CARDIFF SCHOOL of ART & DESIGN

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Considering summertime overheating in highly insulated homes

Factsheet for housing owners and occupiers.

Introduction

This factsheet aims to provide you with a better understanding of the impacts of summertime overheating on houses that have been highly insulated and provides some suggestions on approaches to tackling them.

By highly insulated properties we are referring to homes that have walls with U-values equal to or lower (more insulated) than 0.3 W/m2k. These U-values are in line with current building regulations for new build properties.

U-values of solid walls

As an uninsulated solid brick wall with a thickness of 225mm has an assumed U-value of 2.70 W/m2k, there has been a lot of interest in insulating solid wall dwellings. Consequently, both internal (IWI) and external wall insulation (EWI) systems have been used to improve the U-values of solid walls. If your solid brick (or stone) walls have had IWI or EWI applied to them, this advice (and the advice on summertime relative humidity in older properties) is particularly for you.

U-values of cavity walls

Cavity walls became the norm in the 1930s. However, until 1995 it is assumed that they were built but left unfilled (with insulation). All cavity walls built after 1996 are assumed to have filled cavities as part of more stringent building regulations. Retrofitting insulation in existing cavity walls has frequently been used for better energy efficiency and improvements in U-values. (see Table 1).

Typically, there tends to be less ventilation in highly insulated dwellings, and therefore fewer opportunities to reduce the build-up of heat due to external factors including increasing temperatures and solar flux (concentrated sunlight).

Table 1: U-values of cavity walls

Dwelling age	Unfilled	Filled
prior to 1900	2.0 W/m2k	0.45 W/m2k
1900 – 1975	1.6 W/m2k	0.35 W/m2k
1976 – 1982	1.0 W/m2k	0.3 W/m2k
1983 – 1995	0.6 W/m2k	0.2 W/m2k

Where the airtightness of a building is elevated without adequate ventilation, overheating is likely to occur (as well as condensation and the potential for damp and mould growth). This is intensified where there are large areas of glazing and south facing facades. The effects can be exacerbated by high humidity, either internally or externally.

We need to prepare for changing weather patterns and adapt our homes accordingly. Nevertheless, overheating in buildings is caused by both external and internal gains. Therefore, we also need to understand the activities inside our dwellings that may intensify the issue.

Energy efficiency measures to reduce heating bills in the colder months can result in occupant discomfort in the warmer months if dwellings are not correctly managed. Overheating refers to the occurrence of high internal temperatures which cause thermal discomfort, affecting occupants' health and wellbeing including sleep that may impact cognitive function and productivity. Please note, *these impacts are already being reported in highly insulated properties*. We will outline climate risks, as well as make suggestions on appropriate adaptations at behavioural, maintenance and refurbishment levels.

Climate change and Climate vulnerabilities

Figure 1: Climate Change predictions by 2050 and 2080 taken from the UK Climate Projections (UKCP18) dataset.[1]

By 2050	By 2080
Summer average temperatures in Wales are projected to increase by **1.34°C**	**Summer average temperatures in Wales** are projected to increase by **3.03°C**
Winter precipitation in Wales is projected to increase by **5%** ↑	**Winter precipitation in Wales** is projected to increase by ↑ **9%**
Summer precipitation in Wales is projected to decrease by **16%** ↓	**Summer precipitation in Wales** is projected to decrease by ↓ **23%**
Sea levels are predicted to rise across the country*, For example in	**Sea levels** are predicted to rise across the country*, For example in
North Wales (Llandudno), by **19cm** ↑	**North Wales (Llandudno)**, by ↑ **34cm**
Mid Wales (Aberystwyth), by **22cm** ↑	**Mid Wales (Aberystwyth)**, by ↑ **38cm**
South Wales (Cardiff), by **24cm** ↑	**South Wales (Cardiff)**, by ↑ **42cm**

1 – UK Climate Projections (UKCP18), Met Office https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/index

The urgency and likely impact of climate change has been thoroughly assessed by scientists, the results of which are now widely published and regularly reported in the mainstream media.

