

OVERHEATING IN HOMES THE BIG PICTURE

EXECUTIVE SUMMARY



The Zero Carbon Hub was established in 2008, as a non-profit organisation, to take day-to-day operational responsibility for achieving the government's target of delivering zero carbon homes in England from 2016. The Hub reports directly to the 2016 Taskforce.

To find out more, or if you would like to contribute to the work of the Zero Carbon Hub, please contact: info@zerocarbonhub.org.

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FOREWORD

In recent decades the construction and energy efficiency sectors have made substantial progress in rising to the challenge of delivering highly energy efficient homes.

All new homes are now required to meet strict energy efficiency standards and millions of existing homes in England and Wales are better insulated, have energy efficient glazing and efficient heating systems. A growing proportion of the housing stock is also benefiting from low carbon energy production through decentralised systems and technologies such as photovoltaic (PV) panels.

Properties are becoming more cost-effective to run and the built environment is playing its part in the transition to the low carbon economy. As a result of this effort, the sector is making progress in tackling the problem of cold homes and fuel poverty, although there is still much work to be done.

However, as we get better at building and retrofitting homes to prevent heat losses in the winter, we may inadvertently increase the risk of overheating in warmer months.

Throw into the mix likely increases in the number of unusually hot summers as the climate changes, more frequent and intense heatwaves, and continuing construction in dense cities, then more people could find they are living in homes which reach uncomfortable or excessive temperatures. Temperatures beyond, for example, those referenced in the Government's Housing Health and Safety Rating System (HHSRS), or beyond the thermal comfort limits recommended by professional bodies such as the Chartered Institution of Building Services Engineers (CIBSE).

It is hard to imagine anybody wanting to live in a home which they find uncomfortably hot or which could lead to them falling ill. Similarly, it is hard to imagine building professionals setting out to construct or retrofit homes which are likely to overheat. Unfortunately, however, it is clear that overheating is happening – potentially in up to 20% of the housing stock in England.¹ The expectation that the issue will worsen in the future is further cause for concern.

Why does overheating happen? How can the construction and energy efficiency sector prevent the issue getting worse? What can local and national governments do to support the housing sector? And why does it matter?

1. See Chapter 4 for the research behind this figure and for discussion on the position in Wales.



These questions prompted the Zero Carbon Hub (ZCH), with the backing of government departments and industry partners,¹ to create a two-year project to take stock, investigate the extent to which the housing sector is gearing up to address overheating risk, and assess what changes to business processes and government frameworks could increase the resilience of the housing stock to extreme heat.

This report presents preliminary findings from the project so far, with a particular focus on reflecting what the housing sector has told us about their concerns and level of preparedness to tackle overheating. It is the ‘big picture’ on overheating. It is evident from the feedback the ZCH has received that many organisations are at the beginning of the journey. For others, processes intended to minimise overheating risk are being embedded in their businesses.

Going forward our national strategies must be geared towards minimising and preventing overheating as far as possible. To have simple checks and processes in place during construction and retrofit projects to identify potentially high-risk properties, and promote the use of designs and measures which can limit or remove unwanted heat. Such checks are more important than ever as buildings become more airtight.

A second phase of the project will begin this year, aiming to make detailed recommendations about the types of policies and frameworks that could help the sector take a significant step forward in keeping people comfortable and healthy in their homes.



Rob Pannell
Managing Director, Zero Carbon Hub

¹ See Annex A of the full report for a list of partners and stakeholders.

ACRONYMS

ASC

Adaptation Sub-Committee of the Committee on Climate Change

ARCC

Adaptation and Resilience to a Changing Climate

BRE

Building Research Establishment

CCRA

Climate Change Risk Assessment

CIBSE

Chartered Institution of Building Services Engineers

DCLG

Department for Communities and Local Government

DECC

Department of Energy and Climate Change

DEFRA

Department for Energy, Food and Rural Affairs

GHA

Good Homes Alliance

GLA

Greater London Authority

HHSRS

Housing Health and Safety Rating System

LAAP

Local Adaptation Advisory Panel

LCCP

London Climate Change Partnership

NAP

National Adaptation Programme

NPPF

National Planning Policy Framework

PHE

Public Health England

PPW

Planning Policy Wales

SAP

Standard Assessment Procedure

ZCH

Zero Carbon Hub

Box 1. The term 'Housing Provider'

The term 'Housing Provider' is used throughout this report to refer to organisations who build, manage, rent or retrofit domestic properties. The term covers:

- Housebuilders and developers
- Private landlords
- Registered social landlords/housing associations
- Local authority housing providers
- Companies providing energy efficiency retrofit services

The project team also engaged with technical and other experts who directly influence the types of homes being built and how retrofit projects are carried out. These include:

- Architects
- Building services engineers
- Building physicists
- Manufacturers
- Specialist contractors
- Academics
- Building control
- Warranty providers
- Trade associations
- Planners
- Local authorities
- Environmental Health Officers
- Public health representatives
- Health and Well-being Boards
- Central government departments

The term 'housing sector' means Housing Providers plus this wider group of organisations.

The geographical scope of the project is England and Wales. The findings relate to new and existing dwellings.

CONTEXT

CHAPTER 1 SUMMARY

What is the concern about overheating in homes?

During the summer heatwave in Northern France in August 2003, unprecedentedly high temperatures for a period of three weeks resulted in 15,000 excess deaths. The vast majority of these were among older people. Research after the heatwave event revealed that at least 50% of these deaths could have occurred due to exposure to heat in people's homes.¹

Across England and Wales that same year, there were over 2,000 excess deaths during the ten-day heatwave in August, compared to the previous five years over the same period. Again, the worst affected were people over the age of 75 years.²

It is widely predicted that climate change will lead to more frequent and intense heatwaves, as well as increases in average temperatures across the country. Combined with increased urbanisation and an ageing population, thousands more people are expected to be affected by heat-related ill health by 2050.

Historically, heat has been lost in uncontrolled ways from buildings due to lower levels of thermal insulation and infiltration through gaps in the building fabric. This has contributed to keeping levels of overheating in dwellings low. More recently, the drive for energy efficient, airtight buildings, which is integral to the fuel poverty agenda and objectives to reduce cold-related deaths, means greater care must now be taken to consider and reduce the potential for overheating when homes are being built or refurbished.

In short, the concern is that more people will become exposed to excess heat in their homes with consequences for their health and well-being. Overheating is therefore an important issue which needs to be dealt with.

What has been done by the Government to tackle the issue already?

The Governments in England and Wales have taken steps to lessen the impacts of future heatwaves and overheating in homes more generally. Amongst these measures:

- The Heatwave Plan for England was introduced to 'protect the population from heat-related harm to health'.³

1. *Includes deaths in care homes. Fouillet et al (2006).*

2. *Johnson et al (2005).*

3. *The Heatwave Plan for England (2015); See also the historical Heatwave Plan for Wales (2012).*

“As temperatures rise due to climate change there is an increased risk of overheating in buildings.”

ENVIRONMENTAL AUDIT COMMITTEE

- The National Planning Policy Framework (NPPF) and related guidance in England plays a key role in minimising vulnerability and increasing resilience to the impacts of climate change, and Local Plans must also take account of climate change. The Planning Policy Wales (PPW) has similar overall objectives, and specifically references increased thermal discomfort as an impact of climate change;
- The Housing Health and Safety Rating System (HHSRS) provides an approach to evaluate the potential health and safety risks from specified deficiencies in dwellings, including from ‘excess heat’;
- An overheating ‘check’ for new dwellings in the Standard Assessment Procedure (SAP) was created, underpinned by Criterion 3 in Approved Document Part L1A of Building Regulations;¹
- Overheating was flagged as key risk in the 2012 UK Climate Change Risk Assessment (CCRA) and in Cabinet Office contingency planning;
- The National Adaptation Programme (NAP) 2013 was created, which sets out actions geared towards tackling overheating and names organisations with the responsibility for delivery; and
- Progress against these actions is now monitored by the independent Adaptation Sub-Committee of the Committee on Climate Change (ASC) and their first statutory progress report to Parliament is due this summer.

