The risks to housing from overheating

Prepared for: Kathryn Humphrey
Senior Analyst
Adaptation, Committee on Climate Change

24 February 2014

Client report number 293696

Prepared by

Name Helen Garrett

Position Senior Consultant

Signature Helen Garrett

Approved on behalf of BRE

Name Simon Nicol

Position Group Director, Housing and Energy

Date 25th February 2014

Signature Simon Nicol.

BRE
Watford
WD25 9XX
T + 44 (0) 1923 664000
F + 44 (0) 1923 664010
E enquiries@bre.co.uk
www.bre.co.uk

Foreword

The Adaptation Sub-Committee of the Committee on Climate Change (ASC) will produce its first statutory report to Parliament in 2015, assessing the level of preparedness in England to a number of key climate risks set out in the 2012 UK Climate Change Risk Assessment. To inform this report, between 2012 – 2014 it has been producing a series of progress reports containing an assessment of our latest understanding of the level of risk and action underway across a number of climate risks.

The risks to health from high temperatures are a key theme for the 2014 progress report. To inform its analysis, the ASC asked the Building Research Establishment to conduct a study on the data that is available through the English Housing Survey on the extent on overheating in homes in England.

This report summarises the results of that study. It should be noted that the findings in this report refer only to the data that is available on overheating risk in the English Housing Survey, and not wider research or evidence on the scale of the issue. The results should therefore not be considered in isolation, but compared to other findings from a range of empirical and other research. The ASC has included some of this wider research in its 2014 progress report, alongside the results contained in this study.

.

Kathryn Humphrey

Senior Analyst

Adaptation, Committee on Climate Change

Contents

Introduction

The Adaptation Sub-Committee of the Committee on Climate Change is seeking to better understand the risks and likelihood of overheating in the English housing stock as part of its analytical programme regarding climate change. This research was commissioned to:

- understand what data is available on overheating risk
- what sort of results the data provides at national level
- what sort of dwellings are affected by the risk of overheating
- whether the research can be used as a benchmark to re-visit in future years in order to establish whether the risk is becoming greater or not.

The work is purely exploratory in nature, dealing only with findings of the data available in the English House Survey used in the analysis.

This report outlines the methodology underpinning the research, the findings and how this research may be built upon in future years.

Description of our approach for the research

This research used data from the English House Survey (EHS)[1]. The survey comprises: an interview survey which is conducted with all householders in the sample; and a physical survey, involving a physical inspection by qualified surveyors of a subsample of dwellings. Currently, some 6,200 dwellings receive a full physical inspection each year. The EHS collects comprehensive information on, for example, the type and construction of homes, their heating systems, type and levels of insulation. It also collects a small amount of information on the likelihood of overheating which is collected as part of the Housing Health and Safety Rating System (HHSRS) assessment of the dwelling.

The EHS data relating to excess heat is not currently reported on separately because of the small sample size (6,200 dwellings) of the annual physical survey allied to the fact that the incidence of 'extreme' overheating risks is very low. Owing to these factors, this analysis used the 2009 - 2011 EHS surveys which collected house condition data on some 23,000 dwellings nationwide. These three annual datasets were combined and re-weighted to reflect the total number of dwellings (22.6 million) at the mid-point, 2010. For the remainder of this report we shall therefore refer to the results as being for 2010.

The Housing Health and Safety Rating System (HHSRS), the EHS and assessing excess heat

The HHSRS is a means of identifying defects in dwellings and evaluating the potential effect of any defects on the health and safety of occupants, visitors, neighbours and passers-by. The system provides a means of rating the seriousness of any hazard, so that it is possible to differentiate between minor hazards and those where there is an immediate threat of major harm, or even death. The HHSRS produces scores for dwellings based on the statistical risk of the health and safety hazard leading to harm to the occupants. The HHSRS scoring procedure uses a formula to generate a numerical Hazard Score for each of the hazards identified at the property. The higher the score, the greater the severity of that hazard. The most serious hazards are called Category 1 hazards. Further information can be found in the HHSRS Operating Guidance (DCLG, 2004). Appendix 1 of this paper also provides an extract from this Operating Guidance for the assessment of excess heat through an inspection of a dwelling.

For HHSRS assessments, the emphasis is placed on the potential effect of any defects on the health and safety of people, particularly those who might be regarded as 'vulnerable', over a one year period. For the assessment of the risks from excess heat, the most vulnerable group, stipulated in the DCLG guidance, is people aged 65 years or over.

For the EHS, surveyors are required to collect a broad range of information for a relatively short and non-intrusive property inspection. The survey cannot therefore fully replicate the HHSRS

[1] Further details of the EHS and its methodology can be found at https://www.gov.uk/government/collections/english-housing-survey

assessment that would be carried out by a local authority environmental health practitioner. Nonetheless, surveyors (many of whom are experienced environmental health practitioners) working on the EHS have received extensive training and support to help ensure their HHSRS assessments are consistent and robust. Appendix 2 provides details of the additional training guidance received by EHS surveyors.

