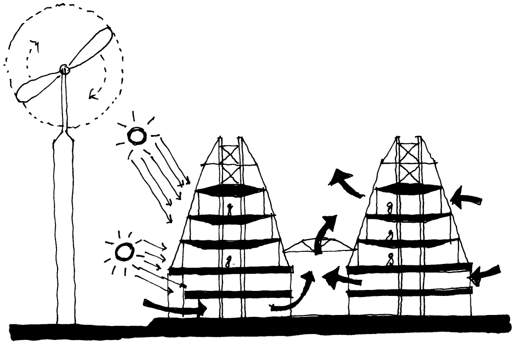

Figure 4.58 *'Sustainable' orthodoxy.*

mental impact in their manufacture and transport to the site.

In the pursuit of sustainable architecture, this suggests a further 'sub-set' of design principles to add to those discussed elsewhere: harnessing climate and natural energy sources; selecting re-cyclable materials of low embodied energy; and energy conservation. Arguably, these principles are long established in architectural history, and have only recently been rediscovered to represent the architectural aspirations of the twenty-first century, but it is their interaction which promises a new 'holistic' architecture with genuine sustainable credentials and fresh opportunities for formal invention.

Climate and natural energy

Harnessing the climate to improve human comfort is nothing new; the Greeks and Romans well recognised the benefits of designing dwellings whose principal rooms faced south to improve thermal comfort. But in some climates, designers are met with the problem of cooling spaces to improve comfort, and here, similarly, we can look to tradition. High-density Middle Eastern courtyard housing used shade and a water fountain to cool air within the courtyard, which was then exhausted via wind towers to assist cooling of the habitable rooms (**Figure 4.59**). Window openings were kept to a minimum to restrict solar gain. By contrast, the traditional Malay house moderated a tropical climate by using a framed structure of low thermal mass with overhanging eaves to a pitched roof, which offered shading from the sun but also protection from monsoon rains. Wall openings at roof level provided cross ventilation to assist cooling (**Figure 4.60**).

But how have contemporary designers used climate as a source of renewable energy to

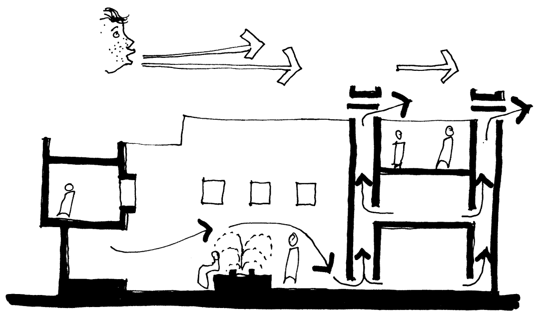

Figure 4.59 *Middle East courtyard house.*

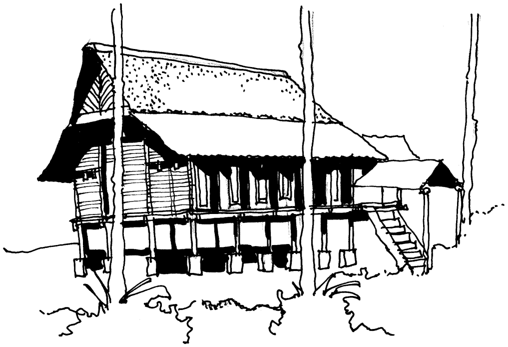

Figure 4.60 *Malay house-on-stilts.*

heat, light, and cool buildings and to improve comfort? Most techniques involve solar energy used actively and passively, or wind power.

Passive solar energy

Because passive systems of recovering solar energy are readily accessible, and after twenty years' development have reached a sophisticated level, they are the most prevalent. At a fundamental level, passive solar design depends upon: (a) principal façades facing south-east to south-west; (b) the site's orientation and gradient; (c) avoiding overshadowing on site from existing obstructions; and (d) avoiding overshadowing from obstructions beyond the site boundary. Passive systems embrace simple direct gain (of solar energy), indirect gain, or a combination of both.

Direct gain, as its name implies, depends upon a majority of the building's fenestration facing south-east—south west (for the northern hemisphere) so that solar radiation enters the building directly. Ideally, such fenestration should relate to principal spaces, relegating purely service areas to north-facing façades. The high thermal mass of floor slabs in direct contact with solar radiation can be used as a thermal 'store' to moderate internal temperature fluctuations; in domestic situations, the warmed floor slab will release its stored heat during the evening when occupancy is likely to be at its highest. At night, the detailed design of fenestration (preferably triple-glazed with low-emissivity glass) can assist this heat retention by including internal insulated blinds; daytime overheating in summer can be reduced by incorporating external shading devices (blinds or louvres), or simply by extending the canopy of roof eaves. Analysis of existing direct gain systems in domestic applications suggests that the dwelling depth should be limited to 12 m and that solar glazing should be no more than 35 per cent of the room's floor area. For optimal solar collection in the UK, roof pitch should be at 30° to 40° with solar façades at 60° to 70° from the horizontal (**Figure 4.61**).

Indirect gain depends upon an 'interface' of high thermal mass located between the sun and habitable spaces, so that solar energy is transferred indirectly to the interior. The Trombe wall is the most common 'indirect gain' device and employs a 300 mm thermal storage wall located between an outer skin of glazing and habitable space. Its area should