It is, however, far from clear that these frameworks alone will be sufficient to drive significant reductions in the incidence of overheating in homes at a national level over the longer term. This issue is discussed in greater detail in Chapter 7.

Questions about the effectiveness of existing frameworks have also been raised recently by Parliament’s Environmental Audit Committee and by the London Assembly’s Environment Committee.²

What has been done by the housing sector to tackle the issue already?

Many organisations representing or advising Housing Providers including the ZCH, the NHBC Foundation, CIBSE, the Good Homes Alliance (GHA), BRE, Arup and Aecom, have published evidence reviews and practical guidance on building design and adaptation measures. A list of relevant publications can be found at www.zerocarbonhub.org.

Major programmes of research funded by Innovate UK, including the Design for Future Climate competition (D4FC) and the Building Performance Evaluation (BPE) Programme, have also contributed significantly to the sector’s knowledge and understanding of building thermal performance.

Similarly, a large body of evidence has been produced by the academic community. The Adaptation and Resilience to a Changing Climate (ARCC) network, for example, has brought together research projects looking at adaptation and resilience in buildings, and drawn out key messages for policymakers.



‘At the request of Government, the Zero Carbon Hub is currently developing a project to assess the case for action on dealing with overheating in homes...’

Committee on Climate Change, Adaptation Sub-Committee, ‘Managing climate risks to well-being and the economy’ (2014)

1. Which can be found at Appendix P. There are no corresponding provisions for existing dwellings.

2. ‘Environmental Audit Committee – Tenth Report, Climate Change Adaptation’ (4 March 2015); London Assembly Environment Committee, ‘Come Rain or come shine’ (26 March 2015).

A range of organisations have created networks to raise awareness on overheating, share research and expertise and help to drive action, including the Environment Agency's Climate Ready network, Climate UK (and the related partnerships), Climate Local and the Local Adaptation Advisory Panel (LAAP).

It is also apparent that a growing number of Housing Providers are carrying out their own research. For example, they are monitoring temperatures in their residential stock or surveying occupants to check how thermally comfortable their homes are. See, for example, the ZCH's Rowner Research Project Overheating Report (2015).

There is therefore a substantial body of advice and guidance available. The concern is, that for a number of reasons, this best practice is not being fully embedded within the organisations that have responsibility for shaping the performance of future homes. See Chapter 7.

What is the purpose of this report?

At the request of Government, the ZCH formed the project 'Tackling Overheating in Homes' in 2014. Supported by our partners and over 100 stakeholders the team has gathered evidence and information on:

1. The current extent and impact of overheating in homes;
2. The possible future extent;
3. The degree to which the housing sector is already gearing up to tackle the issue; and
4. What further action could be required to adequately manage the risk of current and future overheating.

We are enormously grateful to our partners and stakeholders, many of whom have contributed time and expertise to this project for free. See Annex A of the full report for a list of contributors.

This report presents our preliminary findings – the 'big picture' on overheating. Our spotlight on process has allowed us to draw early conclusions on what appear to be appropriate next steps for decision-makers, and these will inform the second phase of the project.

The report is intended for government and industry audiences with an interest in future policies and frameworks on overheating in England and Wales. It is not guidance.

The full report (online only) and the Executive Summary can be found at www.zerocarbonhub.org.





What information has informed this report?

- Over 400 research papers and reports;
- 6 thematic Evidence Reviews (see below);
- A survey of 75 Housing Providers (representing 207, 728 homes) in partnership with Sustainable Homes;
- 33 in-depth interviews with Housing Providers and other industry experts; and
- Workshops and one-to-one meetings.

Evidence Reviews

The ZCH commissioned a series of Evidence Reviews from experts on key themes. These were published in March 2015 and can be found at www.zerocarbonhub.org.

DEFINING OVERHEATING

by the Chartered Institution of Building Services Engineers (CIBSE), ARCC, University College London (UCL), and the London School of Hygiene and Tropical Medicine (LSHTM)

ASSESSING OVERHEATING RISK

by Inklings LLP, CIBSE, UCL and ARCC

IMPACTS OF OVERHEATING

by AECOM

OVERHEATING RISK MAPPING

by AECOM

DRIVERS OF CHANGE – OVERHEATING IN HOMES (leaflet)

by the ZCH and AECOM

A sixth Evidence Review by BRE will set out the range of technical and behavioural solutions available to address overheating in new and existing homes. This will be published in July 2015.

DEFINITIONS

CHAPTER 2 SUMMARY

“The definition is very difficult...there isn't one single definition that will fit all circumstances.”

HOUSING ASSOCIATION

“We're finding increasingly that the local environmental health officers have a view and they're potentially at odds with their building control colleagues.”

HOUSING ASSOCIATION



In general terms, by overheating, the ZCH means the phenomenon of excessive or prolonged high temperatures in the home, resulting from internal or external heat gains, which may have adverse effects on the comfort, health or productivity of the occupants.

Chapter 2 describes the range of definitions, criteria and thresholds used by the sector to understand whether a dwelling is overheating, or might overheat in the future.

Professional bodies, such as CIBSE, have produced guidance on temperature thresholds, which if exceeded for certain periods of time, would result in most occupants in the building feeling uncomfortably warm. In such circumstances the building is considered to have overheated. See CIBSE Guide A Environmental Design (2015) and the Defining Overheating Evidence Review for more detail.

Key findings:

- In common with other studies, the most pressing issue identified is that there is no accepted or agreed definition of overheating which can be applied by the domestic sector as a whole.
- As a result, the ZCH's stakeholder interviews and the Overheating Survey confirm that Housing Providers understand and are using many different ways of defining overheating.
- Where specific criteria are adopted, these relate to thermal comfort,¹ as expected, and most often to CIBSE's Guide A (2006), not newer guidance published in 2013 which incorporates the 'Adaptive Comfort Model'.²
- Health-related guidance usually sets different temperature standards or thresholds, since the people most at risk from the health effects of excess heat may experience those effects at temperatures below the upper thresholds for thermal comfort. Prolonged heat exposure, which can cause serious health problems for vulnerable groups, is also not well accounted for by simple temperature thresholds.
- Health-related standards are also usually based on external temperatures, making them more difficult to apply as design standards for buildings.³
- Housing Providers reported that the range of different standards and lack of clarity is creating issues for them. For example, if Environmental Health Officers seek to enforce health and safety standards which the dwelling was not designed to deliver, protracted disputes can arise.

1. Thermal comfort has been defined as "that condition of mind which expresses satisfaction with the thermal environment". ISO 7330.

2. The Adaptive Comfort Model seeks to take account the ability of occupants to acclimatise to recent external temperatures and adapt themselves or the building they are in.

3. Although the HHSRS references 25°C, which is presumed to be an internal temperature.

“Indoor thresholds for health are needed as a protective measure against preventable morbidity and mortality.”

OVERHEATING IN NEW HOMES. A REVIEW OF THE EVIDENCE (2012), NHBC FOUNDATION (NF46)



For a summary of the range of temperature thresholds related to heat and the built environment see the ZCH's Defining Overheating Evidence Review (2015), and the London Climate Change Partnership (LCCP) and Environment Agency's Heat Thresholds Project Final Report (2012).