Physical surveys for the EHS are undertaken throughout the year. For the HHSRS assessment of excess heat risks, the surveyor is essentially assessing whether a vulnerable person, could suffer from excessively high indoor air temperatures during the day and at night, from which they have no means of ‘escape’, for example, by moving to any available cooler room or by opening windows without the risk of severe noise, lack of security or safety, or high external temperatures. During this assessment no actual temperature measurements are taken. The surveyor makes an assessment based on relevant factors affecting the likelihood of an occurrence of excess heat and the severity of the outcome. These factors include:

- Thermal insulation – inadequate provision for thermal insulation particularly in attic flats which are more prone to overheating than larger dwellings
- Orientation of the dwelling and glazing – large areas of south facing glazing in inappropriately designed dwellings[2].
- Day and night-time ventilation provision (natural or by any mechanical device or air conditioning) and its control. Also whether the dwelling has disrepair to the ventilation systems or devices
- Heating controls –faulty, inappropriately designed, or inadequate controls to the heating system.

For each dwelling, the surveyor’s assessment of HHSRS excess heat will fall into one of four given categories: significantly lower than average risk, average risk, significantly higher than average risk or extreme risk (a Category 1 hazard).

Due to the nature of the EHS physical survey, it is very rare for a dwelling to be assessed by the surveyor as an extreme risk. However, a sufficient number are assessed as having a significantly worse than average risk enabling some useful analysis to be undertaken on these homes. For the analysis, a variable was created from the raw physical survey data which identified homes with an overheating risk. These were homes where the surveyor had assessed the risk of overheating as either significantly higher than average or extreme as part of the HHSRS assessment. This variable comprised of some 116 raw cases. These cases were then weighted to reflect the total number of dwellings with an overheating risk within the English housing stock. All findings were subjected to significance testing.

[2] Shading systems such as blinds are not recorded during the survey

Findings

In 2010, around 122,000 English dwellings assessed as at risk from overheating, of which roughly 1,000 were assessed as having an extreme risk, that is, a Category 1 excess heat hazard. This figure for Category 1 hazards must be treated with particular caution because the sample size is extremely low.

As the majority of surveys do not occur during the warmest months of the year, there is a strong possibility that the EHS underestimates the overall number of homes with an overheating risk. Although the surveyor is, at all times of the year, assessing the relevant factors that impact on the likelihood of overheating; the surveyor has to determine whether any risk is especially significant during a brief survey inspection. Consequently, any risk should 'leap out' at the surveyor. Assessing any means to escape from constant excessively high indoor temperatures is, however, less easy to ascertain during the cooler months of the year. That said our research showed that dwellings with risks from overheating were surveyed fairly evenly across the four quarters of survey fieldwork.

All underlying data for figures in the report can be found in Appendix 3

Stock profile indicators

Looking at the profile of these 122,000 dwellings with risks from overheating, our analysis suggests[3] that;

- Around one third (33%) were built before 1919, 22% were built from 1919 to 1945, 34% were built from 1945 to 1980 and the remaining were 11% built after 1980 (Figure 1).
- These homes were overrepresented (34%) in city and urban areas (Figure 2), indicating that geographic location is a likely contributory factor to overheating.
- The average total floor area among these homes was $97m^2$ with total floor area ranging from just $21m^2$ to $361m^2$. The distribution of these homes within a banded range of total floor area was very similar to the total English housing stock (Figure 3).
- Flats comprised 19% of these homes (very similar to the proportion of flats within the total stock).
- Although the London, Eastern and West Midland areas of England appear to be overrepresented among these homes, these findings were not statistically significant, likely due to the small sample size available (Figure 4)

[3] Findings are only estimates and should be treated with caution due to small sample sizes

Figure 1: Profile of dwellings with a risk of overheating compared to the whole English housing stock by dwelling age, 2010

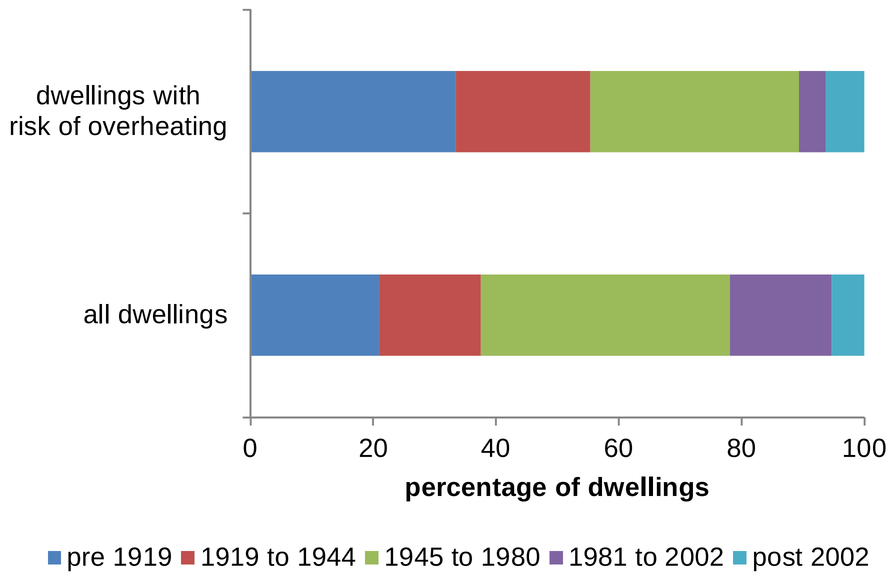


Figure 2: Profile of dwellings with a risk of overheating compared to the whole English housing stock by location, 2010