Current international decarbonisation efforts are unlikely to hold global warming to 1.5˚c. Consequently, we need to plan for warmer, wetter weather in Wales, and with this more extreme weather patterns including high winds, storm surges and intense precipitation. Our summers will be hotter, drier, and we are likely to experience heatwave episodes.

Overheating risks are therefore more likely to occur due to climate change, i.e., changed temperature and solar flux patterns that impact building envelope temperature dynamics. This will also impact indoor environmental quality and occupant health, particularly if it leads to persistent overheating.

Current and future risks

Climate vulnerability modelling (Hayles et al., 2022) has demonstrated that it is now more important than ever to consider how we adapt our buildings to address the challenges caused by a changing climate. Understanding present and future climate stressors will help inform climate mitigation and adaptation approaches and how to tackle these collectively.

Figure 1b: Daily Average Temperature

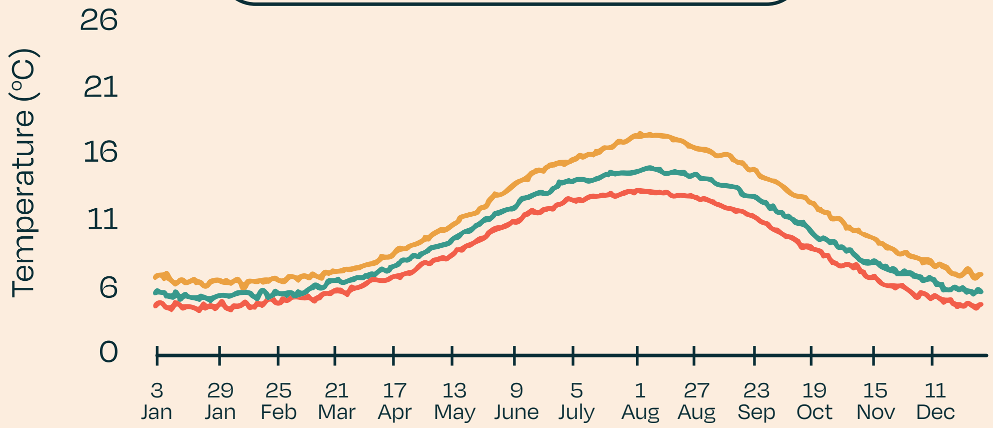
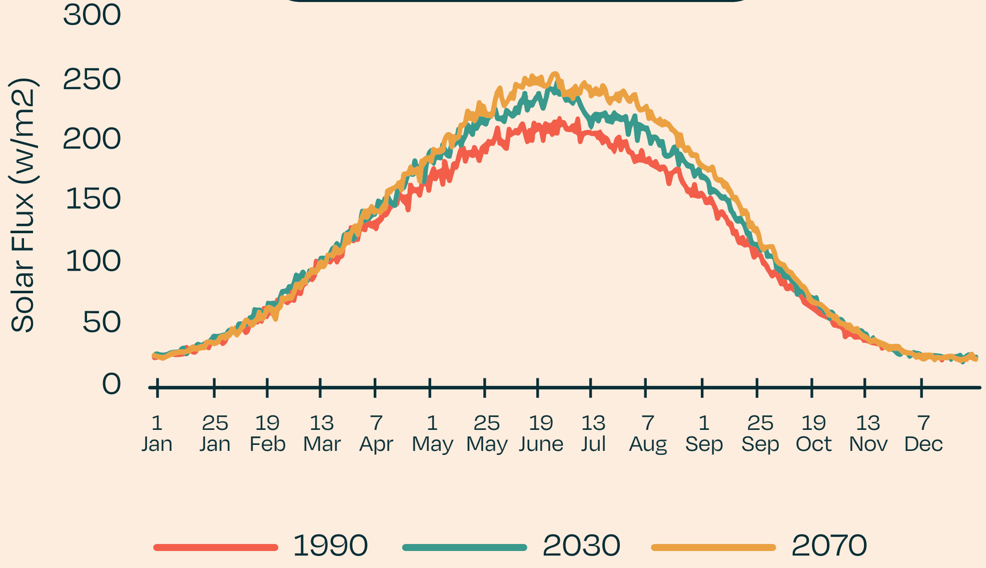