- Lastly, new guidance on adaptive thermal comfort published by CIBSE was developed primarily from evidence from the non-domestic sector. The approach needs to be fully road-tested in the domestic sector and further field studies are needed to confirm its applicability to bedroom comfort temperatures during the night.

There are a number of limitations and issues associated with the range of current methods of defining overheating which are explained more fully in Chapter 2.

What could this mean for future frameworks?

Without a sector-wide accepted definition:

- Dwelling designs which have the same characteristics as existing dwellings where high temperatures are known to have caused harm to health could inadvertently be approved by Building Control Officers;
- Overheating risk assessments of dwellings will continue to be judged against different criteria, limiting comparison between them;
- Housing Providers will continue to experience a lack of clarity about what reasonable steps they are required to take to safeguard current and future occupants, and be subject to very different types of planning requirements, for example, depending on which part of the country they operate in; and
- Without a level playing field, those who invest in taking reasonable steps to safeguard the comfort and health of occupants may find they are commercially disadvantaged.

Agreeing a definition is unlikely to be an easy task. Many practical issues need to be considered, including how any definition would account for:

- Climatic variation across the country, including future climate projections and the ability of people to acclimatise and adapt;
- Neighbourhood effects and local microclimates in urban environments which can compound the effect of the urban heat island;
- The importance of night-time temperatures in dwellings (compared to non-domestic buildings);¹
- The different overheating risk profiles of the housing stock;
- The subjective nature of the experiences of occupants; and
- Vulnerable occupants.

What form the definition would need to take in order to be universally applicable, what status it would have (e.g. in guidance or regulation), what unintended consequences having a very precise definition could create, and what alternative ways of driving action exist, will all need careful exploration.

Action

ZCH to form a working group of experts to make recommendations to Government on what form an overheating definition or standard could take, and how it would be implemented in practice (by March 2016).

1. High night-time temperatures can impair a person's ability to recover from heat stress during the day and lead to disrupted sleep.

CAUSES AND RISK FACTORS

CHAPTER 3 SUMMARY

Chapter 3 sets out the main causes and risk factors associated with overheating in homes.

In summary, overheating occurs when too much heat builds up inside a dwelling – from external sources such as the sun, or from internal sources such as appliances or hot water pipes – which cannot quickly or easily be rejected or removed.

All buildings should act as a physical buffer between the outside and inside to protect their inhabitants from the extremes of the external environment. Where a building is located, how it is orientated, how it is constructed, how it is ventilated, how it is heated, and how it is used, all contribute to how well a dwelling fulfils this role. Recent research by Mavrogianni et al (2012) explored the links between external and internal temperatures in dwellings in London, and the extent to which the building can amplify external temperatures.

Figure 2. Illustration adapted with permission from 'Understanding Overheating – Where to start' (NHBC Foundation NF44, 2012) showing some of the causes and cumulative effects of overheating in homes



1. Site context

External pollution, noise and excessive noise may prevent occupants from opening their windows. Surrounding hard surfaces will absorb heat and release this during the night.

2. External temperature

On a warm, still day when external temperatures are high, fresh air may not provide enough of a cooling effect to address overheating.

3. Solar gains

Double-glazed windows with a low-e coating prevent heat from escaping. Houses with unshaded west-facing glass will suffer from higher levels of solar gain in the warmer part of the day.

4. Internal gains

Electrical appliances, occupant activities such as cooking, and building services, e.g. boiler and hot water storage, all have the potential to radiate heat that may contribute significantly to the increasing internal temperatures.

5. Building design

Modern homes have increased levels of insulation and airtightness, resulting in more heat being retained within the homes. This means any built-up heat in the homes will have to be actively removed.

Box 3. Examples of risk factors

The following summary has been adapted with kind permission from guidance produced by the ARCC network in 2013.

Location

Summer temperatures are generally higher in the South and South East England. Built up neighbourhoods will be at higher risk of overheating as a result of the Urban Heat Island effect (UHI).

Type of properties

Many factors affect the risk of overheating, including built form and orientation. Flats, especially on the top floor, are often identified as being at highest risk.

Fabric characteristics

The position of insulation, how lightweight the construction is, the colour of the facade, and the type, area, and position of the glazing can all affect the likelihood of buildings overheating.

Orientation and exposure

West-facing (and potentially east-facing) windows are especially problematic. Although south-facing rooms also experience overheating, they are easier to shade from the high angle summer sun.

Occupancy/behaviour

Occupants staying at home all day could experience more overheating than an occupant who does not.

Ventilation

Where noise and security issues discourage the use of window opening for cooling.

Key findings:

- Not all types of dwelling overheat. The risk of overheating varies from building to building. Those which have a higher propensity to overheat usually have recognisable risk factors, which means the sector can be cautiously optimistic about being able to identify and treat them;
- The generic causes of heat gains and overheating risk factors are well understood. Nearly all Housing Providers the ZCH interviewed had a good sense of the types of developments within their stock which would be more prone to overheating,
- However, it was clear that problems can arise when trying to identify the precise causes of a particular overheating problem once it is happening. Interviewees considered that detailed knowledge across the sector as whole is lacking.
- It was also common for Housing Providers to report issues with internal overheating risk assessment processes which could result in inherently risky designs and projects not being flagged early enough in the construction or refurbishment process. Once designs or specifications are fixed, it becomes more difficult to make changes to address any concerns about overheating.
- Conversely, a number of interviewees described how their technical teams are using their experience and knowledge of overheating risk factors to identify sub-sets of properties or designs which have characteristics that make them more likely to overheat, before carrying out any formal modelling exercises. A form of 'first pass'.
- These 'higher risk' properties were then subjected to detailed 'dynamic' thermal modelling, and if found to fall short of the chosen overheating criteria, measures would be installed or design changes made to reduce the potential for overheating. The sub-set of units singled out for special attention was often very small – less than 5% of their total stock.
- The Housing Providers carrying out this form of triaging process continued to use the SAP overheating check on their other properties (except one, who used their own more detailed methodology).
- By performing this 'first pass' the teams concerned felt better able to factor in their practical knowledge of the site, such as whether the property in question is located next to a busy main road, meaning windows are not opened in practice. Such factors can be difficult to account for in standardised calculations and models.

“Where we have single aspect apartments or elements with large areas of glazing...I have then insisted we do dynamic modelling to look at the overheating risk. The judgement on whether dynamic modelling is needed is also based on...the layout, orientation, what's around the building, how much glazing it has, is it dual aspect, what's the ventilation system... all of these things influence whether we are going to get an overheating problem.”

HOUSEBUILDER

Box 4. Doesn't SAP Appendix P already flag high risk properties?