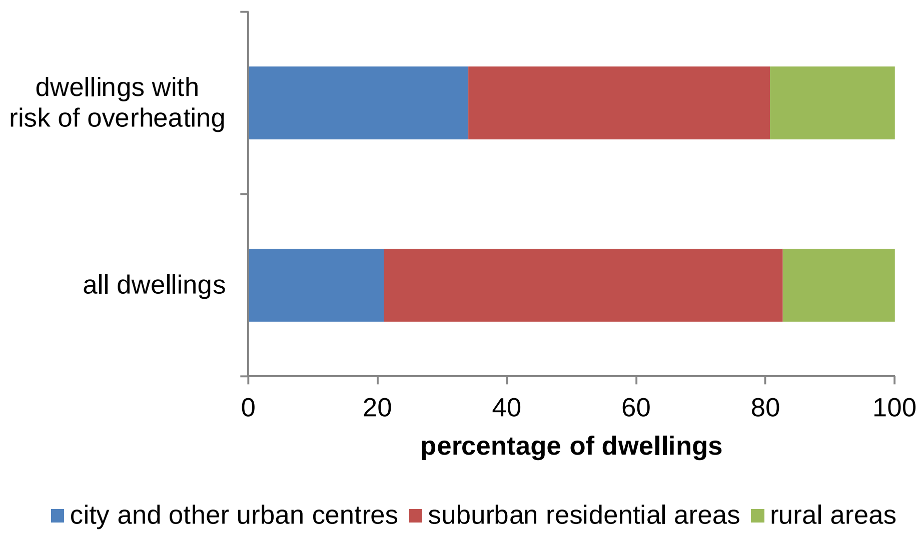


Figure 3: Profile of dwellings with a risk of overheating compared to the whole English housing stock by dwelling size, 2010

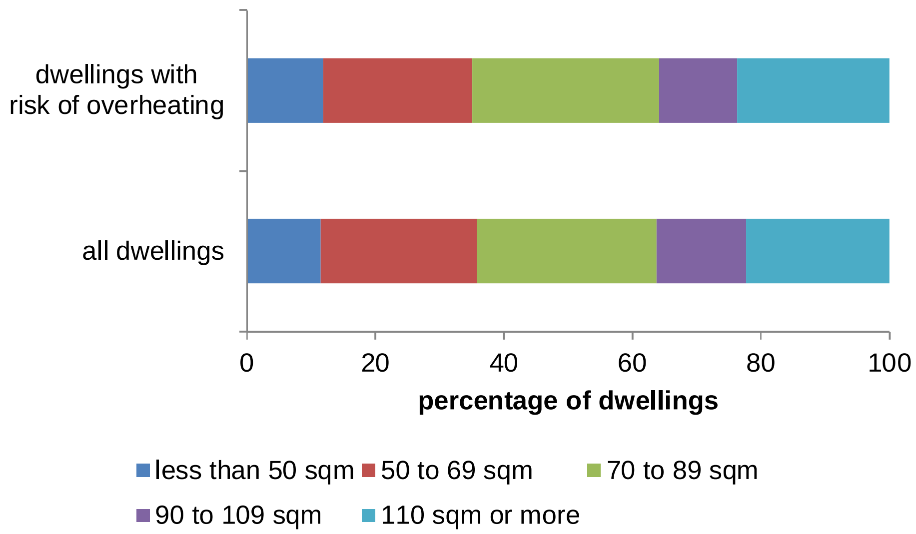
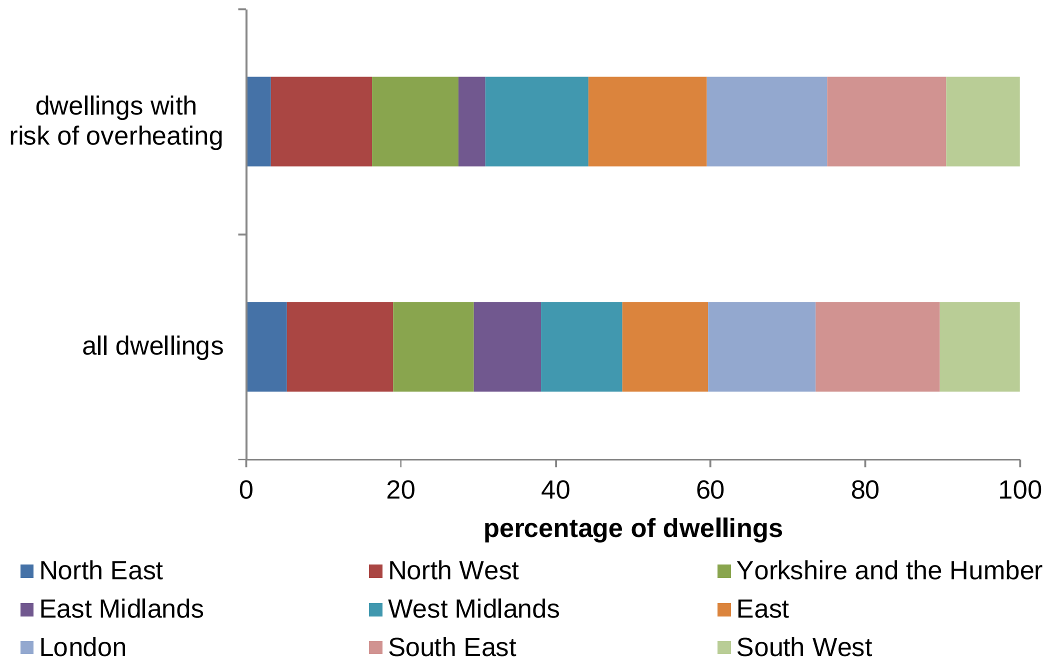


