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ADAPTING UK HOMES TO REDUCE OVERHEATING

We all live and work in buildings; maintaining a comfortable indoor temperature is vital to ensuring our general well-being and productivity. Warmer summers can increase the risk of overheating, varying from building to building, depending on factors such as location, fabric, orientation and use. Without intervention, many existing buildings will become uncomfortable places to live and work in the future whilst new buildings need to be designed to meet the challenges of a changing climate.

Overheating of homes during the summer is likely to become more common in the UK as a result of our changing climate. This paper describes the key findings of research to identify the best ways to adapt existing homes to reduce the risk of overheating. Various retrofitting options and packages are presented that could be considered now, if overheating is already an issue, or in the future.

The advice in this document is relevant to homeowners that are looking to retrofit or improve the performance of their homes, landlords that are looking at retrofitting more than one property and policy makers that are working on relevant policies.

Background

Most housing retrofits aim to reduce energy used for winter heating. However, climate change means that there is likely to be an increase in temperatures, including the potential for warmer periods and heatwaves. The last major heatwave in the UK, in August 2003, led to over 2000 excess deaths.

Home refurbishment should provide a safe and comfortable environment throughout the year, which will include measures to minimise overheating, as well as reducing demand for heating.

Two EPSRC funded research projects investigated the thermal performance of different types of UK homes and used computer tools to assess different types of retrofit options to tackle potential overheating.

The Community Resilience to Extreme Weather (CREW) project looked at: typical 1930s semi-detached house, 1960s ground, mid-floor and top floor flats, Victorian (19th century) end and mid-terraced houses and modern detached house (constructed to 2006 Building Regulations).

The Suburban Neighbourhood Adaptation for a Changing Climate (SNACC) project looked at semi-detached, purpose built flats (mid floor), mid-terraced and detached houses, all constructed between 1919 and mid 2000s. SNACC also looked at the costs of different options and packages for options for a semi-detached house, purpose-built flat (ground and top floor) and block of 16 flats similarly constructed to the purpose-built flat.

These housing types are the most common ones in the south-east of England. Although both projects used different construction details, occupancy patterns and overall assumptions to model their selected house types, there are some key messages that could be derived from the resulting research:

Key messages

- Retrofitting options that address overheating will need to be tailored to each building (type, construction), occupancy pattern, location and orientation.
- Interventions during refurbishment will need to address both low carbon and overheating concerns so as to support and not challenge each other's potential benefits.
- Occupancy patterns should be considered when determining the risk of overheating and the most appropriate retrofitting options. Homes occupied during the day are more likely to result in greater overheating exposure.
- Flats (especially in middle and upper floors) are the most exposed to overheating risk.
- Detached, solid wall terraced and semi-detached houses are the less exposed to overheating risk, with the exception of modern (designed to 2006 Part L) detached houses which show increased risk of overheating.

Effective adaptation options

- No single solution fully addresses the overheating risk so a combination or package of adaptation options is likely to be needed to reduce the risk of overheating.
- Appropriate occupant behaviour (such as opening windows when outside temperatures are lower than inside) is an effective, no-cost adaptation option to address overheating.
- Shading, especially external (including shading from trees), is the most effective option for almost all house types researched, offering in some cases more than 50% reduction in overheating risk.
- High albedo of external walls (e.g. painted in light colour) is also shown to consistently reduce overheating risk, while also reducing the UHI effect.
- External wall insulation outperforms internal and cavity insulation, but its effect is reduced with the decrease in the number of exposed walls (i.e. the effect of external insulation is more significant in a detached house than in a terraced).

- Increased (especially internal) insulation and air tightness (to reduce heating energy in the winter) could lead to higher risk of overheating during the summer, resulting in occupants introducing intensive mechanical cooling means, such as air-conditioning, which compromises the low carbon objective. Solutions to this potential problem include using appropriate insulation or combining insulation with other adaption measures e.g. solar shading and high albedo walls.
- Some low carbon options have shown to also be effective in increasing the resilience of homes to the risk of overheating. Such options are roof and appropriate wall insulation, low-e double or triple glazing. These obviously need to be correctly implemented as stated in the above bullet point.