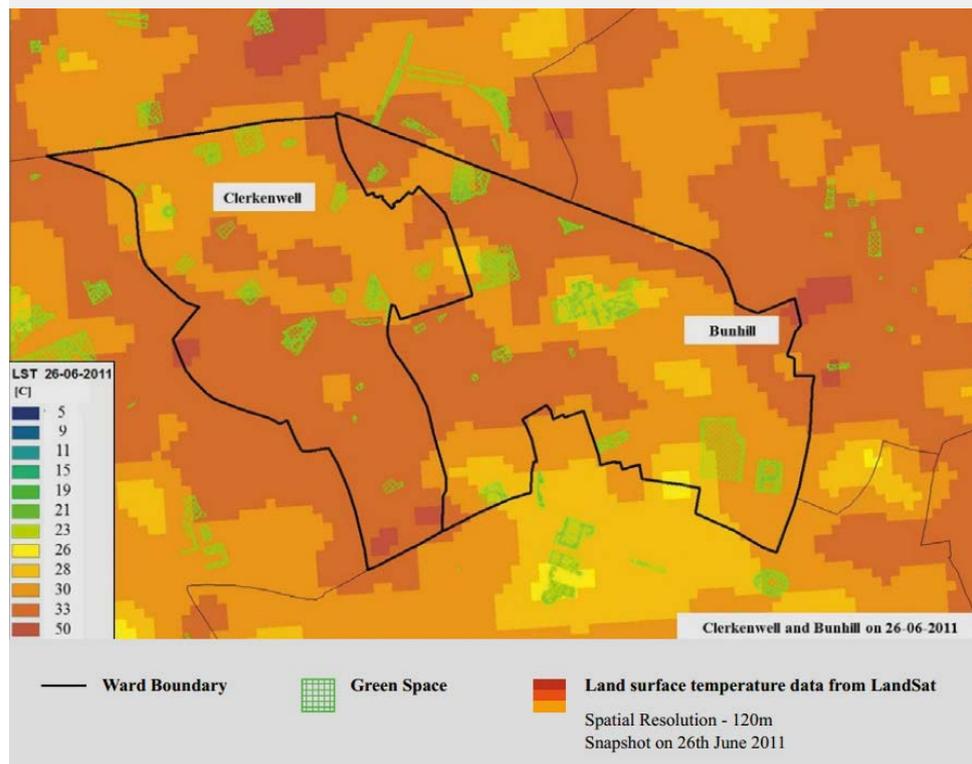
Appendix P and other overheating assessment tools and methodologies have certain limitations which are discussed in greater detail on page 22, in Chapter 7 and in the Assessing Overheating Risk Evidence Review. Overall, there is concern that the Appendix P process is not identifying high risk properties as intended.

Stakeholders are keen to explore two proposals to further assist planners, Building Control Officers, designers, developers and retrofitters with the process of overheating risk assessment:

- The development of simple 'rules of thumb' or yes/no questions which would ensure that any first pass on a planned development or retrofit project is carried out in a sufficiently systematic way. Its purpose would be to help Housing Providers flag up at an early stage which units 'to worry about'.
- Whether new protocols and resources could be developed to enable property or scheme level risk assessments to take better account of the location and people-related factors which can significantly influence whether a building overheats in practice. For example, whether the property is located in an Urban Heat Island, or the amount of green space nearby known to have a cooling effect. Housing Providers are unlikely to have control of some of these factors, so the challenge is to find a way to make existing (or newly created) data available in a way that does not create unnecessary burdens on businesses.

There are some excellent examples of local authorities carrying out work to identify overheating 'hotspots', for example in Birmingham and London, which Housing Providers could draw on. These are summarised in the Overheating Risk Mapping Evidence Review. One example, produced by Arup for the Greater London Authority (GLA), is shown in Figure 5. ARUP considered two pilot areas within the London Borough of Islington: Bunhill and Clerkenwell. Both locations are in central London and have low green space density and high Land Surface Temperatures (LST). This co-occurrence of factors indicates greater heat risk. Overlaying them shows that larger green spaces appear to influence the LST, whereas smaller spaces have a more limited effect.

Figure 5. Clerkenwell and Bunhill measured Land Surface Temperatures – day time 26th June 2011 and green spaces map overlay (ARUP 2014, 24)



What could this mean for future frameworks?

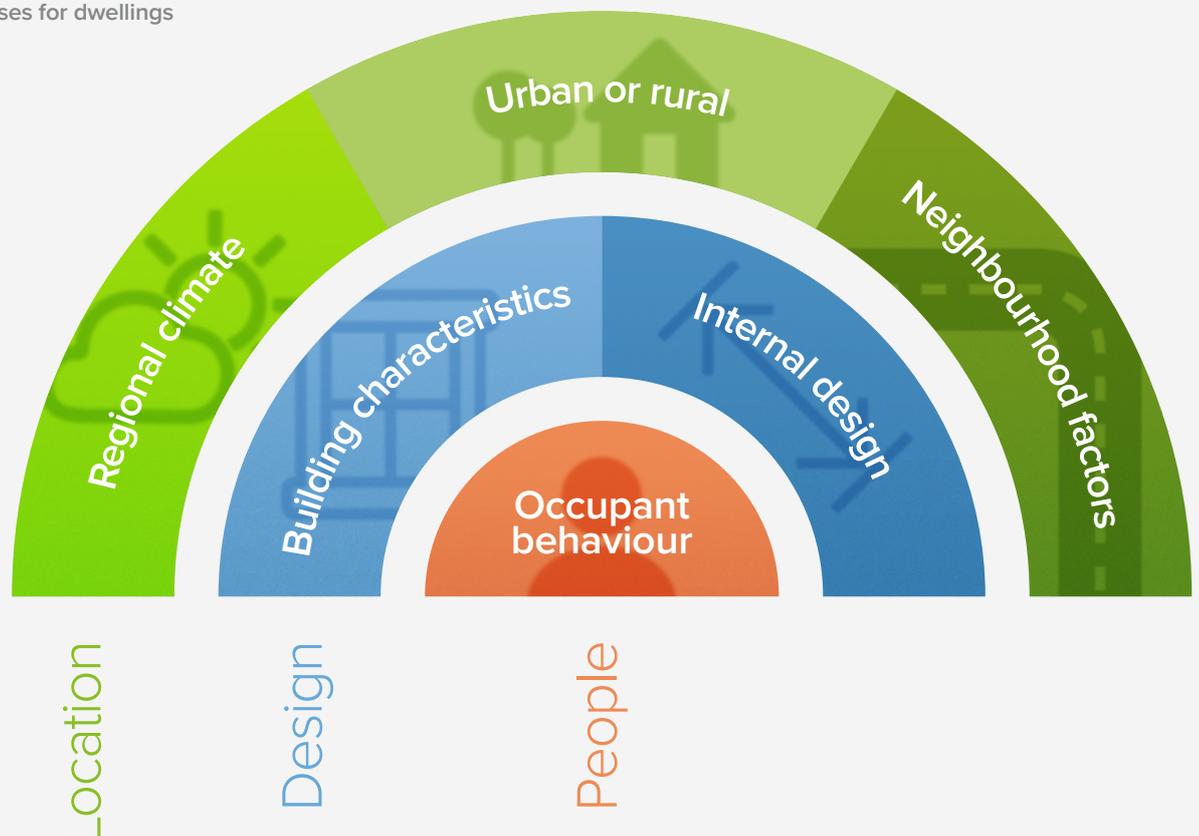
The analysis of overheating risk must start at the concept stage of projects. Future policies and frameworks which support Housing Providers in identifying potentially high risk dwellings within their stock for special attention, from an early stage, should help to ensure that investment in solutions is targeted at the homes and people which need it most. It also appears that such an approach could prove to be cost-effective and relatively simple to weave into current business practices as certain Housing Providers are doing it already.

The feasibility of this type of approach will be explored in greater detail in Phase Two, including consideration of how to avoid potentially problematic homes being missed accidentally.

Action

ZCH to coordinate work to develop proposals on how to improve overheating risk assessment processes and commission guidance on which combinations of location, properties and occupants in England and Wales are more prone to overheating by March 2016.