Figure 4: Profile of dwellings with a risk of overheating compared to the whole English housing stock by Government Office Region (GOR), 2010



It is difficult to draw robust conclusions from the above findings simply because of the small sample size available. Given the findings on the apparent influence of geographic location on overheating risk, we would, for example, expect there to be a stronger association between London and an overheating risk. Such an association may well exist and this is an important area to revisit given increased urbanisation coupled with our ageing population.

The findings also suggest that the risk of overheating is greatest in older properties. One of the reasons for this is the modification of these homes over time to produce attic conversions, where lack of roof insulation and ventilation increase the risk of overheating. The impact of these conversions using EHS data is explored later in this report.

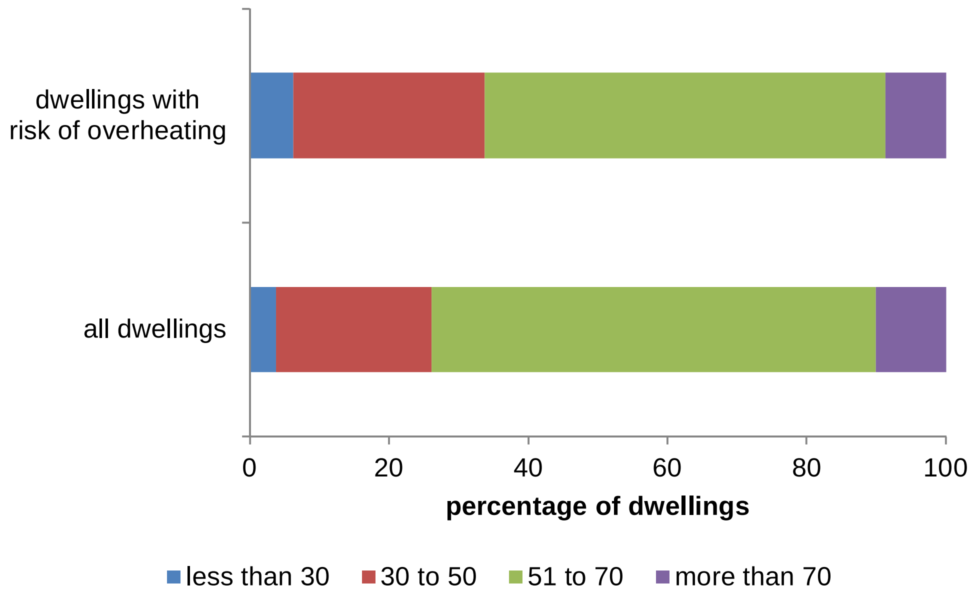
Energy related indicators

The most energy efficient homes (a SAP rating higher than 70) were statistically no more likely to have a risk of excess heat than the worse energy efficient homes (a SAP rating less than 30). However, sample sizes are small and we should approach this finding with caution, particularly as we would expect the best insulated homes to have less ventilation through which indoor heat can escape.

The distribution of homes with a risk of overheating by banded SAP rating is provided in Figure 5. Around two-thirds (66%) of homes with a risk of overheating had a SAP rating of at least 51 (the average SAP rating was around 55 in 2010). The EHS estimates that a small proportion (6%) of homes with overheating risk had the poorest energy efficiency, i.e. a SAP rating less than 30. However, the sample size was very small for these homes.

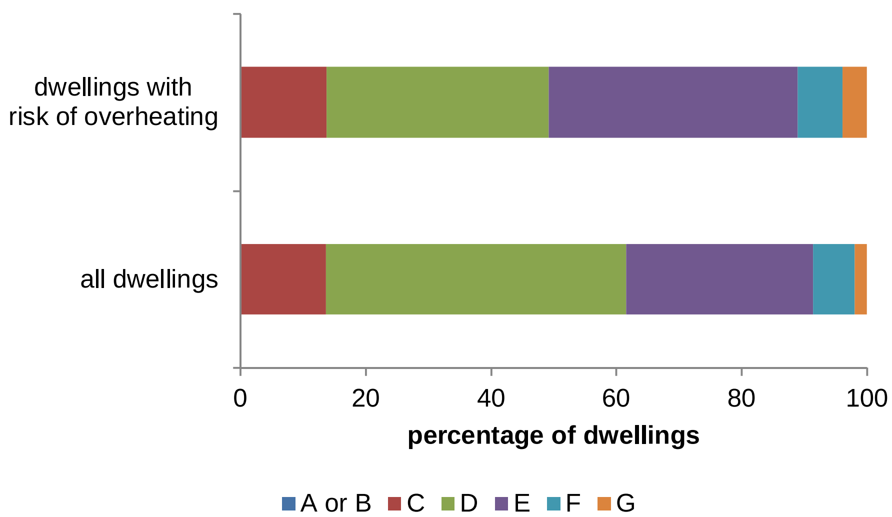
It is not surprising that a small proportion of dwellings with relatively poorer energy efficiency have a risk of overheating as these may have relatively higher levels of glazing. In such cases the occupier may face heat loss where there is non-energy efficient glazing coupled with risks of overheating where there are large expanses of south facing glazing.

