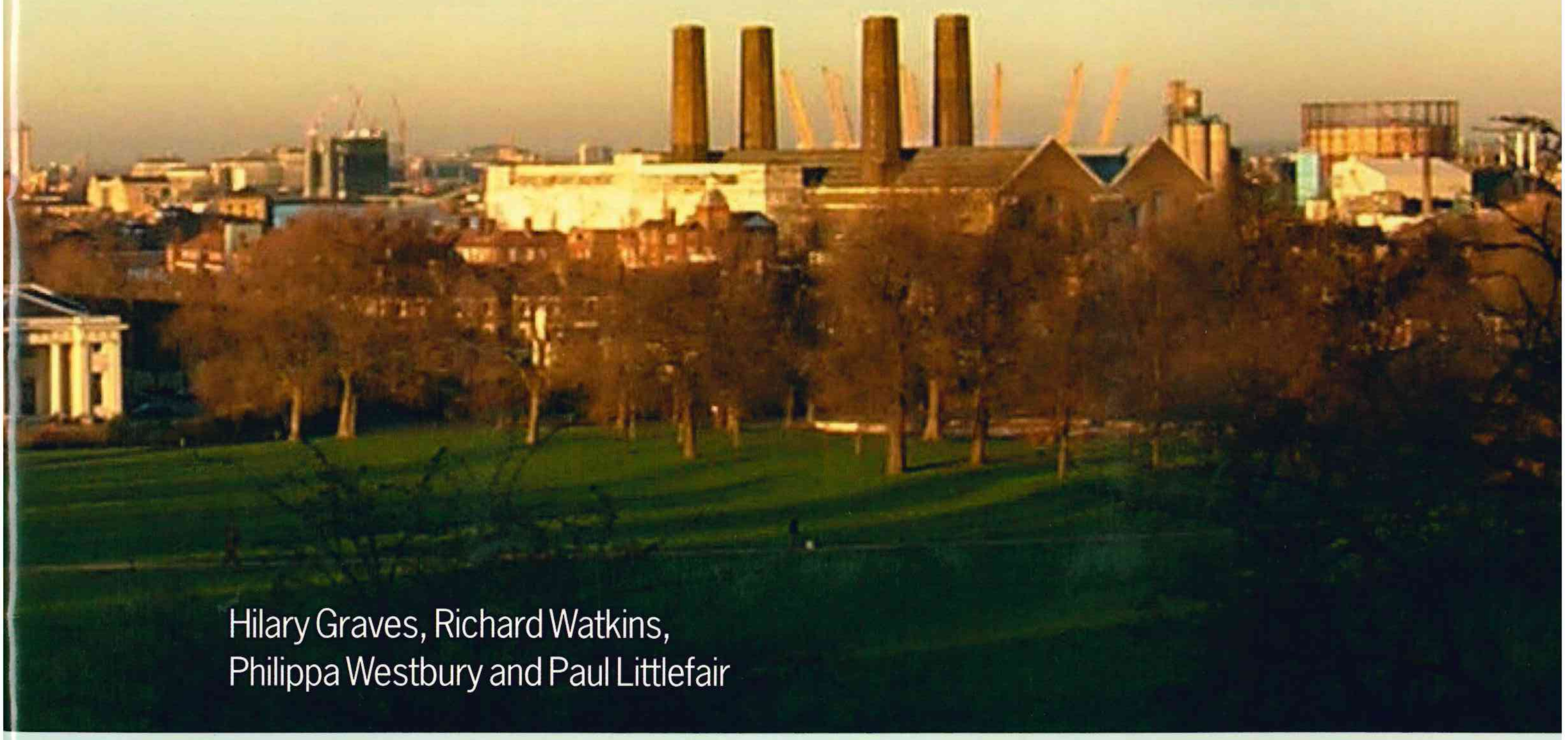
Cooling buildings in London

Overcoming the heat island



Hilary Graves, Richard Watkins,
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Introduction

BRE has been developing guidance for building designers on low-energy design solutions which maximise the application of solar access and passive cooling strategies in the urban environment. This guide and the design tool it includes have been produced to enable the construction industry to move towards reducing the impact of the urban heat island on peak cooling-energy demand in buildings.