Figure 6. A conceptual diagram of the types of factors which, if they can be accounted for, should improve the reliability of overheating risk assessment processes for dwellings



EXTENT

CHAPTERS 4 AND 5 SUMMARY

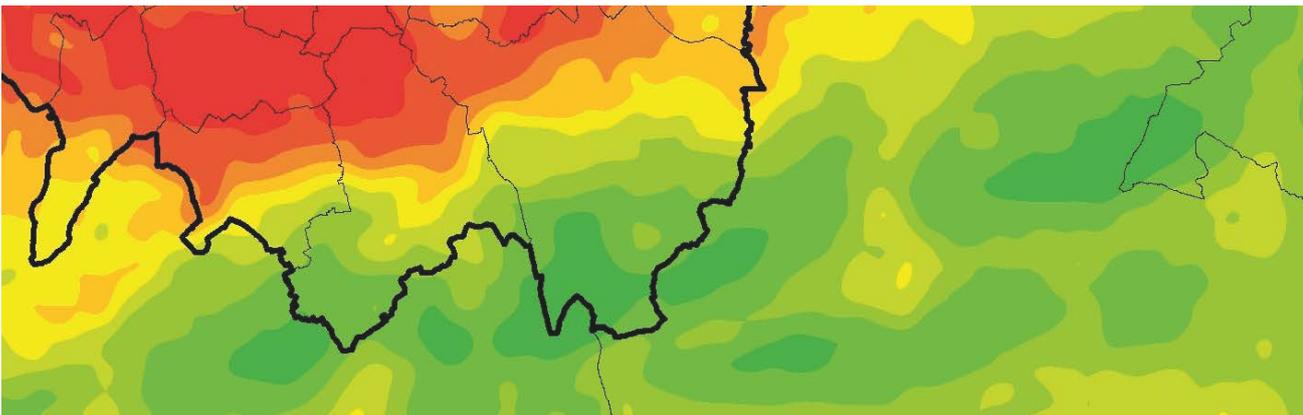
One of the barriers to taking concerted action on overheating has been a lack of evidence about the scale of the problem.

Chapters 4 and 5 summarise information and evidence about the current and possible future extent of overheating, the severity of observed cases and the perceptions and experiences of Housing Providers. The ZCH has also published a leaflet describing how certain drivers of change could affect the incidence of overheating in the future.

Key findings:

- Much of the available evidence on overheating comes from small-scale monitoring studies carried out by individual organisations or is anecdotal in nature e.g. in the form of case studies or logs of reported cases.
- A number of recent larger studies, summarised in Box 5, provide insight into the scale of the issue for properties in England. The first, Beizaee et al (2013), was the basis for the ASC's observation in their 2014 report that up to 20% of homes may already exceed defined thresholds for overheating, even in cooler summers.¹
- Recent industry surveys and interviews also suggest that Housing Providers are finding cases of overheating in their stock. This type of information should, however, be used with caution due to the potential for self-selection.
- The ZCH's Overheating Survey aimed at Housing Providers, for example, found that 53 (70%) out of a possible total of 75 organisations reported experiencing at least one instance of overheating in their housing stock in the last 5 years (i.e. in dwellings they had built or now manage). 7% reported no overheating problems, and the remainder did not answer the question.

¹ *Managing climate risks to well-being and the economy, ASC progress report (2014).*



Box 7. Summary of larger-scale studies which investigated the extent of overheating in homes in England

Beizaee et al (2013)

Nearly 200 unheated homes throughout England of mixed dwelling type and age were monitored during the summer of 2007. Despite this being a relatively cool summer (the majority of England had its coldest August since 1993) the team found that 21% of bedrooms exceed 26°C for more than 1% of night-time hours. 47% of bedrooms exceeded temperatures of 24°C for more than 5% of occupied hours – the temperature at which sleep is thought to become impaired.

Lomas and Kane (2013)

A monitoring study of over 200 unheated homes in Leicester in 2009 found that almost 27% of living rooms exceed the threshold of 28°C for 1% of occupied hours. Nearly 20% of bedrooms had temperatures over 24°C for 30% of the two-month summer monitoring period. Again, average external temperatures during monitoring were cooler than normal for the time of year, although there was a short hot spell.

The Energy Follow-up Survey (2013)

A study carried out by BRE for DECC found that 20% of the 2616 households interviewed in 2010/11 in England had difficulty keeping one or more rooms cool during the summer months. Monitoring of a sub-sample of 823 homes confirmed that temperatures in the homes reporting overheating were 0.5°C to 1.5°C higher than in households who did not report any issues. The average mean temperature for those households who reported a problem equates to a 'medium' overheating risk in the SAP Appendix P scale.

The Risk to Housing from Overheating, BRE (2014)

Interestingly, using English Housing Survey (EHS) data, just 0.5% of the housing stock was assessed to be at risk of overheating against HHSRS (health-related) criteria. The BRE, however, noted that this research was exploratory and that these figures are likely to be an underestimate due to the small sample size, the fact that the building assessments used were not restricted to summer months, and because the data used was not as detailed as would be collected by environmental health practitioners conducting a full HHSRS assessment.

- As would be expected, most instances of overheating reported in the Overheating Survey were from companies operating in London, the South East and the South West of England. However, companies operating in Wales, the Midlands and Northern England also reported cases too.
- The detailed findings of the larger scale studies referenced in Box 7 suggest that only a small proportion of homes are reaching very high temperatures or have high temperatures for prolonged periods of time.
- For example, in Beizaee et al (2013), it was noted that 'whilst the average maximum temperatures were not unduly high, 25.7°C in the living rooms and 25.4°C in the bedrooms, individual dwellings had living room and bedrooms temperatures up to 30.3°C.' It should be noted that vulnerable occupants, in particular, can start to suffer health effects from heat exposure at much lower temperatures than these.
- Looking forward, whilst predicting the future incidence of overheating is not possible, an examination of drivers of change, climate change studies and modelling exercises all point towards the conclusion that overheating will become more common in the housing stock in England and Wales.
- Should temperatures in homes more frequently exceed recognised thermal comfort or health-based thresholds for longer periods of time and by larger margins in the future, then the consequences for the occupants of those dwellings could also become much more severe.

Box 8. Heatwaves

By the 2040s a summer as hot as 2003, when over 2,000 excess heat-related deaths occurred, is expected to be very common in the UK – potentially every other year (Christidis et al 2014).

“We have tended to get complaints where we have had single elevation apartments that don’t have a good ability to create drafts and air circulation through the building. Also a couple of complaints came from ground floor properties where the residents didn’t want to leave their windows ajar.”

HOUSING ASSOCIATION

“We have only had one case of overheating. In that instance the client had removed shading devices from the designs, against our advice”

ARCHITECT – WALES

What could this mean for future frameworks?

Although information on the current extent of overheating in homes at a national level is still patchy, when pieced together the picture is cause for concern. It is also apparent from the range of studies referenced throughout the report that overheating is being observed in summers with normal or below average temperatures – and is not limited to hot spells and heatwaves.

However, as stressed in Chapter 3, dwellings which overheat tend to have recognised risk profiles. There is no suggestion that any home could overheat at any time. Similarly, cases of overheating are not distributed evenly across England and Wales. London and the South East of England are usually affected most, but as average temperatures rise across all areas of the UK in the next century, more locations could see overheating issues.

Unfortunately, the larger-scale studies carried out to date do not cover dwellings in Wales, making it very difficult to make a reliable statement on the extent of overheating in the Welsh housing stock. Anecdotal evidence from the Overheating Survey and from stakeholder interviews with Welsh organisations suggest, as might be expected, that the incidence of overheating in Wales is currently low.

Further large-scale monitoring studies in England, and particularly in Wales, would deepen our understanding of the incidence, causes and regional patterns of overheating – but it is unlikely that gaining an exact number of the homes at risk is ever possible. Lack of certainty should not delay the sector in making careful progress towards addressing the issue.¹

One of the challenges Housing Providers and governments face is to decide how to plan on the basis of evidence of current overheating, whilst also acknowledging the complexity and uncertainty around future levels.

Action

ZCH to work with the research community to determine whether it is possible to develop a methodology to model the potential future incidence of overheating at the national and local level and what this could tell us (by December 2015).

