SOLUTIONS TO OVERHEATING IN HOMES

LEAFLET

citb

OVERHEATING IN HOMES

Overheating has not, historically, been something the UK housing sector has needed to grapple with, but it is a growing problem. Potentially up to 20% of the housing stock in England is already affected and the issue is likely to become more prevalent in future.

> "As temperatures rise due to climate change there is an increased risk of overheating in buildings."
> **ENVIRONMENTAL AUDIT COMMITTEE**

WHAT IS OVERHEATING?

Overheating is the term used to describe situations where the temperature inside a person's home becomes uncomfortably or excessively warm. It happens most often during warm weather in the summer, but it can happen in winter months too.

Both sudden spikes in temperature and prolonged periods of excess heat can be difficult for people to cope with, especially if they have an underlying health condition.

GET IT RIGHT FIRST TIME

In the long-run, it is far better to design-in measures to prevent overheating, than to address the issue if it occurs later.

When refurbishing existing homes, for example to improve winter energy efficiency, it is important to avoid inadvertently introducing overheating problems. Tackling any overheating at the same time as other planned refurbishments can make projects more cost-effective.

PURPOSE OF THIS LEAFLET

This leaflet highlights some of the many technical and behavioural solutions, which can be used to avoid or reduce overheating, without automatically resorting to energy-using cooling systems. It is based upon the 'Solutions to Overheating in Homes' Review, prepared by BRE for the Zero Carbon Hub as part of its large-scale project 'Overheating in Homes'.

Please note that in a short leaflet such as this it is not possible to discuss questions related to when it is appropriate to use certain measures, how solutions may be staged over time or which measures are most suited to specific causes of overheating. Expert advice should be sought or detailed technical design guidance consulted.

THE ZERO CARBON HUB'S OVERHEATING PROJECT

At the request of Government, the Zero Carbon Hub formed the project 'Tackling Overheating in Homes' in 2014 to gather evidence and information on the current and possible future extent and impact of overheating in homes. We also looked at the degree to which the housing sector is already gearing up to tackle the issue and what further action could be required to manage the risk of future overheating.

Our 'Overheating in Homes – the Big Picture' baseline evidence report, published in June 2015, presents our findings from:

- Over 400 research papers and reports;
- 6 thematic Evidence Reviews;
- 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.

All our Overheating publications are available online at **www.zerocarbonhub.org**

The term Housing Provider covers all organisations who build, manage, rent or retrofit domestic properties, for example developers and private and social landlords.

EVIDENCE REVIEWS

As part of the Overheating in Homes project, a series of Evidence Reviews were commissioned from experts on key themes related to overheating.

DEFINING OVERHEATING
by CIBSE, ARCC, UCL, and the LSHTM

ASSESSING OVERHEATING RISK
by Inkling LLP, CIBSE, UCL and ARCC

IMPACTS OF OVERHEATING
by AECOM

OVERHEATING RISK MAPPING
by AECOM

DRIVERS OF CHANGE – OVERHEATING IN HOMES
by the ZCH and AECOM

SOLUTIONS TO OVERHEATING IN HOMES
by BRE

LEAFLETS FOR HOUSING ASSOCIATIONS AND LOCAL AUTHORITIES

MONITORING OVERHEATING – HOUSING ASSOCIATION CASE STUDIES

LOCAL AUTHORITIES – TACKLING OVERHEATING IN HOMES

HOW TO REDUCE OVERHEATING

Overheating occurs when too much heat builds up inside a dwelling which cannot be adequately "purged" or rejected. Heat can come from a number of sources inside or outside the building.

LIMIT HEAT BUILD UP

Experts advise reducing the amount of heat coming into a dwelling in the summer as much as possible.

THERMAL MASS

Heavyweight building materials have "thermal mass", which can smooth out peaks in temperatures – as long as the heat stored in them is removed regularly.

REJECT HEAT

- By ventilating with cooler outside air.
- By cooling the ventilation air or the structure of the building, either passively or fan-assisted.
- With mechanical cooling using refrigeration based systems.

Many of these measures can be used in combination. Stakeholders interviewed by the ZCH tended to support approaches which encourage good building design and the use of passive measures first.

EXAMPLES OF HEAT SOURCES

- Solar radiation falling on the outside of the building, especially the windows
- Direct transfer of heat by conduction or air movement when it is hotter outside
- Building occupants
- Electrical equipment
- Cooking
- Hot water pipes and tanks

WHEN TO COMBAT OVERHEATING

During the construction of a building, there are significant opportunities to minimise overheating.