Figure 1c: Daily Average Solar Flux



Overheating

In a naturally ventilated home, TM59 CIBSE's design methodology for the assessment of overheating risk in homes states that bedrooms may only be warmer than 26°C for 1% of the year's sleeping hours before they are considered to be unsuitable. That means for 32 hours in any year (between 10pm-7am) a bedroom can be oppressively hot and cause sleeplessness, but no more.

The climate modelling research carried out by Hayles et al. (2022) that focussed on the six-week period from 22nd July through to 31st August, projected that the percentage of hours that would exceed CIBSE guidelines for thermal comfort would be far higher and more dangerous than this. (See Figure 2)

We need to adapt dwellings to deal with climate change now, not in the future.

Building design, construction, orientation, and household characteristic will all influence a dwelling's propensity for overheating. There is a greater overheating risk in certain types of dwellings, such as flats and mid-terraced houses, as well as rooms that face south or west. Internal heat gains influence overheating levels with impacts being more pronounced in high use areas. This may be more common in purpose-built flats where an open floor plan is more likely to be used, especially for the kitchen, dining and living areas; and single-aspect flats (new-build or conversions) that do not allow for cross ventilation.

Figure 2: Projected changes in daily temperature between 22nd July and 31st August for six locations across Wales

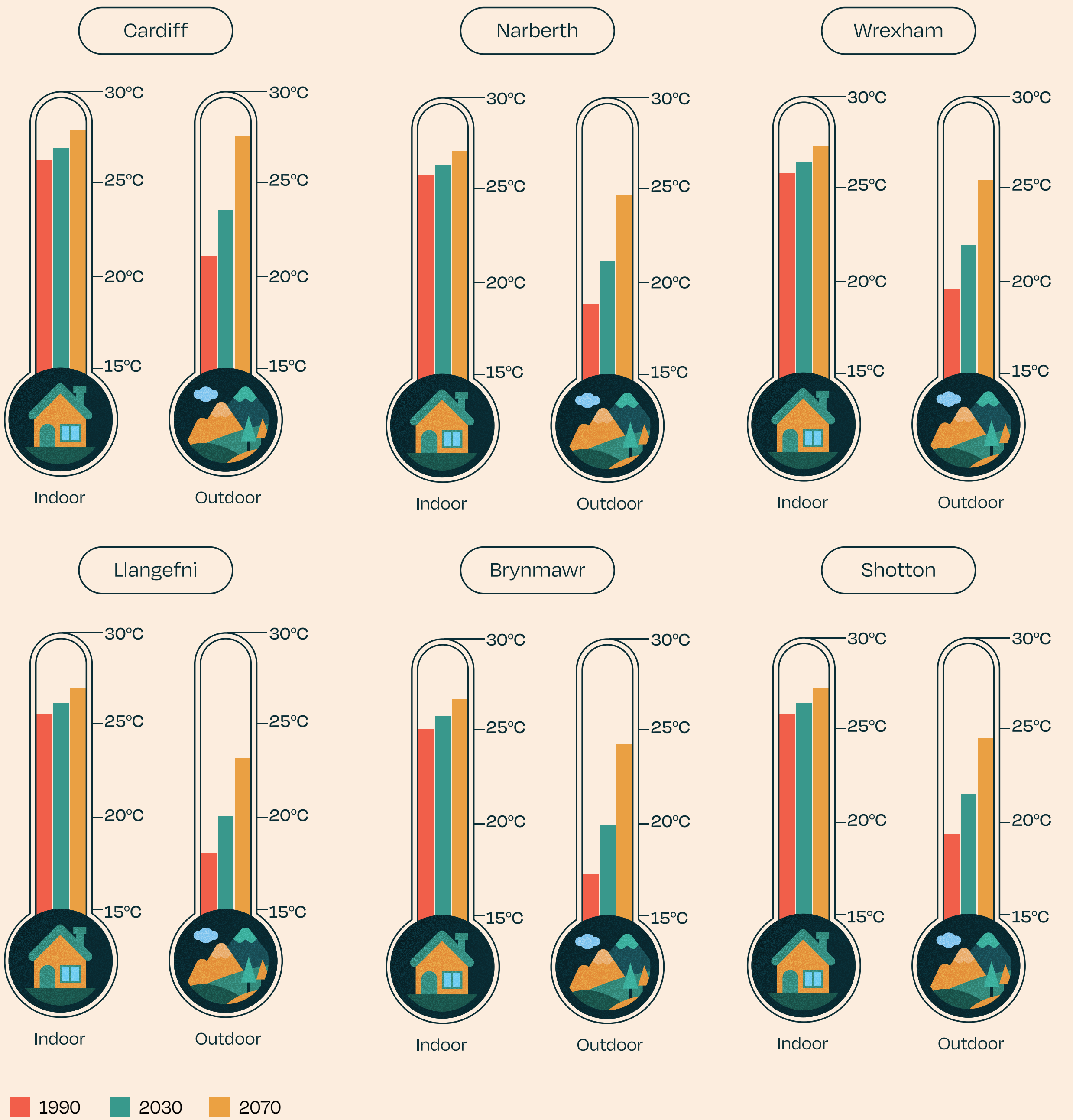
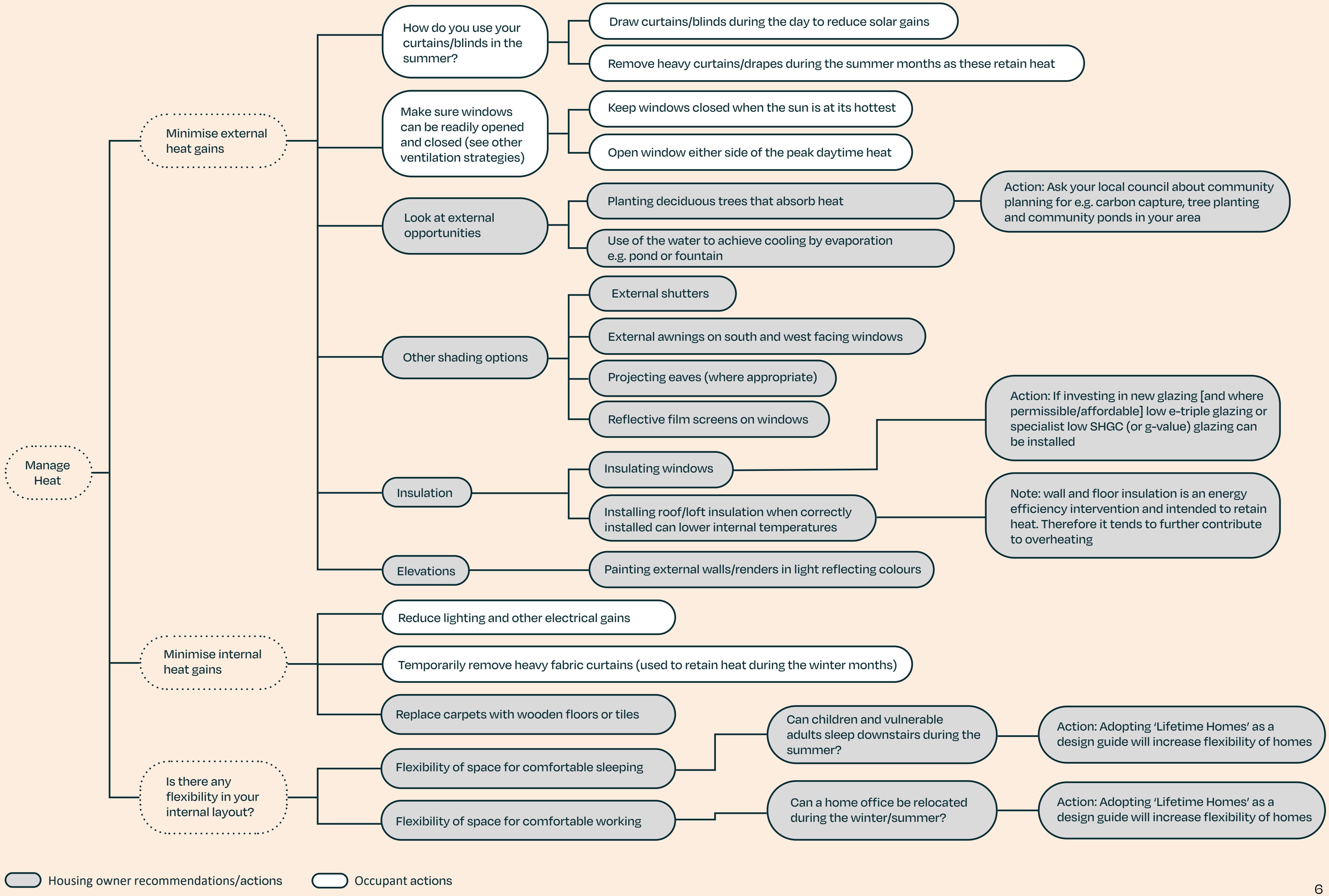