1. These drivers of change are discussed in more detail in Chapter 5 and in the ZCH's Drivers of Change – Overheating in Homes leaflet.

IMPACTS

CHAPTER 6 SUMMARY

“The cost is that I’ve had to spend time and the worry of having to deal with [overheating] after it’s happened. That’s a cost in itself.”

HOUSING ASSOCIATION

“Overheating can damage residents’ health and well-being, increase social care costs, reduce economic activity, increase NHS costs and lower quality of life.”

YOUR SOCIAL HOUSING IN A CHANGING CLIMATE

“Healthy individuals have efficient heat regulation mechanisms to help cope with increasing temperatures, yet there are limits to the amount of heat exposure an individual can tolerate.”

JENKINS ET AL 2014

Chapter 6 explores the consequences for occupants, Housing Providers, and for the health sector and the economy when homes overheat.

A more detailed summary of the impacts of overheating can also be found in the Impacts of Overheating Evidence Review.

Key findings;

- Housing Providers report that overheating problems can damage customer relations, and lead to reputational harm and costly remedial works.

One housebuilder shared their experience of carrying out extensive remedial works on a recently completed apartment building in order to gain Building Control sign off and to satisfy the local Environmental Health Officer, operating under the Housing Act. Without the apartments being heated, winter temperatures exceeded 27°C. During this time, the housebuilder experienced negative media coverage and customer dissatisfaction. Remedial works, which costed approximately £100,000, were required to bring the worst affected apartments within acceptable humidity and temperature ranges.

- Heat-related morbidity (incidence of ill health) and mortality (incidence of death) is sometimes used as a proxy for overheating. There are currently approximately 2,000 heat-related deaths per year in England and Wales, and this figure is projected to rise to over 7,000 by the 2050s as a result of climate change and a growing and ageing population.¹ A tripling of current levels.

Excess heat can have significant health implications, particularly for vulnerable groups, including the elderly, infants, those who are obese or have chronic illnesses, people who are socially isolated and those who live in urban environments. These groups are often less physically able to acclimatise or adapt to keep cool at home when external temperatures rise.

- The evidence base on potential healthcare costs resulting from overheating is limited. The CCRA did, however, estimate that by 2050, annual heat-related mortality and morbidity costs could increase from 2012 levels by a further £84m and £183m (respectively).² These figures represent a four-fold increase in mortality-related costs and a doubling of morbidity-related costs.

1. Hajat et al (2013).. See Chapter 6 for the methodology used. Cold-related deaths are projected to decline by 2% from a baseline of 41,000.

2. 2012 levels are £23m and £73m. At 2010 prices. See Chapter 6 for the methodology used.

- Economic losses are also expected as a result of work-days lost, accidents and reduced productivity resulting from overheating in homes as a result of sleep deprivation (or when working at home).
- Overheating in the workplace and the resulting economic losses to businesses was also investigated in the 2012 CCRA. It estimated that the number of staff days lost once internal temperatures exceed 26C would to financial losses of £1.1bn to £5.3bn by the 2050s, compared to the current estimate of £0.77bn.¹ The same kind of analysis is needed to relate the cost of productivity losses in the workplace due to ill health and sleep deprivation caused by overheating in homes.
- Lastly, the energy efficiency and fuel poverty agendas could suffer set-backs if the sector begins to use more energy to cool homes as standard practice.² In the absence of policies and frameworks which clearly drive action on building design, form and fabric first, the use of mechanical cooling could become more common.
- It is estimated that approximately 3% of the housing stock in England currently has air-conditioning.³ The potential impact of any increased uptake in mechanical cooling on the electricity grid needs further exploration.
- Nearly all stakeholders interviewed by the ZCH support approaches which encourage good building design and the use of passive measures first, with mechanical cooling being used if such approaches are not able to deliver the temperature reductions needed. A good example of this type of approach being used is the 'Cooling Hierarchy' adopted by the GLA in their planning policy guidance.⁴

What could this mean for future frameworks?

By proactively supporting and working with Housing Providers to help them reduce the number of cases of overheating in their stock, local authorities and national governments could also see benefits in terms of reduced healthcare burdens, reduced productivity losses and better integration of policies with the energy efficiency agenda. Even small reductions in internal temperatures can result in a lowering of heat-related mortality.⁵

These benefits will need to be weighed against the costs associated with implementing policies to drive reductions in overheating as the costs of designing-in or installing measures in homes will often fall to Housing Providers, while the direct benefits will accrue to the occupants. However, Housing Providers should also benefit from avoided costs over the longer-term, including from unexpected remedial works.

Action

In Phase Two, the ZCH will commission economic analysis to assess the high-level costs and benefits of a range of policy options intended to tackle overheating at the national level. These could range from light-touch options such as increasing awareness of overheating, to regulatory options including tightening up provisions in Building Regulations or creating new legal standards (by March 2016).

1. See Chapter 6 for the methodology used.

2. Gupta et al (2015).

3. Frontier Economics, Irbaris, Ecofys (2013).

4. London Plan Policy 5.9.

5. Jenkins et al (2014).

PREPAREDNESS

CHAPTER 7 SUMMARY

A theme running through this report is the value and importance of being prepared.

Chapter 7 summarises information gathered by the ZCH on the extent to which Housing Providers are making preparations to prevent future cases of overheating and are able to respond effectively when cases occur.

Key findings:

- Addressing overheating risk has not, historically, been a high priority for many of the Housing Providers interviewed by the ZCH, but this is beginning to change.
- Those who reported that consideration of overheating has been a low priority for them also said they had not experienced many problems with elevated temperatures in their stock, which they also viewed as inherently low risk.
- However, it is clear that the risk profiles of buildings can change when projecting out to future decades.

A new piece of economic analysis for a housing association operating in Southern England found "a 13% increase in heat-related health costs as a result of stock expansion, and a doubling of costs as a result of climate change in 2040, is judged to be possible", and that 'targeted investment in flooding and overheating measures now would make significant financial savings for them in the future'. This analysis is being used to highlight the importance of investment in overheating measures. Further examples of housing associations going through similar long-term business planning exercises are included in the full report.

See Building the Business Case for Targeted Investment in Resilience Planning by the Global Climate Adaptation Partnership, Daniel Black & Associates, the University of Bath and the University of Manchester.

- Interestingly, 59% of the 74 Housing Providers answering the relevant question in our Overheating Survey reported having a form of assessment process in place intended to identify properties at risk of overheating. However, 36% did not, and the remainder did not know. The level of robustness of the methods used is highly variable.

“We have never been asked to get to the level of quantifying overheating in a housing scheme in a discussion with a client or a housing association. There is just a general anxiety about it.”

ARCHITECT

- A variety of methods are being used to assess risk, ranging from informal approaches, SAP Appendix P, detailed dynamic simulation modelling (DSM) and the Passive House Planning Package (PHPP).