During a major refurbishment project, the structure and orientation of the building is usually set, but significant changes can be made to windows, internal layout, or the means of ventilation.

During a simple retrofit options are usually more limited.

When designing for or improving the winter energy efficiency of homes, it is good practice to also check the potential effect on thermal comfort in summer.

REDUCE EXTERNAL TEMPERATURES

THE URBAN HEAT ISLAND

City centre temperatures can be significantly higher than in surrounding rural areas, by up to 9°C in London and 8°C in Manchester. This "Urban Heat Island" effect is most intense on calm nights with clear skies (see Figure 1).

Options which can be employed at a city-wide level down to an individual building level, to cool the external environment include:

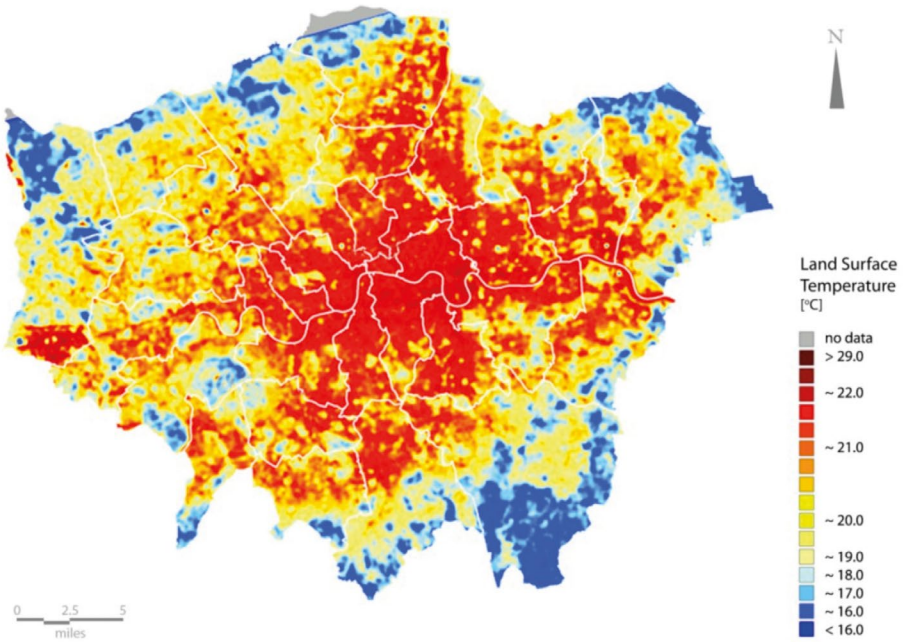
- Using lighter coloured surfaces so that less solar radiation is absorbed;
- Open water; and
- Foliage and vegetation.

COOL AND GREEN

Trees can be used to shade buildings and outdoor spaces and surfaces so that they receive less solar radiation. Plants not only intercept the sunlight, but also use a significant proportion of it in the process of photosynthesis to produce food for their own growth.

Plants also draw up water through their roots and then evaporate it through their leaves. This process is called transpiration. As water evaporates from the leaves and also the soil around the plants, the leaves, soil and surrounding air are all cooled.

Figure 1. **Land Surface Temperature in London at 21:00 on 12 July 2006 (LUCID project)**



REDUCE EXTERNAL HEAT FROM THE SUN

Electrochromic glass © Gallop Photography

THROUGH THE BUILDING FABRIC – OPAQUE ELEMENTS

For new-build dwellings and those which have undergone major refurbishment, any heat gain through the building fabric due to high outside air temperatures and solar radiation will be relatively small compared to other sources of heat gains, for example from solar radiation through the windows.

In dwellings where the building fabric thermal performance falls below that currently required by the Building Regulations, insulation may help limit heat gains and therefore overheating, as long as other factors leading to excess heat are well-controlled.

GREEN ROOFS

Green roofs can reduce summer surface temperatures. This can also have a positive impact when using solar PV panels, as they work more efficiently at lower temperatures.

The London Borough of Islington has actively promoted the use of green roofs through its planning department, increasing their uptake.

THROUGH THE WINDOWS

Sunlight falling on windows, patio doors or French windows is transmitted immediately through the glass and will quickly heat up a home. In summer this can cause a room or dwelling to overheat.

Windows to the east and west receive most sunlight, as the low sun shines directly on them in the morning and afternoon. External air temperatures are at their maximum during the afternoon when the sun is in the west.

South-facing windows can also lead to overheating, even though they will receive less direct sunlight in summer, as the sun is at its highest point in the sky.

