13] DCLG, *English Housing Survey, Stock Profile* (2011)

[14] DCLG, *House Building: Sept Quarter 2013, England* (Housing Statistical Release, 21 Nov 2013)

[15] ibid

[16] Rajat Gupta and Matthew Gregg. *Using climate change projections to adapt existing English homes for a warming climate*, Building and Environment 55 2012 20-42 (Elsevier, 2012)

[17] Citizens Advice Bureau http://www.adviceguide.org.uk/england/housing

[18] ODPM, *Housing Health and Safety Rating System, Operating Guidance* (Feb 2006)

[19] ODPM, *Housing Health and Safety Rating System, Operating Guidance* (Feb 2006) p.63

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[25] Peter Thompson and Jon Bootland *GHA Monitoring Programme: Technical Report* (GHA, 2011)

[26] Melissa Taylor and Dr Laura Morgan *Ventilation and good indoor air quality in low energy homes: Finding proven good practice* (GHA, Nov 2011)

[27] Rajat Gupta and Matthew Gregg. *Using climate change projections to adapt existing English homes for a warming climate*, Building and Environment 55 2012 20-42 (Elsevier, 2012)