Box 9. SAP Appendix P

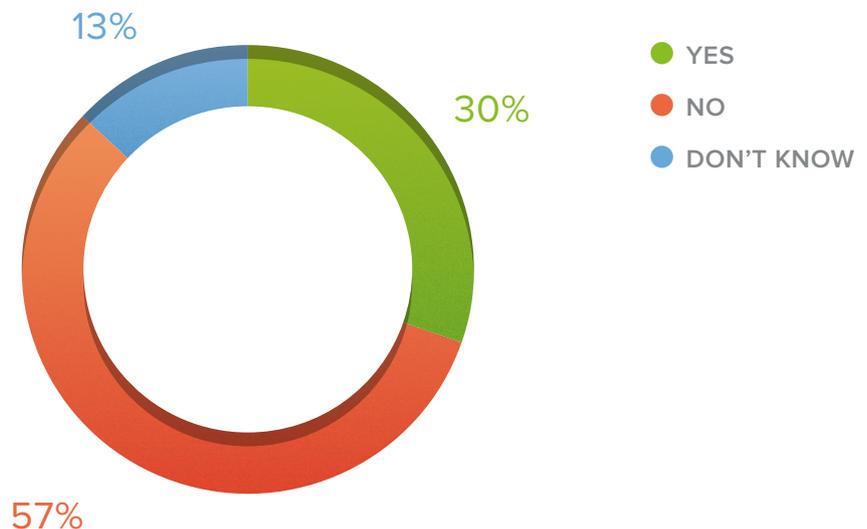
The overheating check for new dwellings set out in Appendix P of SAP is a route made available by Government to demonstrate compliance with Criterion 3 in Building Regulations to conserve energy by ‘limiting heat gains’. The test is performed during the normal SAP assessment.

Appendix P consists of a calculation for each month of June, July and August using average weather data for the month in question and produces a single predicted average internal temperature for the property for each month.

This temperature is then compared to a threshold temperature in order to determine the risk of overheating. The overheating risk is categorised as either ‘high’, ‘medium’, ‘slight’ or ‘low’.

- Housing Providers and experts raised many concerns with Appendix P. The view, summarised by the quote ‘no one fails Appendix P’, suggests the process is not separating out properties which are genuinely at risk of overheating as effectively as it could. DECC plans to consult on proposed amendments to Appendix P.
- In addition, risk assessments carried out on residential units do not usually give a picture of the future likelihood of properties to overheat or take into account wider contextual factors which make the property more prone to overheating. Factors such as future weather, unusual occupancy patterns, and location effects such as the UHI and the building’s microclimate, are not factored in as standard.
- Another indicator of preparedness relates to the extent to which supply chain contracts cover overheating and how well defined the requirements are. By way of example, 57% (of the 23 Housing Providers who answered the specific question on new-build properties) said they do not specify requirements on overheating in contracts with architects or designers.

Figure 11. Does your organisation currently specify overheating related requirements in your contracts with architects / designers?



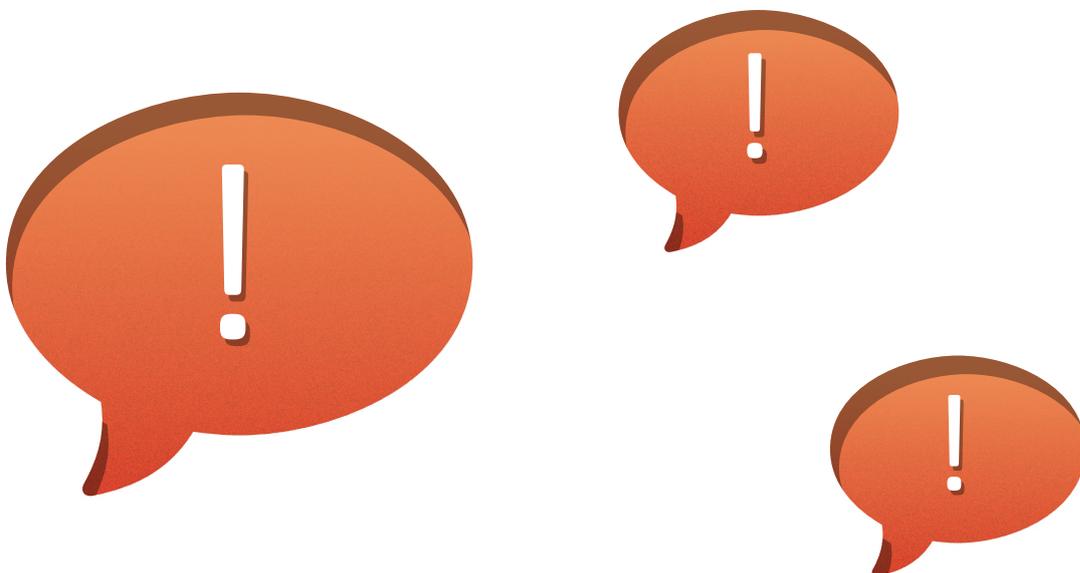
- Regarding technical solutions, information gathered during our stakeholder interviews suggests, similar to the causes of overheating, there is a reasonable level of general knowledge within the sector on the types of technical solutions available to address overheating at the property or development level.
- However, stakeholders felt more guidance is needed on how effective different combinations of measures are at reducing temperatures and keeping buildings cool for different house-types and locations, particularly on the use of thermal mass to moderate heat flows. A number of interviewees wanted to see more advice on what types of measures to deploy if their tenants were experiencing severe overheating during a heatwave or hot spell.

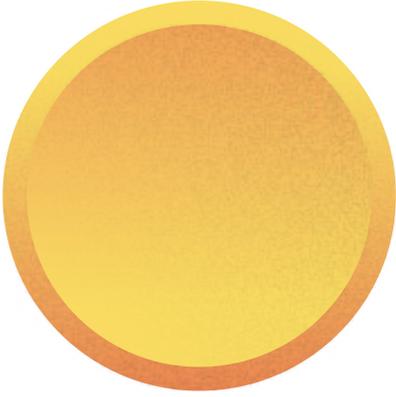
Links to technical guidance documents and case studies produced by a range of experts can be found at www.zerocarbonhub.org. The ZCH will also publish a summary of technical and behavioural solutions, commissioned from the BRE, in July 2015.

- Although concerns were raised during the stakeholder interviews about overheating measures being 'value engineered' out during projects, two thirds of 72 Housing Providers in the Overheating Survey said they have a process in place to check that designs and measures are delivered in practice. Only 22 (30%) said they have no process.

The ZCH's 'Design versus As-Built' project highlighted the impact on the performance of buildings when designs are not delivered as intended, and the same is true for overheating. Product substitution and value engineering can mean that even when dwellings are designed to stay comfortable, in practice they do not.

- Lastly, a significant proportion – 41% (out of 51 organisations answering the relevant question in the Overheating Survey) – reported finding out about overheating problems only after receiving unsolicited feedback or complaints by occupants. This approach risks overheating becoming severe before being addressed, or masking a larger problem as there is evidence that, culturally, people can be reluctant to complain about being too hot.





“There is nothing that forces you to think about [overheating] at the concept stage. When you get to the detailed design stage, it’s hard to then add external shutters like those seen in Europe, for example. You can’t do that without planning permission.”

HOUSEBUILDER

What does this mean for future frameworks?

Balancing requirements on heat gains and heat losses in very airtight homes will become even more important as the climate changes. As summers become warmer and heatwaves occur more frequently, Housing Providers will need to ‘worry’ more about summer thermal comfort and how people will keep cool. It is equally important that the policy and regulatory frameworks guiding action support them in this process.

This question of what detailed amendments may be needed to national and local frameworks will be considered in detail in Phase Two of the project, focusing in on the differences between the English and Welsh regimes. However, evidence gathering so far provides some early insights. The following issues were consistently raised by stakeholders:

- Modelling of overheating risk is being done too late in the process to influence the design of projects;
- Unrealistic assumptions are being used in models resulting in properties being incorrectly assessed as ‘low risk’ or passing overheating criteria;
- Use of modelling and/or checklist can create false expectations that the risk of overheating has been effectively mitigated, without follow-up;
- Many models do not incorporate factors that are known to exacerbate overheating, such as a property being located in an Urban Heat Island, corridors overheating due to heat gains from hot water pipes, or cumulative heat gains through the building fabric over a whole summer;
- National planning guidance does not explicitly cover overheating in England, and where Local Plans include provisions, there is a question mark over whether these are fully implemented or enforced;
- Building Regulations contain only very general provisions relating to the reduction of heat gains in Part L1A, there are no specific provisions on overheating in Part F on ventilation either, and low priority is being given to the issue by Building Control Officers;
- Initiatives designed to drive energy efficiency retrofitting of existing buildings, such as the Green Deal and Energy Companies Obligation, do not explicitly give advice to guard against overheating;
- Most voluntary building codes and standards do not include specific provisions on the summer thermal performance of buildings, although this also appears to be changing. See Box 10.