Daylight is essential for occupants' health and wellbeing and to avoid using excessive artificial lighting. But it is important to be able to control the amount of sun coming in, especially in summer, either by:

- shading windows and glazing, internally or externally; or
- using special types of glass.

SHADING WINDOWS FROM THE SUN

In the UK, many people are unaware of how effective shading windows from the sun can be in reducing the risk of overheating.

Drawing the curtains or blinds on the inside of a window can help but some heat will still pass through the window into the dwelling.

It is almost always better to shade the outside of the window, as this stops the sunlight before it passes through the window. Indeed, many different types of external shutters and blinds are used in Continental Europe.

With clever design, windows can also be partially shaded by the building itself, for example by balconies, overhanging eaves or deep window reveals.

There are more options for shading south-facing windows compared to those facing east or west. As well as external shutters and blinds, awnings and fixed overhangs can be used to block out the high summer sun.

BUILDINGS WEARING SUNGLASSES

A novel way to stop sunlight heating up a building is to use different types of glass.

TINTED AND/OR REFLECTIVE GLAZING AND TINTED AND/OR REFLECTIVE FILMS (which can be retrofitted onto existing windows) 'Spectrally selective' glazing tints allow more visible daylight through while stopping most of the heat of the sun.

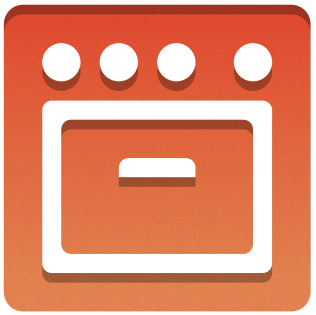
PHOTOCHROMIC GLASS
This glass has chemical coatings that change colour in response to light and is commonplace in spectacles. The lenses gradually darken and become less transparent as the light intensity increases.

ELECTROCHROMIC GLASS
This glass changes colour when a small burst of electricity is applied. The user can switch the windows from clear to coloured to control the amount of sunlight coming through. Solar PV cells in the window can be used to supply power, avoiding the need for more extensive wiring.

THERMOCHROMIC GLASS
This glass changes colour as its temperature increases. When used for windows, it is formulated so that the glass will darken only when sunlight is falling directly on the windows. Unlike electrochromic glass, it does not depend upon the building occupant to control it.

These innovative technologies have already been used in domestic as well as commercial buildings, and could become more widely used in the future as the cost comes down.

REDUCE INTERNAL SOURCES OF HEAT



ELECTRICAL AND ELECTRONIC APPLIANCES

Almost all electrical power used in a dwelling is turned into heat. The number of electrical and electronic appliances in our homes is still increasing.

Modern appliances and lighting are becoming much more energy efficient, but their older predecessors can emit significant amounts of heat.

Some housing and extra care schemes have already moved appliances which produce large amounts of heat, e.g. washing machines and tumble driers, out of individual dwellings into shared communal facilities.

HOT WATER SYSTEMS

INDIVIDUAL DOMESTIC HOT WATER SYSTEMS

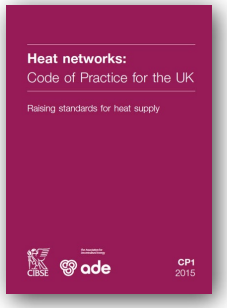
Make sure the pipes and cylinders are properly insulated.

CENTRAL HEATING AND HOT WATER DISTRIBUTION SYSTEMS

In communal heating systems significant heat can be lost from the pipes which circulate hot water throughout the building.

Guidance published by CIBSE and the Association for Decentralised Energy in June 2015 made recommendations to, for example:

- Avoid locating distribution pipes in corridors where possible;
- Make sure all risers are ventilated in summer; and
- Use sufficient insulation thickness.



THERMAL MASS WITH AN EFFECTIVE VENTILATION / COOLING STRATEGY

Heavyweight building materials, such as brick, stone or concrete, have “thermal mass”, i.e. the capacity to soak up and store heat - or cold. This can help stabilise the temperature inside the home where the thermal mass is exposed, not covered up, e.g. by carpet or ceiling tiles.

They also conduct heat slowly. In homes which have walls built of thermally massive materials, it may take several hours for heat from outside to pass through the walls into the inside.

However, the heat absorbed by the thermal mass must also be removed.

OPTIONS FOR COOLING THERMAL MASS

OPENING WINDOWS

As long as temperatures are lower outside than inside, buildings can easily be cooled down by opening windows at night.

If opening the windows in homes at night is not an option, there are other ways of getting rid of the heat stored in the thermal mass.