Figure 3: Cooling Strategies for a more comfortable indoor environment



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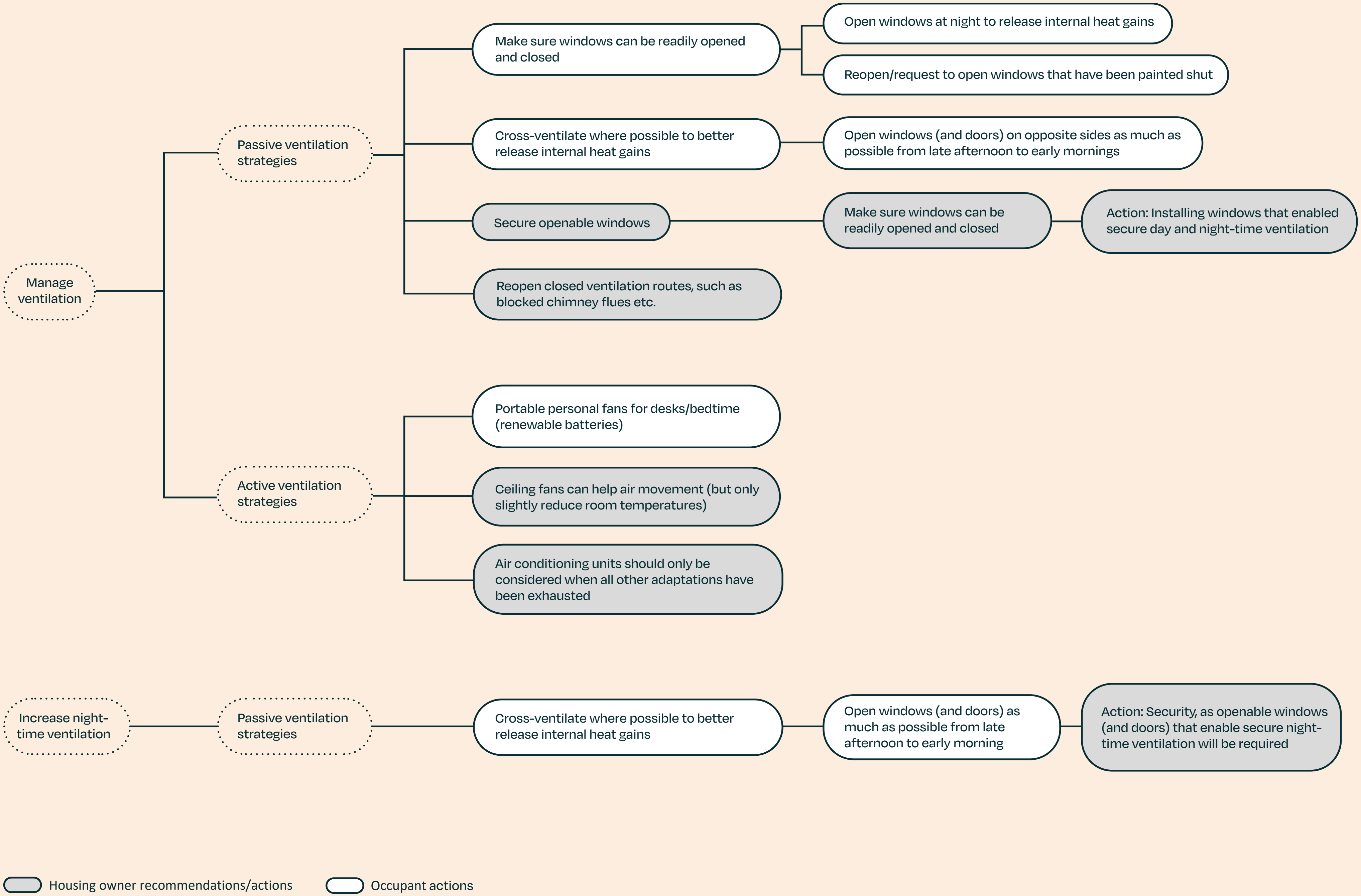

