'modernist city' where urban functions were separated in the form of large zones of single use (Vale and Vale, 1991; Owens, 1991; The Urban Task Force, 1999). The vitality of the city can be enhanced further if a mix of activities occurs within buildings, in addition to those that occur at the scale of the neighbourhood or locality. The mixing of functions within buildings is likely to maintain activity in the streets at all times in the day. Buildings designed for a combination of, for example, flats and office space are more likely to be successful if the width of the block is about 10 metres; building blocks wider than 10 metres are unsuitable for double-aspect residential accommodation, which is the most flexible housing type in the British climate, where it is important for sunlight to reach all the main rooms. With the double-aspect home, most orientations are acceptable. One of the standard building blocks of the northern European city is, therefore, 9 to 13 metres wide and about four stories high: it has a traditional pitched roof to protect it from snow and rain, while at the same time providing an opportunity to insulate the building adequately. The three- to six-storey linear building block is found in many European cities: as the standard urban built form it serves the purpose well and is capable of many interpretations.

In contrast, other building forms have developed appropriate to conditions in tropical regions of the world. In the harsh climate of the humid tropics, conditions are such that good natural ventilation is critical. These conditions impose certain requirements on the plan form of a building and its cross-section: ideally, buildings should be one room wide and have an access veranda along one side with openings in both long facades to ensure cross-ventilation; this is essential if air-conditioning is to be avoided. In contrast again, the traditional building form in arid tropical regions is often deep with internal spaces that are lit and ventilated from secondary sources or from deep-shaded courtyards (Moughtin, 1985; Koenigsberger *et al*., 1973).

A key element in the design of green or flexible buildings, which are capable of modification for different activities, is the staircase and associated facilities. The staircase, landing and service ducts are usually grouped to serve a number of units on different floors. When a building changes use and is remodelled internally, these shared facilities – since they serve the same function for the new use – remain unchanged. Because this service element is so expensive to change during modification or refurbishment, it is often referred to as the 'hard zone'. 'Usually these spaces are 'hard', and . . . must be positioned where they will not restrict the use of the remaining space'. (Bentley *et al*., 1985). The optimum position for such hard zones is at intervals of 10 or 20 metres; at these intervals a variety of spaces can be arranged, including small or double-aspect office units and also larger floor areas of open office space. Such distributions of service core, or hard elements can also be used for residential purposes. For example, in buildings that have hard zones 10 metres apart it is possible to accommodate a single floor flat (*apartment*) of 50 square metres, a two-storey maisonette (*duplex*) of about 100 square metres, or a three-storey town house of 75 square metres.

The building envelope – that is, the external walls and roof together with the ground slab – is the part of the building where heat loss is registered. It is here also that the building must be made weatherproof in other ways. A building which has the lowest ratio for the area of the envelope to the usable floor area, not only costs less to build for any given building volume (assuming the same materials are used in the construction), but also uses less energy to construct and is more efficient in terms of energy use during its working lifetime. Energy costs – both the energy expended in the construction and in the running of the building – tend to increase as the ratio of the area of the building envelope to the usable floor area increases. A sustainable building is, therefore, one where its envelope is the smallest for a given usable floor area. The single-storey square plan has an advantage over the elongated rectangular plan shape, but two-, three- and four-storey buildings are more effective than both in terms of energy conservation.

The relationship of energy expenditure and building geometry has been considered so far for buildings standing in isolation as three-dimensional forms in space. In cities this is not always the case. It has been argued elsewhere, in this series of books on urban design, that the city comprises of spaces surrounded and formed by buildings (Moughtin, 2003). In terms of energy conservation there is much to commend this built form. By grouping small units together, the semi-detached house rather than two detached houses, or the terrace rather than semi-detached houses, it is possible to make savings in the area of external walling or envelope. Furthermore, if the plan shape of each unit is changed from a square to a rectangular one with a narrow building frontage, then additional savings in the area of the external wall can be made: there is then a corresponding conservation of energy. By composing the individual units into three- and four-storey blocks of flats or *apartments*, additional savings in the size of the building envelope is possible without the energy expense of providing lifts. This rather oversimplified argument presupposes that disadvantaged or special needs groups are allocated ground-floor accommodation.

Further energy savings can be made by designing the building to work well within the conditions set by the local climate. The vernacular tradition has much to teach in the art of relating the building to its site. The traditional dwelling in countries with colder climates is often sited just below the brow of a hill on a southward slope: it is protected from the cold northerly winds by the hill, which is often augmented with a shelterbelt of trees and bushes. The northern face of the building usually has few openings, and if it is a farmhouse it may be further protected from the weather by outhouses. The southern façade contains the main windows maximising the benefit of any sun. This common-sense approach to the location of a building on its site and the organization of the building elements to mitigate the worst effects of a cold winter climate has valuable lessons for the greening of building design. It would seem from this model that the ideal orientation for a building in our climate is with its long axis running east to west. The northern façade should be fronted by accommodation not requiring good views or good lighting, and by rooms where the highest levels of heating are not necessarily desirable – that is, this wall acts a barrier between the cold outside world and the snug interior living rooms. The type of accommodation facing north would be circulation space, storage, toilets and, possibly, working kitchens. In contrast, the rooms with a southern aspect would be the living rooms and bedrooms. Large windows are desirable in the southern face of the