Figure 5: Profile of dwellings with a risk of overheating by energy efficiency rating (SAP09), 2010



The energy efficiency rating (SAP) is also presented in an A-G banding system for an Energy Performance Certificate, where Band A rating represents low energy costs (i.e. the most efficient band) and Band G rating represents high energy costs (the least efficient band)[4]. Given the above findings on SAP and risk of overheating, it is not surprising that a small proportion (11%) of homes with an overheating risk had the lowest Energy Performance Certificate (EPC) ratings (F and G bands). Sample sizes were again especially small for this group of dwellings. The vast majority of dwellings with overheating risk were in EPC bands D or E, Figure 6.

Figure 6: Profile of dwellings with a risk of overheating by EPC band (SAP09), 2010



[4] The break points in SAP used for the Bands are: Band A (92–100), Band B (81–91), Band C (69–80), Band D (55–68), Band E (39–54), Band F (21–38), Band G (1–20)

Interestingly, the proportion of homes in EPC bands D and C (very few English homes attain an A or B banding), is relatively smaller for those with risk of overheating (49%) compared with 62% of all homes. These EHS findings appear to indicate that the relationship between the energy efficiency of a home and the risk of overheating is a complex one; highlighting the significance of the many other factors that may increase the risk such as solar gains through windows, type of heating systems, dwelling design, climatic conditions and occupant behaviour. The impact of all these factors is beyond the remit of this research, but EHS data has been investigated to inform discussion on the impact of additional factors.

Aspect of dwelling

The EHS began collecting data on dwelling aspect for the 2011 physical survey so only one year of data was available for analysis. Sample sizes for dwellings with a risk of overheating are, therefore, especially low (just 31 raw cases) and can only serve as a benchmark for further analysis in future years. The profile of the orientation of the front face[5] for those dwellings with risk of overheating is provided below.

Table 1: Profile of dwellings with a risk of overheating by dwelling aspect

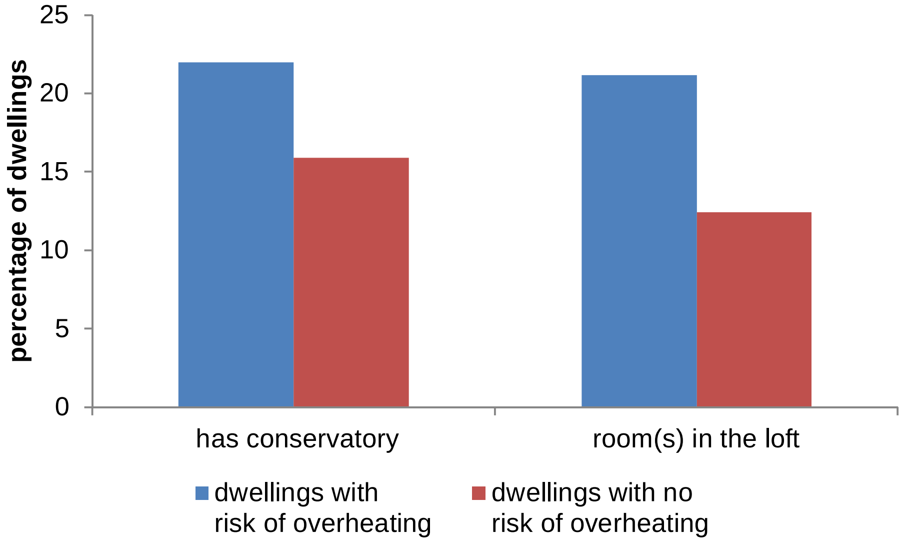
orientation of front face	dwellings with a risk of overheating (000s)	dwellings with a risk of overheating (%)
North	1	3.5
North-east	9	23.1
East	6	14.9
South-east	4	9.8
South	9	22.0
South-west	3	6.6
West	5	12.8
North-west	3	7.2
all dwellings with risk of overheating	41	100.0

Conservatories and rooms in the loft

The research has found some indication of a correlation between the presence of a conservatory or a room (or rooms) in the roof and the risk of overheating throughout the home, but as the sample sizes for homes with each of these features is small, the results must be treated with caution. From Figure 7, it appears that the presence of a conservatory or rooms in the loft is more common in homes with an overheating risk. Significance testing indicated that homes with a conservatory and homes with rooms in the loft were statistically more likely to have a risk of overheating. This possible correlation would be worth revisiting with larger sample sizes and over time when more data becomes available in future years.

[5] The front face is normally the face of the house or survey module (for flats) facing the road.

Figure 7: Profile of dwellings with a conservatory or rooms in the loft by risk of overheating, 2010.



Examples of homes with risk of overheating

The following examples show the types of homes assessed as having a risk of overheating as part of the EHS physical survey. In keeping with the report, these are where the surveyor has assessed the risk as either significantly worse than average or an extreme risk (Category 1 hazard). The photos for these examples are taken from BRE's photo library and are for illustrative purposes only.