Central areas of London can be significantly warmer than the surrounding areas, a phenomenon known as the heat island effect. These increased temperatures have an important impact on the cooling loads in buildings. Average cooling demand in a central London site is more than that at a rural site, and the efficiency of air-conditioning plant is decreased at higher temperatures. So the use of rural temperature data to calculate cooling loads can result in significant underestimates.

This guide presents the results of a unique long-term monitoring experiment to measure air temperatures at 80 sites spread around London. Summertime temperatures from some of the sites were then used in a model for a typical office building. The resulting design tool on the diskette included with this guide allows the designer to modify temperature data from Bracknell (the reference site for temperature data on pages 2–71 of CIBSE Guide A[1]) for the calculation of peak summertime cooling loads at 80 different locations in London.

The guide also outlines a range of techniques to reduce or even eliminate the effects of the heat island by careful design of the building and its surroundings, including:

- Alternative cooling strategies such as natural ventilation, night cooling, mixed mode
- Building layout to encourage wind flow and ventilation
- Landscaping and vegetation using trees and green areas, vines and other plants on walls
- Water features
- Surfaces with high albedo, to reduce heat build up
- Solar shading
- Reducing casual gains; avoiding unnecessary cooling caused by inefficient equipment and lighting

Chapter 1 London's heat island

Impact of building design on the urban heat island and peak cooling load

Properties of urban climate influenced by urban planning and building design

Cities have their own urban climates. The presence of buildings, and the activities taking place in the city, can change:

- Air and radiant temperatures
- Wind velocity and turbulence intensity (or 'gustiness')
- Humidity
- Air pollution

Air temperature has the largest impact on a building's peak cooling load, with humidity having a secondary effect. Wind velocity and turbulence, and air pollution, additionally influence the feasibility of cooling using natural ventilation rather than mechanical cooling. Air pollution also influences local climate, since absorption and scattering of incoming solar radiation by air pollutants affects the overall radiation balance for a city. Figure 1 illustrates the accumulation of a layer of pollutants in still winter conditions, producing a haze over the city of London.

Effective building design can have a beneficial effect on the urban climate and contribute towards reducing the intensity of the urban heat island , as well as directly reducing the peak cooling load of a building.

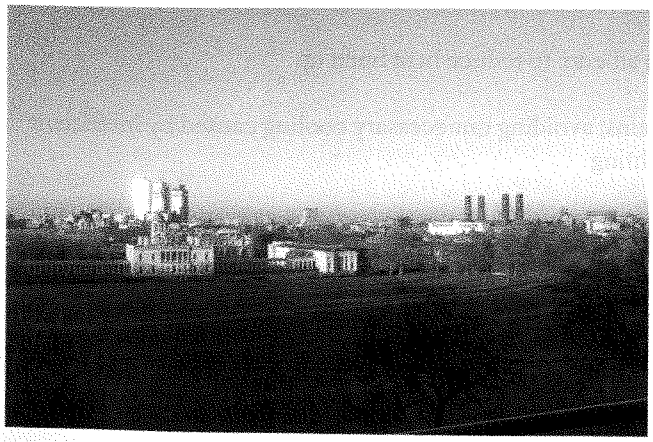

Figure 1 Polluted layer over the city of London

Urban heat island intensity

The urban heat island is described by its 'intensity', which is defined as the peak difference between urban and rural temperatures. In London, the urban heat island is most intense at night-time rather than during the day, and in calm, clear conditions.

Microscale and macroscale effects of building design and urban planning

Microscale effects

The design of individual buildings and small groups of buildings can influence the air temperature, wind characteristics and other climate features close to the building, ie the microclimate. Local variations in microclimate around the building or development can occur.

Macroscale effects

Each of the microclimates generated by small-scale features of the urban landscape (individual buildings and groups of buildings) will combine together to influence the larger-scale climate or urban heat island. For example, small-scale heat islands within the city will contribute to raising the overall city temperature. In addition, urban-scale factors, for example the size of a city and the density of the built-up area, will influence the intensity of the urban heat island.

Main factors contributing to the urban heat island

The main factors contributing to the urban heat island include:

- The increase in overall net radiation gain relative to a rural area, caused by the lower rate of radiant cooling during the night
- The storage of solar energy during the day by building materials, particularly those with dark surfaces. This is released at night
- Anthropogenic heat sources (eg transportation, heating and air conditioning, cooking and other industrial processes)
- The reduction in evaporation from soil and vegetation
- Decrease in convective heat loss from buildings to the air due to reduction in wind speed