Overheating assessment methods

- BS EN 15251 (2007). Indoor and environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics, 2007. London, UK: British Standards Institution
- CIBSE (2013). TM52 The limits of thermal comfort: Avoiding overheating in European buildings. London UK: The Chartered Institution of Building Services Engineers.
- CIBSE (2017). TM59 Design Methodology for the assessment of overheating risk in homes. London: The Chartered Institution of Building Services Engineers.
- CIBSE Guide A (2006). Environmental design. London, UK: Chartered Institute of Building Services Engineers.
- Passivhaus Trust (2018). Passivehaus criteria: Passivhaus UK buildings database. London, UK.

Further Reading on overheating and keeping cool in the summer

- Alrasheed, M. and Mourshed, M. (2023). Domestic overheating risks and mitigation strategies: the state-of-the-art and directions for future research. Indoor and built environment Vol 0(0) 1-21.
- BRE (n.d.) Overheating in dwellings: Guidance Document. Available online at: 116885-Overheating-Guidance-v3.pdf (bre.co.uk)
- BRE (n.d.) Overheating in dwellings: Assessment Protocol. Available online at: 117106-Assessment-Protocol-v2.pdf (bre.co.uk)
- Hayles, C. S. (2022). How resilient are buildings in the UK and Wales to the challenges associated with a changing climate? Welsh Government. Available online at https://gov.wales/resilience-buildings-challenges-associated-climate-change-report
- Hayles, C. S., Huddleston, M., Chinowsky, P., & Helman, J. (2022) 'Summertime impacts of climate change on dwellings in Wales, UK. Building and Environment', https://doi.org/10.1016/j.buildenv.2022.109185
- Murtagh N, Gatersleben B and Fife-Schaw C. (2019). Occupants' motivation to protect residential building stock from climate-related overheating: a study in southern England. J Clean Prod 2019; 226: 186–194.

Additional Guidance

- NHS (2022) Heatwave: how to cope in hot weather. Available online at: Heatwave: how to cope in hot weather - NHS (www.nhs.uk)
- The Green Age (2013) Getting to grips with U-values. Available online at: Getting to grips with U-values! - TheGreenAge
- UK Government (2019) Research into overheating in new homes. Available online at: Research into overheating in new homes - GOV.UK (www.gov.uk)
- UK Government (2022). Beat the heat: keep cool at home checklist. Available online at: Beat the heat: keep cool at home checklist - GOV.UK (www.gov.uk)

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