Example 1: Dwelling with an extreme risk of overheating (Category 1 excess heat hazard)

This purpose built flat was built in the 1930s, is privately rented and is positioned above the home of the boiler which provides the communal heating. The flat which has just 28m² of space, has one external wall. The other walls are adjacent to other flats and the internal passageway. The surveyor recorded that the flat and internal passageway were “stifling hot” as part of the HHSRS assessment. The flat has no double glazing and suffers from serious condition and mould, indicating that the occupier has difficulty ventilating the home. This problem is likely compounded by the position of the flat next to a busy urban road: the surveyor identified serious problems relating to noise at the time of the survey. The dwelling has a SAP rating of 70.6.

Example 2: Dwelling with a risk of overheating (low SAP rating) but not a Category 1 hazard

This mid terrace house built between 1850 and 1899 has been converted into bedsits, and has an attic room. The house has the lowest EPC band (G), but is at risk from overheating as the dwelling has very low levels of overshading to the windows and roof.

Example 3: Dwelling with a risk of overheating (high SAP rating) but not a Category 1 hazard

A modern purpose built flat constructed in the 1990s with a SAP rating of 80. The flat is heated by electric storage heaters. Each room has thermostatically controlled electric panel heaters but no roomstat, making it difficult for the occupier to control the temperature. Furthermore the dwelling's south facing aspect means that it receives no overshading to the windows.

Conclusion and recommendations

This exploratory research suggests that the EHS is very likely to underestimate the prevalence of overheating risks among the English housing stock owing to the nature of the survey, which is conducted throughout the year, and the relatively small sample size of dwellings surveyed. The EHS assessment of the risk of excess heat under the HHSRS cannot fully replicate the assessment that would be carried out by a local authority environmental health practitioner. Nonetheless the research has identified a significant number of homes, around 122,000 where the occupiers faced risks of overheating owing to a variety of factors, particularly where their home had a conservatory or rooms in the loft. Dwellings with a risk of overheating were generally overrepresented among older dwellings and in city centre locations.

Analysis confirmed that the relationship between the energy efficiency of the home and the risk of overheating is a complex one, highlighting that other factors such as the ability of occupiers to adequately ventilate and shade their homes, plays a critical part in the development of these risks. Whilst the EHS collects some limited data on the average level of overshading of the dwelling windows and the roof, it is not designed to collect data on, for example, the presence of blinds or curtains or whether the occupier opens their window at night; all these factors can reduce the risk of overheating.

Owing to the small sample sizes available, the findings of the research can only serve as useful indicators of the profile of these homes, but provide a valuable benchmark to map out any trends when more data becomes available over time.

Looking into the future, the EHS is proposing to collect some additional data which may help in the assessment of overheating risks. Firstly, it is intended that the household be asked a question on any difficulties they may have in keeping their home cool as part of the small household questionnaire which is undertaken during the physical survey. It is recognised, however, that as overheating is a very complex issue, the wording of a question will require careful consideration. Surveyors will not always be undertaking a survey when the weather is hot so overheating may not be at the forefront of the respondent’s mind. Furthermore, respondents may not accurately recall their previous summer experiences or have lived at the property during the last period of prolonged warm weather. It is anticipated that two years of data for this new question would be available from 2017.

Although the relationship between the energy efficiency of the dwelling (SAP) and overheating is a complex one, it would be possible to use the EHS data that is currently used to model SAP to produce a ‘flag’ to signpost an overheating risk. This is because the factors used to calculate SAP will also relate to the risks of overheating, for example, solar gains and ventilation[6]. Whilst this flag

[6] See Appendix P of The Government’s Standard Assessment Procedure for Energy Rating of Dwellings http://www.bre.co.uk/filelibrary/SAP/2009/SAP-2009_9-90.pdf

would not take the surveyor's assessment into account, it could be compared to this. BRE do not currently produce this flag but it could form a further piece of ad-hoc analysis.

References

1. DCLG Housing Health and Safety Rating System Guidance (Version 2), CLG London, (2004).

Appendices

Appendix 1: DCLG HHSRS operating guidance - excess heat

Excess heat

This category includes threats from excessively high indoor air temperatures.

Potential for harm

Most vulnerable age group and statistical averages

The most vulnerable age group is all persons aged 65 years or 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)

Basis of Estimates

- The averages relate to persons aged 65 years or over who suffered illness, including fatal illness, as a result of excess heat in their dwelling. The statistics for Class I were derived from data for heat related mortality. The estimates for Class II and Class III include emergency hospital admissions for cardiovascular illness and are derived from the Hospital Episode Statistics. The figures for Class IV are from data on new GP consultations from the General Practice Research database and from the Fourth Morbidity Survey of General Practice.

- As there are no direct indicators for heat vulnerable dwellings that can be related to the health statistics, it has been assumed that the living and sleeping areas of 5% of converted flats are immediately under the roof and suffer from significantly larger temperature rises during heat-waves. It has also been assumed that there is no risk from heat associated with houses in the UK. Consequently, there is a weak evidence base for these statistics.

- Overall, the burden of heat-related mortality and morbidity in the UK has been modest, and data to allow quantifiable attribution to dwelling condition is weak. However, the summer of 2003 suggests there may be an increase, and rates are anticipated to be higher in future years.

