Written evidence submitted by Professor Rajat Gupta and Matt Gregg, Low Carbon Building Research Group, Oxford Institute for Sustainable Development, School of Architecture, Oxford Brookes University

Response to Call for Evidence

Heat resilience and sustainable cooling

1. Introduction

The Low Carbon Building (LCB) Research Group is based in the multi-disciplinary Oxford Institute for Sustainable Development (OISD) at Oxford Brookes University. Led by Professor Rajat Gupta (Professor of Sustainable Architecture and Climate Change), the LCB group had secured extensive research grants (£14 million as Investigator) and produced numerous publications (over 150 papers) on building performance evaluation, monitoring of overheating and indoor air quality in housing and care settings. Gupta is Co-Investigator (Co-I) on the NERC funded network grant on the health and equity impacts of climate change mitigation measures on indoor and outdoor air pollution exposure (HEICCAM). He is also Co-I on two NERC funded projects worth £1.09 million on climate resilience of care settings (NE/T013729/1 and NE/S016767/1). Previously he led Joseph Rowntree Foundation (JRF) funded study (2015-2016) on Care provision fit for a future climate that monitored for the first time, overheating risk in four care homes outside London.

The LCB Group has produced numerous publications on measuring and tackling the risk of overheating in homes and care settings. The relevant publications are listed in the references section.

We are pleased to provide written submission addressing the issues raised in the call for evidence.

2. Addressing the questions in the call for evidence

Our submission is organised to address the following questions mentioned in the call for evidence.

What evidence exists on the relationship between heat and human health (mortality and morbidity), and which communities are worst affected?

- Gupta et al. (2016) summarises that studies have shown a linear relationship between higher external temperatures and increases in mortality. According to Public Health England the principal causes of illness and death during heatwaves are cardiovascular and respiratory disease.
- Heat related illnesses include heat cramps, heat rash, heat oedema, heat syncope and heat exhaustion.

- Globally, across a wide range of locations and climates, studies indicate that older people (>65 years) are particularly vulnerable to the effects of excessive heat.
- People with chronic or severe illness (e.g., renal disorders, diabetes, Parkinson's disease, or severe mental illness) are also more vulnerable to excessive heat.
- Heat-related mortality during heatwaves in the UK, France and Germany have been found to be highest among occupants of residential and nursing homes.
- Of the 19% of homes classified as non-decent (e.g., not providing a reasonable degree of thermal comfort/in disrepair), half of them is occupied by someone over 55 years old.[1]
- 18% of households where an occupant has a long-term illness or disability are classified as non-decent.[1]

How can sustainable cooling solutions and adaptation strategies be implemented in such a way as to minimise overheating, reduce energy consumption and prevent overloading of the electricity grid during peak demand?

- Shading has been found to be one of the most effective passive strategies. Shading over windows controls the amount of solar gain that enters the home through the window, a significant contributor to heat gain. Shading can and should be designed to consider the angle of the sun on a seasonal basis to minimise blocking solar gain in winter. All other solutions, especially increased insulation and airtightness should be combined with prioritisation of shading (Gupta and Gregg, 2012). In addition, where active solutions are present shading will help reduce the energy consumption of these systems (Gupta et al., 2015).
- High albedo wall and roof materials have been modelled to be effective in reducing overheating risk (Gupta and Gregg, 2012).
- Thermal mass (with night ventilation for purging heat) has been modelled to be helpful in reducing overheating risk or reducing cooling load; however, thermal mass can require more careful planning in terms of placement and positioning of the mass in relation to heat and ventilation sources (Gupta and Gregg, 2012, Gupta et al., 2015). Consideration of existing thermal mass may impact where (interior or exterior) insulation is added to a building.
- Measures to mitigate overheating will also need to take place at neighbourhood level. Examples of neighbourhood change could include more tree cover, lighter coloured / high albedo / high reflective paving, and permeable paving (Gupta and Gregg, 2011).
- Ceiling fans are a low cost and low carbon tool to provide the feeling of coolness without actually cooling the ambient air (Gupta et al., 2015).
- Heat pumps can be used as low energy cooling systems; coupling heat pumps with renewable systems and batteries are recommended to help prevent peak overload in bother summer and winter.

What actions can be taken to protect those most vulnerable to the impacts of extreme heat?

- Educate and create awareness at all levels (e.g., building management, homeowner) – make clear the health risks of extreme heat and overheating.
- Correct the misconception that cold is the only health risk (Gupta et al., 2016).

---

[1] https://ageing-better.org.uk/sites/default/files/2020-01/Non-Decent-Homes-fact-sheet.pdf

- Reevaluate the regulatory or standard practices in care homes and healthcare (for those less adaptable) regarding the seasonal heating schedule.
- Adaptive retrofit, e.g., seasonal shading devices, cool roof materials.
- Ensure extreme heat / heatwave events are included as 'extreme weather' in emergency alert service system.[2]
- Create personal alert devices that measure indoor temperature and CO2 to inform occupants when they may need to turn off heating[3], ventilate, operate shading device, or leave the home and seek cool shelter.

