



BEATING THE HEAT:

keeping UK buildings cool in a warming climate

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The Arup team also included Michael Holmes (Modelling Leader) and Gavin Davies (Project Director). The preparation of the report was assisted by Mark Wolfeden at Arup and Courtney Blodgett at UKCIP.

The results contained in this report are drawn from a longer technical report published by the Chartered Institution of Building Services Engineers (CIBSE): Climate Change and the Indoor Environment: Impacts and Adaptation (CIBSE TM36). The illustrations of the case study buildings in this report were provided by CIBSE. Photographs on pages 27 and 28 courtesy of MS Hacker. The work for the study was carried out by the consultants Arup working with the UK Climate Impacts Programme (UKCIP) and other stakeholders. The study was co-funded by Arup and the Department of Trade and Industry through the Partners in Innovation scheme.

Foreword

Climate change is threatening the future existence of mankind. Research and delivery of ways to avoid this catastrophe must be our primary aim. Buildings are responsible for 50% of the world's generation of CO₂. How can design mitigate this alarming statistic?

The priority is to find alternative, preferably 'natural' means of achieving benign environmental conditions. Working with the climate, rather than trying to defeat it, means accepting, for example, that architecture should respond to its location – a building in Marrakech should not be a duplicate of one in Montreal. The urgent task is to forge environmentally responsible modern architecture, to use technology to achieve beneficial ends - the ultimate aim being to achieve carbon dioxide neutral environments.

The 1970s saw a growing recognition of the enormous opportunity for a dramatic, design-liberating discipline for buildings. Today, the issue is not about 'saving energy' (or money) but about saving the planet. Finally, after decades of indifference, all those involved in the process of construction are beginning to respond to that cause. In a typical city, 47% of all energy is consumed by buildings (which generate half the total emissions of carbon dioxide), 27% by industry and 26% by transport (with the private car taking the lion's share). Since the Second World War, the crisis of the 1970s notwithstanding, commercial and public buildings in the developed world have generally become sealed, artificially-lit containers, heated in winter, air-conditioned in summer, which while meeting the requirements of low capital cost (and thus making a quick buck) are disastrous when measured against long-term sustainability. The increasingly evident threat to the global environment posed by buildings of this sort cannot be ignored.

The findings of this report indicate that there will be increasing challenges to designing a sustainable built environment over the next 100 years. Designers will require greater creative skills and better understanding of building performance to ensure that such low energy and passive buildings can continue to meet end-user needs and expectations. The good news is that this study demonstrates how passive, low energy buildings can be designed despite a likely increase in global warming over the coming century. The downside is that more passive features are likely to be needed to achieve the necessary performance.

We must endeavour to employ technologies that sustain rather than pollute, that are durable rather than replaceable, and that add value over time rather than falling prey to short term economies. Many projects have been developed that explore to a high degree the use of alternative sustainable energy solutions. Central to all discussions on sustainability issues must be the conviction that the structural and conceptual framework of modern architecture has the potential for environmental benefit and that architectural progress is not about re-styling.

The main issue is how technology is used, who controls it, and to what end.



Richard Rogers
Architect

Richard Rogers

Main messages

The majority of buildings in the UK are cooled in summer by opening windows.

Traditionally, this approach has prevented thermal discomfort. But summers are getting warmer because of climate change. When it is hotter outside then we want it to be inside a building, opening windows provides no real cooling benefit. Climate change means, therefore, that buildings in the UK are likely to become increasingly uncomfortable in summer unless other methods of cooling are used.

In this briefing report, the likely implications of climate change for increased thermal discomfort in existing buildings are examined through computer modelling of a number of case study buildings.

The latest climate change projections for the UK [1] were investigated for three different locations: London, Manchester and Edinburgh. These scenarios indicate that peak summer temperatures could be up to 7°C warmer than today by the 2080s. One solution to reducing uncomfortably hot indoor temperatures is wider use of air conditioning. However, this is undesirable since it will increase the energy consumption of buildings and hence the carbon dioxide (CO₂) emissions that are causing climate change. Here, ways in which buildings can be adapted to minimise thermal discomfort are examined with a focus on passive and low-energy methods. Further details can be found in the companion technical report CIBSE TM36 [2]. Buildings currently account for around 50% of national CO₂ emissions and so it is critical that low-energy solutions are found if the UK is to meet its emissions reductions targets [3].

The most successful passive cooling adaptation options identified (in approximate order of effectiveness) were:

- Shading from the sun
- Making provision for controllable ventilation during the day and high levels of ventilation at night (without compromising building security)
- Using heavier weight building materials combined with night ventilation, to enable heat to be absorbed and released into the building fabric
- Improving insulation and air tightness (e.g. cutting down on draughts) which enables undesirable heat flows to be controlled.

Passive measures can greatly reduce mechanical cooling needs. For homes in London, they have been shown to work well into the 2080s. For London's offices and schools, it is likely they will need to be supplemented by mechanical cooling from the 2050s onwards.

This is because offices and schools have high indoor "waste heating" from people, lighting, computers and other electrical appliances. One solution is to adopt a 'mixed mode' approach in which passive cooling measures are used as far as possible but mechanical cooling systems are still provided for times of need. With careful design and system management, such buildings can provide high levels of indoor comfort while still operating in a relatively energy efficient manner.

In London, it was found that increased thermal discomfort is likely to be a major problem for many existing buildings unless they are adapted for the changing climate.

In Manchester, the climate is currently significantly cooler than in London and this will continue to be the case under the climate change scenarios; thermal discomfort is therefore currently less of an issue. However, it has been found that by the 2050s, levels of thermal discomfort in buildings in Manchester are likely to be similar to those in London in the 1980s. The climate of Edinburgh is cooler still and for this location, no significant occurrences of thermal discomfort were found in the case study buildings until the 2080s. These findings indicate that significant variations will exist across the UK with regard to potential for summertime thermal discomfort. Consequently, a 'one size fits all' form of architecture will become less and less appropriate for the UK.

Thinking about climate change today when planning new developments will help to ensure a lasting legacy in the building stock by providing sustainable development for the future.

Climate change is no longer a distant threat but something we are having to live and deal with now. Delivering buildings that provide the optimal balance between high quality indoor environment and reduced carbon dioxide emissions is a challenge that is becoming increasingly important.

The decisions we make today will determine how well buildings can deliver on those objectives over their design lifetimes.