VENTILATED VOIDS

Air can be passed through, for example, raised floors or false ceilings, to cool down the building without making the rooms too draughty.

VENTILATED DUCTS

Special concrete floors with hollow cores allow a large amount of air to be passed through to cool down the structure of the building.

Mechanical ventilation can be used in both systems. Good control is essential to avoid condensation or over-cooling.

THERMALLY ACTIVE BUILDING SYSTEMS/UNDERFLOOR COOLING

Underfloor heating has been widely used for over 20 years in buildings. Thermally active building systems extend this principle to also provide cooling. Pipes embedded under the floor, for example, carry hot water to heat the home in winter and cold water to cool it in summer.

Thermally Active Building Systems are predictable and effective. They can be operated 24 hours a day and do not rely on the outside temperature being lower than the internal temperature overnight. The cold water used by the system in summer can be obtained from a renewable source such as groundwater.

COOLING

Thermal labyrinth under construction

MECHANICAL VENTILATION WITH EVAPORATIVE COOLING

These systems use a fine spray of water to cool down incoming or outgoing warm air in a mechanical ventilation system.

COOLING FROM THE GROUND

EARTH TUBES, LABYRINTHS AND BRINE-BASED GROUND LOOPS

In summer, the ground temperature will be much less than the air temperature, especially during the day. The ground can provide cooling.

OPTION 1: External air is passed through "earth tubes" in the ground or an underground concrete labyrinth before it enters the dwelling.

OPTION 2: A network of pipes carrying brine is buried in the ground and used to cool the intake air by means of a heat exchanger.

Both these systems are coupled with mechanical ventilation to supply the cooled air to the dwelling.

SEASONAL THERMAL ENERGY STORAGE FOR DISTRICT COOLING

Thermal energy can be stored between seasons. In summer, excess heat is collected and stored and then used for heating in winter. Likewise, excess cold stored in winter can be used as a cooling source in summer.

Options for storing the heat or cold include surface water ponds and aquifers. The first aquifer thermal energy storage system in the UK was at the Westway Beacon residential development in west London, built in 2006.

There are alternative systems, which use piping under asphalt, e.g. in car parks or playgrounds, to collect heat and cold, in summer and winter respectively.

Systems which provide cooling from the ground require extensive groundworks and are therefore most suited to larger scale new build developments.

REJECT HEAT – VENTILATION WITH COOLER OUTSIDE AIR

NATURAL VENTILATION

Opening windows is a cheap way of getting rid of hot air and bringing in cooler fresh air.

Windows must be well-designed so that it is possible to open them wide and to secure them at a varied range of opening widths. Air will flow more easily through a home which can be cross-ventilated, but it is difficult to naturally ventilate single-aspect (single sided) dwellings.

Opening windows is sometimes impractical in reality, especially in cities. Noise, pollution and security issues need to be taken into account, but are difficult to control. Changes in transport infrastructure, such as wider use of electric vehicles, could help in the future.

A survey of 450 older people in Islington found that fear of crime and noise concerns prevented many residents from opening their windows, particularly at night, even if they wanted to.

MECHANICAL VENTILATION

Many new-build homes, and some older homes which have been refurbished to improve their energy efficiency, incorporate a mechanical ventilation system to provide a background flow of incoming fresh air. They are not intended for cooling.

REJECT HEAT – COOLING

WHY NOT JUST INSTALL AIR CONDITIONING?

In general, refrigeration based mechanical cooling is effective and fail-safe, except for plant-failure, and may be necessary in some scenarios.

But air conditioning uses energy, meaning fuel poor households may have problems paying.

In addition, the waste heat from AC systems is nearly always ejected into the outside air. This has the potential to intensify the Urban Heat Island.

There is also concern that increased demand for mechanical cooling could put additional strain on the electricity grid, particularly during hot spells and heatwaves.

The August 2003 European heatwave led to a market-boom in air conditioning in France. Energy demand rose significantly, but at the same time, water stress caused by the hot weather led to a reduction in energy supply.

Since our formation in 2008, the Zero Carbon Hub continues to work with Government and industry to identify risks, remove barriers to innovation and help demonstrate that energy efficient, healthy new homes can be delivered by the mainstream house building industry.

Get in touch to find out how we can assist you

0845 888 7620

info@zerocarbonhub.org

Zero Carbon Hub, Layden House,
76-86 Turnmill Street, London EC1M 5LG

Visit our website and follow us on social media for the latest information

www.zerocarbonhub.org

@zerocarbonhub

/company/zero-carbon-hub