To what extent do the Government's Climate Change Risk Assessment and National Adaptation Programme (as well as other related strategies such as the Net Zero Strategy and Heat and Buildings Strategy) identify and address the risks from extreme heat? (*Note: The third NAP, covering the five-year period from 2023-2028, is expected to be published in the summer of 2023*)

- The Government's Climate Change Risk Assessment and National Adaptation Programme recognize and address the risks of extreme heat to a satisfactory degree.
  - Risks to health and wellbeing from high temperatures, for example, is recognised as very high from 2050s – 2080s
  - The report recognizes that solar shading and increased ventilation are effective at reducing indoor temperature. In addition, the universal need for shading to be coupled with most other mitigation/adaptation measures.
  - The UK government is undertaking valuable research to evaluate the risk and impacts on buildings and people, e.g., *Cooling in the UK* report (DESNZ and BEIS, 2021)[4] assessing potential future cooling needs in buildings and *The heat and buildings strategy* (DESNZ and BEIS, 2023)[5] considering overheating risk and IAQ risk when developing policy to decarbonise the housing stock. This should continue.

Does the current planning framework do enough to encourage heat resilience measures such as cooling shelters, water bodies, green infrastructure and shading to be integrated into urban planning? Where such measures are incorporated, how accessible and successful are they?

- According to the framework[6], strategic policies are suggested to make sufficient provision for (p.9):
  - Community facilities: however, 'cooling shelters' (or equivalent) are not specifically named. Cooling shelters should be specifically named in relation to their purpose as refuges in extreme heat events. In addition, the concept of using community/cultural centres (e.g., community centres, education buildings) as places that would be or could contain cool shelters.
  - Green infrastructure

---

[2] https://www.ageuk.org.uk/scotland/latest-news/2023/april/a-handy-guide-to-the-national-emergency-alert-system/

[3] It is not uncommon to find heating on in summer (Gupta at al., 2016). Additionally, if occupants are accustomed to a specific seasonal date on which they turn on/off heating, this can shift and create discomfort or harm if occupants are not aware of the weather outside.

[4] https://www.gov.uk/government/publications/cooling-in-the-uk

[5] https://www.gov.uk/government/publications/heat-and-buildings-strategy

[6] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1005759/NPPF_July_2021.pdf

- The planning framework encourages the enhancement of undeveloped land to mitigate urban heat island (though this term is not specifically used and perhaps should be explained and included) through shading (p.35).
- As recommendations are a little vague and generally use the term 'should' the framework would benefit from case studies and examples from anywhere in the world that would provide examples and inspiration.

What can be done to protect the UK's existing public and private sector housing stock from the impacts of extreme heat while ensuring that homes are sufficiently warm in the winter months?

1. Assess the retrofit need – light touch / early stage assessment

An example includes Good Homes Alliance (GHA) overheating tool for retrofits[7], a risk-based tool developed by GHA, Oxford Brookes University and partners. This light-touch assessment tool is intended for use at the early stages of residential retrofit projects, or on existing homes to identify key factors contributing to overheating risk and possible mitigation measures. This tool has the capability to overcome the barrier of lack of knowledge to integrate adaptation measures into traditional home improvement / retrofit.

The tool:

- is a simple one-page risk assessment balancing mitigation and risk measures which is aimed at the early design stages,
- is easy to use by non-specialists,
- promotes holistic consideration of overheating risk together with the site context and linked design issues such as ventilation and noise,
- acts as 'first filter', directing users to more complex modelling if risk cannot be mitigated through the simple tool alone,
- helps users identify rooms or areas which may be at higher risk e.g., due to typical variations in temperatures that naturally occur within a single home between north and south facing rooms, or ground and upper floors.

2. Detailed assessment

Where a building is at risk of overheating assessments can include:

- 'Simplified Method' based on design criteria as reflected in the new Part O of the Building Regulations,
- Steady state model – SAP based assessment,
- Dynamic thermal simulation and thermal comfort criteria following the CIBSE TM59 approach.

Reasonable provision must be made to:

- limit unwanted solar gains in summer and
- provide an adequate means to remove heat from the indoor environment.

These assessments overcome the barriers of lack of required skills to integrate adaptation measures and local planning regulations that restrict changes to the external appearance

---

[7] https://goodhomes.org.uk/wp-content/uploads/2019/07/GHA-Overheating-in-New-Homes-Tool-and-Guidance-Tool-only.pdf

of buildings wanting to fit passive measures. These models have the capability to demonstrate the impact of overheating and the benefit of adaptation measures. When coupled with visual modelling software, barriers of aesthetic concern and the difficulty in communicating and convincing building owners and occupiers of the need to mitigate future risk can also be tackled.

3. Retrofit

Combine common retrofit practices (e.g., improved wall and loft insulation, improved airtightness, heat pumps, insulated hot water distribution) with adaptive measured outlined above (e.g., shading, high albedo surfaces, etc.)