Health effects

- As temperatures rise, thermal stress increases, initially triggering the body's defence mechanisms such as sweating. High temperatures can increase cardiovascular strain and trauma, and where temperatures exceed 25°C, mortality increases and there is an increase in strokes. Dehydration is a problem primarily for the elderly and the very young.
- Evidence from investigations into heat waves and morbidity in other countries shows that there is an increase in genitourinary diseases and, as ozone levels rise during heat waves, an increase in respiratory conditions. Also, heat waves have been linked with excess mortality due to mental disorders.
- The elderly, especially those with pre-existing cardiovascular disease, and the very young (infants) are more vulnerable than other groups.

Causes

- While in the UK it has been unusual for risks from over-heating of a dwelling, heat waves are forecast to become more common. It is possible, therefore, that there will be an increase in mortality and morbidity rates from excess heat associated with the inability to maintain a healthy temperature within dwellings.
- The major dwelling factors are solar heat gain, ventilation rates, and thermal capacity and insulation of the structure. Smaller, more compact dwellings, and particularly attic flats, are more prone to overheating than are large dwellings.
- Solar heat gain is influenced by the area and orientation of glazing, the amount of external shading, and the thermal capacity and insulation of the structure. Ventilation and/or the provision of air-conditioning influence the ability to control the indoor air temperature.
- Of particular importance to the risk to health of occupants is the ability to dissipate heat at night. This is influenced by the thermal mass of the structure, the position of insulation in the structure (i.e. whether the insulation is external, in the cavity, or internal, and the night time ventilation rate).
- Defects to a heating system, or the inability to control the dwelling's heating system, can also be a cause of excessive heat in dwellings.
- Dwellings in multi-occupied buildings are more likely to be affected by excessively high indoor temperatures. Particularly those located immediately beneath an uninsulated roof, those with only a south facing elevation, and those with district heating systems not controllable by the occupier.

Preventive measures and the ideal

- The structure of the dwelling should provide or incorporate sufficient thermal insulation, having regard to its construction, its geographical location, its position in relation to other dwellings and buildings and its orientation.
- Where there are large expanses of south facing glazing there should be appropriate shuttering or blinds to control solar heat gain in summer months.
- There should be means for cooling during hot summer weather, either by natural ventilation or by air conditioning. The means should be controllable, properly installed and

maintained, and appropriate, having regard to the particular part of the dwelling. While openable windows can provide ventilation, occupiers may be reluctant to use them for security reasons, or because of external noise levels, especially at night.
- There should be adequate controls to the heating system within the dwelling, particularly for district heating systems, enabling the occupier to control temperature.
- There is little relevant information in the UK on protection from excess high indoor temperatures. However, see in particular – Building Regulation *Approved Document L1: Conservation of fuel and power in dwellings, Approved Document F: Ventilation of buildings* and the Chartered Institution of Building Services Engineers (CIBSE) *Guide A: Environmental design, and Guide B2: Ventilation and air conditioning.*

Relevant matters affecting likelihood and harm outcome

Matters relevant to the likelihood of an occurrence and the severity of the outcomes include:
a) Thermal insulation – inadequate provision for thermal insulation particularly in attic flats.
b) Orientation of glazing – large areas of south facing glazing in inappropriately designed dwellings.
c) Heating controls – faulty, inappropriately designed, or inadequate controls to the heating system.
d) Ventilation provision – inadequate or inappropriate provision for ventilation.
e) Ventilation control – inadequate means of controlling the ventilation.
f) Disrepair to ventilation – to the system or devices.

Hazard assessment

The assessment should take account of the provision for ventilation, particularly nighttime ventilation, and the provision and condition of any mechanical ventilation or air conditioning system. Also relevant will be the thermal capacity of the structure and the amount and position of thermal insulation, the extent and orientation of glazing, and the condition of and controls for the heating system.

Appendix 2: Additional EHS guidance to surveyors for excess heat

EXCESS HEAT

DESCRIPTION OF THE HAZARD

This category includes threats from excessively high indoor air temperatures.

POTENTIAL FOR HARM

Most vulnerable age group and statistical averages

The most vulnerable age group is all persons aged 65 years or 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)**

Health effects
Cardio vascular, strokes, respiratory disease.

CAUSES

While in the UK it has been unusual for risks from over-heating of a dwelling, heat waves are forecast to become more common. It is possible, therefore, that there will be an increase in mortality and morbidity rates from excess heat associated with the inability to maintain a healthy temperature within dwellings.

The major dwelling factors are solar heat gain, ventilation rates, and thermal capacity and insulation of the structure. Smaller, more compact dwellings, and particularly attic flats, are more prone to overheating than are large dwellings.

Solar heat gain is influenced by the area and orientation of glazing, the amount of external shading, and the thermal capacity and insulation of the structure. Ventilation and/or the provision of air-conditioning influence the ability to control the indoor air temperature.

Of particular importance to the risk to health of occupants is the ability to dissipate heat at night. This is influenced by the thermal mass of the structure, the position of insulation in the structure (i.e. whether the insulation is external, in the cavity, or internal, and the night time ventilation rate).

Defects to a heating system, or the inability to control the dwelling's heating system, can also be a cause of excessive heat in dwellings.

Dwellings in multi-occupied buildings are more likely to be affected by excessively high indoor temperatures. Particularly those located immediately beneath an uninsulated roof, those with only a south facing elevation, and those with district heating systems not controllable by the occupier.