Box 10. Examples of industry codes and standards

The GHA requires Leader and Developer members to comply with a minimum set of standards on their residential development projects. These include a Health and Well-being Standard under which members should address indoor air quality, thermal comfort and moisture levels within the design process and also consider broader issues such as daylighting, green space and adaptability. Once built, homes should be monitored, both at the point of completion and during occupation, and post-occupancy feedback gathered to prove that they are performing to acceptable standards, including in terms of thermal comfort.

The BRE's Home Quality Mark was launched in March 2015 as part of the BREEAM family of quality and sustainability standards. It is currently being trialled with a number of developers with the aim of becoming an operational standard in Autumn 2015. The My Home section sets specific performance outcomes for new homes, including for comfort and overheating. At the time of writing the technical methodology is under development, but the intention is to make use of existing commonly used assessment methodologies to avoid additional costs. The BRE's website states, "To avoid overheating and ensure affordability, any new home needs to offer a stable and warm environment that is easier to heat at a lower cost in winter but is capable of providing 'cool air' and ventilation in summer."

Motivation

The primary reasons cited by Housing Providers in the Overheating Survey for taking action to manage overheating risk were:

- Customer (occupant) satisfaction;
- Avoidance of reputational damage; and
- Recognition of the general need to adapt buildings to climate change.

The main reasons cited for not taking action or giving overheating lower priority during stakeholder interviews were:

- Not having experienced an overheating problem or never having received any complaints to date;
- The view that the organisation in question only builds or manages low-risk dwellings;
- The assumption that architects, designers and those specifying works will solve the issue; and
- The view that where there are clear legal requirements relating to other aspects of building performance, these take priority.

As would be expected, local authorities and policymakers gave different types of barriers:

- Other policy issues taking urgent priority;
- Lack of resources and funding;
- Lack of quantification of the level of overheating risk (current and future) for the local area.

CONCLUSIONS

CHAPTER 8 SUMMARY

“My general view of the overheating issue is that this, together with indoor air quality, will be the two predominant issues over the next 5 to 10 years [for the sector]. We have learnt how to keep buildings warm quite successfully and our Building Regulations deliver quite a high quality level of heating performance.”

TRADE BODY

Over the last year the ZCH has worked with over 100 organisations to gain an insight into the strategic and practical issues which need to be addressed to enable overheating in homes to be tackled more effectively.

The level of concern about future overheating in the sector appears to be mounting. Most organisations the ZCH engaged with are in the very early stages of figuring out whether their stock might be at risk of overheating in the future, and what to do about this. Others, and particularly those who have experienced difficult to treat overheating cases in the past, are determined to minimise or prevent future cases and are looking closely at their businesses processes, or have already made changes to them. A small number are in the strong position of having not had any significant overheating issues to date, but have invested in overheating prevention measures in any event because it made sense for their business.

Experts and practitioners raised issues about the policy frameworks and regulations which guide the sector. The most challenging being the lack of an agreed sector-wide definition, but also issues with risk assessment processes and enforcement. The current regime does not actively encourage Housing Providers to give serious consideration to whether any of their stock might overheat in the future.

Our conclusion is that overheating cannot yet be considered to be a managed risk for much of the sector. There are gaps and uncertainties in current frameworks which mean inherently risky designs and buildings can be approved. Secondly, despite evidence gaps, there is enough information and evidence about the causes, extent of, and solutions to overheating in homes to warrant taking careful yet concerted action to tackle the issue.

Despite this, the ZCH also found impressive examples of Housing Providers working hard to future proof their stock by making changes to internal processes to fully embed strategies intended to minimise and design-out overheating as far as possible. This focus on prevention is important as the range of options available to tackle overheating become more limited once a building's form and orientation is fixed.

Anecdotal evidence from stakeholder interviews suggests that those with strong overheating risk assessment processes felt confident that their stock will not overheat further down the line, compared to those who did not.



Early indications are that future policies and frameworks which support the sector in minimising and preventing overheating, as far as possible, by identifying and giving particular attention to high risk homes, could prove feasible, effective and relatively low cost compared to other blanket approaches. During Phase Two the ZCH will explore the practicalities of this approach, amongst others, and aim to quantify the costs and benefits.

Finally, we have highlighted the effects of the 2003 heatwave and the expectation that similar heatwaves will become much more frequent in the future. With this in mind, we must ensure that the new homes being built, as well as the existing stock, can cope with such events – even when built to high standards of energy efficiency. This will be even more important with the introduction of the Zero Carbon Standard for new homes in 2016. It is clear that overheating can happen in cooler summers too. Increasing our overall level of preparedness must therefore be an ongoing process – a core part of the frameworks that guide building design and retrofit activity.

Acknowledgements

The Zero Carbon Hub would like to thank all our partners and stakeholders who have contributed an enormous amount of expertise and time to this project. We would also like to express our gratitude to those organisations who were kind enough to tell us about their own experiences of overheating so that the wider sector can learn from the challenges they faced.

A list of contributors can be found at Annex A of the full report and at www.zerocarbonhub.org

NEXT STEPS

The objective of Phase Two is to make recommendations to government and industry decision-makers on the types of frameworks which could cost-effectively incentivise the construction and energy efficiency sector to take action to tackle overheating in homes. To support this core analysis, the ZCH will work in full consultation with partners and stakeholders to:



1. Raise awareness on overheating by publishing a series of short, targeted documents, including: (by July 2015)
 - A publication written by the BRE describing the types of technical and behavioural solutions available to Housing Providers to mitigate or manage overheating;
 - Case studies of temperature monitoring projects carried out by housing associations setting out what prompted the research, what the results were and how this information informed future strategies to address overheating; and
 - A leaflet aimed at local authorities showcasing examples of the work being carried out by certain Local Planning Authorities and others to map heat risk, reduce the incidence of overheating at the neighbourhood or city level, and to plan for future heat-related health and social care provision.



2. Identify potential (short-term) updates to the overheating check in SAP Appendix P and analyse how the role of Appendix P could evolve over time as the sector's approach to tackling overheating changes and new modelling protocols are developed. (by October 2015).



3. Commission work to draw together guidance to link advice on technical solutions to known causes of overheating, and describe the possible impacts of solutions in a range of potential scenarios. (by October 2015).



4. ZCH to work with the research community to determine whether it is possible to develop a methodology to model the potential future incidence of overheating at the national and local level and what this could tell us. (by December 2015).



5. Make recommendations to Government on what form an overheating definition or standard could take, and how it would be implemented. (by March 2016).



6. Provide a preliminary assessment of the costs and benefits of a range of potential policies and frameworks designed to tackle overheating and describe how they would be implemented in practice. For example, would regulatory changes be needed? Particular attention will be given to testing the feasibility and effectiveness of policies which better support Housing Providers in identifying and treating high-risk homes. (by March 2016).



7. Work with partners and legal experts to develop example clauses and templates on overheating for inclusion in design and procurement contracts. (by March 2016).



8. Take advice on whether to commission economic analysis and what a robust methodology would be to:
 - Quantify the cost of productivity losses resulting from overheating in homes, especially at night; and
 - Quantify what reductions in future healthcare costs may be possible at the local level in a range of hypothetical scenarios with low, medium and high levels of future overheating.

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