4. Post-retrofit indoor temperature monitoring and alert system

Indoor temperature monitoring using smart home technology could be installed in different rooms of the house post-retrofit. Such a system could additionally operate as a heat alert system to help protect the elderly, ill and disabled by alerting them and their carers to impending elevated temperatures. When certain heat thresholds are passed, a warning is issued and sent to relevant health professionals and people working in social care. This enables health / social care professionals to take action to minimise the impact of heat on people's health.

Technology to monitor temperatures in homes is low cost, but an agreed monitoring protocol and a method for interpreting the measurements are needed to establish definitively whether a space is overheated or not.

5. User manuals for managing homes in summer

A home user manual can help by providing advice and illustrations on how and when to operate shading and ventilation devices; any new device or system to which householders may not be accustomed. Examples may include:

- When it is best to open windows to ventilate / purge hot air at night
- How to operate fans
- To keep blinds closed / details on how to operate shading elements
- Reminders to turn off unnecessary lighting or equipment that contributes to internal heat gain
- Suggest safe havens or ‘cool rooms’ near or within the home.

What role might reversible heat pumps (which can act as both heating and cooling systems) and other emerging technological solutions, such as the development of smart materials, play in meeting future cooling demands?

- Reversable heat pumps can provide low carbon cooling in the summer.
- If active cooling were considered necessary or required a reversible heat pump would be ideal as heating would also be necessary. This would provide thermal comfort in all seasons using one system as opposed to air conditioning for cooling and a boiler for heating.
- Reversable heat pump has been modelled to be more efficient in summer and winter (and on an annual basis) than installing air conditioning in a home that already has a high efficiency boiler (Gupta et al., 2015).

- Heat pumps in general also fit the UK government's intent to electrify the heat demand.
- Combining energy efficiency, passive cooling measures, heat pump, photovoltaics, and a battery is expected to reduce heating and cooling consumption and reduce peak demand pressure on the grid (Gupta and Gregg, 2022).

3. References

- Gupta, R. & Gregg M. (2022) Performance of Distributed Energy Resources in Three Low-Energy Dwellings During the UK Lockdown Period. Climate Emergency–Managing, Building, and Delivering the Sustainable Development Goals: Selected Proceedings from the International Conference of Sustainable Ecological Engineering Design for Society (SEEDS), Springer, 71-84.
- Gupta, R., Howard, A., Davies, M., Mavrogianni, A., Tsoulou, I., Oikonomou, E. and Wilkinson, P. (2021) Examining the magnitude and perception of summertime overheating in London care homes. *Building Services Engineering Research and Technology*, 42 (6), pp.653-675.
- Gupta, R., Howard, A., Davies, M., Mavrogianni, A., Tsoulou, I., Jain, N., Oikonomou, E. and Wilkinson, P. (2021) Monitoring and modelling the risk of summertime overheating and passive solutions to avoid active cooling in London care homes. *Energy and Buildings*, 252, p.111418.
- Gupta, R. and Gregg, M. (2020) Assessing the magnitude and likely causes of summertime overheating in modern flats in UK. *Energies*, 13 (19), p.5202.
- Gupta, R., Gregg, M. and Irving, R. (2019) Meta-analysis of summertime indoor temperatures in new-build, retrofitted, and existing UK dwellings. *Science and Technology for the Built Environment*, 25(9), pp.1212-1225.
- Gupta, R. and Gregg, M. (2018) Assessing energy use and overheating risk in net zero energy dwellings in UK. *Energy and Buildings*, 158, pp.897-905.
- Gupta, R., Barnfield, L. and Gregg, M. (2017) Overheating in care settings: magnitude, causes, preparedness and remedies. *Building Research & Information*, 45 (1-2), pp.83-101.
- Gupta, R. and Gregg, M. (2017) Care provision fit for a warming climate. *Architectural Science Review*, 60(4), pp.275-285.
- Gupta, R. and Kapsali, M. (2016) Empirical assessment of indoor air quality and overheating in low-carbon social housing dwellings in England, UK. *Advances in Building Energy Research*, 10 (1), pp.46-68.
- Gupta, R., Walker, G., Lewis, A., Barnfield, L., Gregg, M. & Neven, L. (2016) Care provision fit for a future climate, York, Joseph Rowntree Foundation.
- Gupta, R., Gregg, M. & Williams, K. (2015) Cooling the UK housing stock post-2050s. Building Services Engineering Research and Technology, 36, 196-220.
- Gupta, R. and Gregg, M. (2013) Preventing the overheating of English suburban homes in a warming climate. *Building Research & Information*, 41 (3), pp.281-300.
- Williams, K., Gupta, R., Hopkins, D., Gregg, M., Payne, C., Joynt, J.L., Smith, I. and Bates-Brkljac, N. (2013) Retrofitting England's suburbs to adapt to climate change. *Building Research & Information*, 41 (5), pp.517-531.
- Gupta, R. & Gregg M. (2012) Using UK climate change projections to adapt existing English homes for a warming climate. *Building and Environment*, 55, 20-42.

- Gupta, R. & Gregg M. (2011) Adapting UK suburban neighbourhoods and dwellings for a changing climate. *Advances in building energy research*, 5, 81-108.

August 2023