RELEVANT MATTERS AFFECTING LIKELIHOOD AND HARM OUTCOME

Matters relevant to the likelihood of an occurrence and the severity of the outcomes include:
a) Thermal insulation – inadequate provision for thermal insulation particularly in attic flats.
b) Orientation of glazing – large areas of south facing glazing in inappropriately designed dwellings.
c) Heating controls – faulty, inappropriately designed, or inadequate controls to the heating system.
d) Ventilation provision – inadequate or inappropriate provision for ventilation.
e) Ventilation control – inadequate means of controlling the ventilation.
f) Disrepair to ventilation – to the system or devices.

Appendix 3: Supporting data for figures

Figures 1-6: frequencies

	no risk	risk of overheating	all dwellings
			thousands of dwellings
dwelling age			
pre 1919	4,684	*41*	4,725
1919 to 1944	3,721	*27*	3,748
1945 to 1980	9,112	*42*	9,153
1981 to 2002	3,754	*5*	3,759
post 2002	1,180	*8*	1,187
type of area			
city and other urban centres	4,681	*42*	4,723
suburban residential areas	13,886	57	13,943
rural areas	3,884	*23*	3,908
floor area			
less than 50 sqm	2,572	*14*	2,586
50 to 69 sqm	5,453	*28*	5,482
70 to 89 sqm	6,285	*35*	6,321
90 to 109 sqm	3,142	*15*	3,157
110 sqm or more	4,999	*29*	5,028
dwelling type			
house or bungalow	17,974	99	18,073
flat	4,477	*23*	4,500
GOR			
North East	1,195	*4*	1,199
North West	3,078	*16*	3,094
Yorkshire and the Humber	2,326	*14*	2,339
East Midlands	1,971	*4*	1,975
West Midlands	2,353	*16*	2,370
East	2,476	*19*	2,495
London	3,113	*19*	3,132
South East	3,611	*19*	3,630
South West	2,329	*12*	2,341
energy efficiency			
less than 30	839	*8*	847
30 to 50	5,016	*33*	5,050
51 to 70	14,329	70	14,399
more than 70	2,267	*11*	2,278
EPC Band			
A	*1*	*0*	*1*
B	*31*	*0*	*31*
C	3,024	*17*	3,041
D	10,788	*43*	10,831
E	6,686	*48*	6,734
F	1,500	*9*	1,509
G	421	*5*	426
all dwellings	**22,451**	**122**	**22,573**
sample size	***23,013***	***116***	***23,129***

Note: figures in *italics* are based on small samples and should be treated with caution
Source: English Housing Survey, dwelling sample

Figures 1-6: percentages

	no risk	risk of overheating	all dwellings
			percentages
dwelling age			
pre 1919	20.9	*33.5*	20.9
1919 to 1944	16.6	*21.9*	16.6
1945 to 1980	40.6	*34.0*	40.5
1981 to 2002	16.7	*4.4*	16.7
post 2002	5.3	*6.2*	5.3
type of area			
city and other urban centres	20.8	*34.0*	20.9
suburban residential areas	61.8	46.7	61.8
rural areas	17.3	*19.3*	17.3
floor area			
less than 50 sqm	11.5	*11.9*	11.5
50 to 69 sqm	24.3	*23.2*	24.3
70 to 89 sqm	28.0	*29.1*	28.0
90 to 109 sqm	14.0	*12.2*	14.0
110 sqm or more	22.3	*23.7*	22.3
dwelling type			
house or bungalow	80.1	80.8	80.1
flat	19.9	*19.2*	19.9
GOR			
North East	5.3	*3.2*	5.3
North West	13.7	*13.1*	13.7
Yorkshire and the Humber	10.4	*11.2*	10.4
East Midlands	8.8	*3.4*	8.7
West Midlands	10.5	*13.4*	10.5
East	11.0	*15.3*	11.1
London	13.9	*15.5*	13.9
South East	16.1	*15.4*	16.1
South West	10.4	*9.5*	10.4
energy efficiency			
less than 30	3.7	*6.3*	3.8
30 to 50	22.3	*27.5*	22.4
51 to 70	63.8	57.6	63.8
more than 70	10.1	*8.7*	10.1
EPC Band			
A	*0.0*	*0.0*	*0.0*
B	*0.1*	*0.0*	*0.1*
C	13.5	*13.8*	13.5
D	48.0	*35.5*	48.0
E	29.8	*39.7*	29.8
F	6.7	*7.2*	6.7
G	1.9	*3.9*	1.9
all dwellings	**100.0**	**100.0**	**100.0**
sample size	***23,013***	***116***	***23,129***

Note: figures in *italics* are based on small samples and should be treated with caution
Source: English Housing Survey, dwelling sample

Figure 7: underlying data

	no risk	risk of overheating	all dwellings
			thousands of dwellings
conservatory present			
yes	3,570	*27*	3,597
no	18,881	95	18,976
Rooms in the attic present			
yes	2,794	*26*	2,820
no	19,657	96	19,753
all dwellings	**22,451**	**122**	**22,573**
			percentages
conservatory present			
yes	15.9	*22.0*	15.9
no	84.1	78.0	84.1
Rooms in the attic present			
yes	12.4	*21.2*	12.5
no	87.6	78.8	87.5
all dwellings	**100.0**	**100.0**	**100.0**
sample size	***23,013***	***116***	***23,129***

Note: figures in *italics* are based on small samples and should be treated with caution
Source: English Housing Survey, dwelling sample