The cost of effective adaptation

The costs associated with different retrofitting packages were explored by both projects. CREW developed a tool that provides costs of different packages against thermal performance improvements, for different building types. SNACC developed a catalogue of packages for three building types, a semi-detached house, purpose-built flat (ground and top floor) and block of 16 flats similarly constructed to the purpose-built flat.

Both research groups looked at retrofitting packages that both reduced overheating risk in the summer and heating demand in the winter. They found that:

- Many low carbon retrofit options share commonalities with adaptation options and so could potentially share the cost.
- Behaviour change is a free and effective way of addressing overheating, resulting in up to 30% reduction in overheating exposure (CREW).
- Shading is the most effective of the options explored, resulting in some cases in more than 50% reduction in overheating exposure, that could also be a low cost option.

Example

A semi-detached house, 1930s–1950s construction, 3 bed, west facing, day time unoccupied (see Appendix for more information).

SNACC suggests that a retrofit package of £10,000 that mainly includes facade improvements could achieve future reductions in overheating risk of up to 40%.

CREW suggests that a similar retrofit package of £13,000 could achieve a reduction of overheating risk of up to 70% and 30% reduction in heating energy.

Further information

CREW: Community Resilience to Extreme Weather

CREW was established to gain a better understanding of the effects of future climate change on extreme weather events, and to develop a set of tools for improving community resilience. The work focused on five boroughs in South London. CREW was funded by the Engineering and Physical Sciences Research Council.

An online retrofit advice toolkit developed by this research project is available at www.iesd.dmu.ac.uk/crew. It provides information on options to address overheating, for a range of housing types, looking at the relationships between overheating, option performance, cost, construction type, occupancy and orientation. It offers integrated consideration of summer overheating reduction, winter heating energy use and associated retrofitting costs.

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SNACC – Suburban Neighbourhood Adaptation for a Changing Climate

SNACC is a UK Engineering and Physical Sciences Research Council (EPSRC) funded 3-year consortium-based project with the objective to identify effective, practical and acceptable means of suburban redesign in response to climate change projections. SNACC seeks to answer the question: How can existing suburban neighbourhoods be best adapted to reduce further impacts of climate change and withstand ongoing changes? The project aimed to determine which neighbourhood adaptations perform 'best' against three criteria: technical performance, practicality and acceptability. The SNACC final report and other publications can be found at www.snacc-research.org.

Appendix

Sample adaptation package from SNACC project	
Adaptation options	Cost
Low-e double glazing	£5,000
High albedo wall	£3,750
Louvered internal shading	low
Cavity wall insulation	£1,100
Total	**£9,850**
Overheating definition – 1% of occupied hours above or equal to 28°C The SNACC team has identified no overheating risk of the base case* under current climate and until the 2030s.	

Sample adaptation package from CREW project	
Adaptation options	Cost
Low-e triple glazing	£9,500
Reflective wall coating	£1,200
Louvered internal shading	£2,200
Cavity wall insulation	£200 (subsidised price)
Total	**£13,100**
Overheating definition - the number of degree hours over the comfort threshold temperatures (28°C for living areas and 26°C for bedrooms) for the occupied periods. Each 1°C over the threshold temperature for 1 hour equals 1 degree hour. Therefore, a bedroom at 30°C for 1 hour would add 4 degree hours to the total for the heatwave period. The CREW team has identified current overheating risk of the base case* of 170 degree hours. A reduction of overheating risk up to 60% was achieved using the above retrofit package, as well as 20–40% reduction in heating energy.	

**Please note that there are differences between the base case buildings used by each project, e.g. CREW has assumed that a minimum upgrade of 100mm loft insulation and double glazing have been already undertaken to the property. SNACC assumes single glazing and insulated roof.*

Also, the SNACC results are from Oxford which will be a bit cooler that the London Heathrow location used by CREW.