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# Assessment of climate change on UK dwelling indoor comfort

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**Abstract**

The effect of future climate change may reduce heating load but will significantly increase overheating on a largely naturally cooled dwelling stock in the UK. Thermal mass significantly reduces the need for active cooling to be used. The air conditioning installation date for a range of building characteristics is presented with the amount of overheating occurring in a heat wave.
The future weather file for 2080 with 90th percentile data show a large increase in overheating events and is considered too extreme. The need for active cooling in bedrooms is expected to occur around 2035 and is independent of a heat wave. Results for living rooms are more variable with thermal mass mitigating the adoption of active cooling by 40 years and 25% of the overheating in a heat wave event. Designers need to think about thermal mass usage in living rooms to cater for extreme temperature events rather than the whole of the cooling season to delay the adoption of active cooling.



*Keywords:* TM52; Future Climate; Overheating; Heat Wave

## 1. Introduction

The mechanics and the sensitivity of the formulae used in the Chartered Institute of Service Engineers (CIBSE) Technical Memorandum TM52 [1] to establish overheating in buildings are not easily understood by designers. The onset of climate change has increased the risk of overheating in the UK to both new and existing dwellings which have no active cooling systems. This has led to an increasing need to design buildings for robustness over the

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proposed design lifespan of buildings rather than using current regulations which assess designs using historic weather data. Heat wave risks are not explicitly covered by CIBSE TM52 and requires user guidance to be established on the significance and impact of heat waves within the current framework.

To assess overheating in buildings and its resilience to heat waves it is important to estimate the date in which active cooling is required. This leads to a marked increase in future electrical demand The cooling demand increases approximately 3 fold in a future climate in which the heating demand drops by 14% by the year 2080. See Din and Brotas [2] for further details.

The study aims to assess factors inputted into simulation software (Energy Plus v8.2.10) to create the parameters of CIBSE TM52 in a range of values in the normal operation of building design specifications. In particular a full range of future climate weather files [3] covering medium and high climate change scenarios is used to determine the significance of thermal mass parameters. In the evaluation of the criteria for the identification of heat wave scenarios the significance on TM52 protocol for a cooling season is established. This requires the investigation of current definitions of heat waves and the identification of warm periods applied to available weather files.

The paper demonstrates the effect of material and design choices by quantifying their effects against a baseline building physics model, to determine the overheating significance of a cooling season and a heat wave event.

## 2. Background

The evaluation of the robustness of building designs needs to be considered on how climate change will affect the built environment. Previous studies have established probabilistic weather data for future years on established CP09 models [3]. A 60 year lifespan would require a building to be in operation until 2077 which determines the 2080 weather file used in this study to evaluate heat wave periods. Given the slow rate of progress of the global tackling of climate change a high scenario (a1fi under IPCC modeling) was used to determine year of air conditioning install across all future dates. The Design Summer Year (DSY) weather files that use 20 years of the peak summer condition to weight the data has been specified in TM52 and is used as the basis of the analysis in this paper.

The resilience of domestic buildings based on the projected future climate is required to reduce the risk of the building not being fit for purpose over its lifespan [4] requires a change to the specification of building designs. Although thermal mass influence on overheating has been investigated [5] its specification, density or its quantity in a dwelling has not.

Overheating has previously been assessed for living rooms and bedrooms but only on historic weather data using BS EN 15251 criteria [6], this assumes a smaller range of factors than used in TM52. The impact of overheating variables was analysed by Mavrogianni et al [7] but there was no clear statement of the significance of factors under the BS EN 15251 overheating criteria chosen. CIBSE TM36 [8] publication covers a range of future climate scenarios and although a sensitivity study is presented in a range of graphs, there are no distinct outcomes or conclusions on the importance of inputs or design features therefore is of little use in the building design process.

The evaluation of overheating are defined by the proportion of uncomfortable conditions that is experienced by the occupants of a building. This is defined by CIBSE TM52 which establishes a methodology for naturally ventilated building, this is an update when a set internal temperature that is exceeded the basis of previous BS EN 15251 guidance. CIBSE TM52 takes into consideration a relationship between the outside temperature, the occupant's behaviour, activity and adaptive opportunities which affect comfort. Overheating in the standard is defined in three distinct criteria which has some interdependency in their calculation method:

1. The amount of degree hours above 1K over the limiting comfort temperature must be below 3% of occupied hours. Assessed from 1st May to 30th September.
2. The higher the temperature the more significant the effect. This quantifies the severity of temperature on a daily basis. Where the weighted excess of temperature must be less than 6K on any one day for comfort to be achieved.
3. Reports heat stress events 4K above the limiting comfort temperature.

Occupants are likely to experience overheating if two or more of these conditions are not met.

CIBSE TM52 does not deal directly with more sensitive environments but categories have been stated on the grade of sensitivity of the environment assessed. In a previous study the sleeping comfort temperature has been stated as 2K lower than other occupied spaces [2] with a higher class of sensitivity (class I) under CIBSE TM52.