DEVELOPMENT TRUSTS ASSOCIATION
transforming communities for good

The Environment Trust

The Green Asset Guide

Help with improving the environmental performance of built assets

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Contents

Acknowledgements

We would like to thank the following individuals and organisations for their invaluable support with this publication:

Hugh Rolo *Development Trusts Association*

Virginie Marin and Kate Swade *The Environment Trust*

Charles Couzens *Ecos Trust*

FUNDED

This guide is intended for community organisations that are planning to improve or develop land or buildings as assets for their organisation or community. It offers a summary explanation of approaches you can take to reduce the environmental impact of these activities by looking at them through the following themes:

- Climate change and building adaptability
- Waste and waste treatment
- Energy and energy generation
- Management for improved environmental sustainability.

Introduction

The relevance of the guide to any asset development project will depend on the project's circumstances. These include its location, whether it plans to refurbish a building or build a new one, how the building will be used, and the existing or planned individual funding and ownership arrangements.

Once read, this guidance should help organisations to:

- **Understand the particular opportunities that will be available to their project to reduce its environmental impact**
- **Make informed choices about the planning, design and management of their project and its environmental impact**
- **Be better informed when dealing with professional advisors to their project.**

Organisations may want to do this for a variety of reasons including the following:

Principle
Principle because they subscribe to the Precautionary Principle set out in the 1992 Rio Declaration on Environment and Development which states that: *Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost effective measures to prevent environmental degradation.*

This is now widely accepted as applying in broad terms where there is threat of harm to human, animal or plant health, as well as in situations where there is the threat of environmental damage.

Practicalities
Practicalities because they have to meet the growing regulatory framework aimed at lowering the environmental impact of buildings; because they cannot secure available grants and investment if they do not meet the framework or their own circumstances dictate they need to keep the capital and revenue costs of their project down as far as possible if it is to be viable and sustainable in the future.

It is worth noting that if you invest in energy saving technologies such as photovoltaic arrays you are effectively reducing future running costs through this initial capital investment. This makes a great deal of sense for community-based organisations, which will find capital grants far easier to come by than revenue grants. An assessment of the financial benefits of this approach can be quantified by 'whole life costing' of projects, whereby the capital costs of technologies are assessed against the savings in running costs over the building life (see *Useful information p37*).

Whatever your reasons for trying to reduce the environmental impact of your building project, it is not a simple task. Many community-based organisations may never have been involved in the design, development and management of land and buildings. They will know about the political pressure to 'save the planet', but may have little experience of the debates on the environmental impacts of these processes and the project planning and technical changes that are developing to address them.

This short guide aims to help fill in this gap in experience.

Climate change and building adaptability

Buildings exist to provide occupants with a comfortable environment: not too hot, not too cold and protected from the elements. When weather conditions change, modern buildings adapt, for example through energy intensive air conditioning or central heating systems, to keep people comfortable. When energy was cheap and apparently plentiful, this seemed unproblematic, but as energy costs have risen and the relationship between energy use and global warming has become more evident, less energy intensive methods are needed to maintain the adaptability required for occupant comfort.

Building adaptability will become even more important if, as projected, weather conditions become more extreme. If, for example, we have much hotter summers in the future, buildings incapable of the added adaptability required to keep occupants cool may become uninhabitable. Buildings likely to be particularly vulnerable are those that depend on diminishing fossil fuel energy sources for their adaptability.

Decreasing a building's dependency on traditional fossil fuel based energy sources, while maintaining or increasing its adaptability to changing climactic conditions therefore becomes the key to sustainable building.

Before you start, you should consider the effects climate change is likely to have on the area in which you're building. The UK Climate Impacts Programme (UKCIP) and the Intergovernmental Panel on Climate Change (IPCC) set out the most authoritative predictions. You can obtain data for your region from the UK Climate Impacts Programme (see *Useful information p37*).

UKCIP and the IPCC predict that there will be higher levels of winter rainfall and warmer, drier summers over the whole of the UK. More specifically they project that the south east will have hotter and drier summers, while the north and north west will have wetter winters. It is also predicted that sea levels will rise by between 10cm and 90cm over the next ninety years, with the south and south east of the UK most affected.

While you may dispute the accuracy of the IPCC and UKCIP findings, they remain the most definitive climate change projections we have. It is therefore recommended that you use them as assumptions when considering which design strategy to adopt. If the IPCC/UKCIP projections turn out to be correct, but you have commissioned a building that discounts them, you may increase the vulnerability of your building to the effects of climate change.

Make the most of the sun but don't overdo it

Passive solar heating

During the winter months, when the sun position is low in the UK sky, passive solar heating uses the heat from the sun to minimise the need for conventional fuel heating. It does this by optimising the amount of solar radiation that enters the building and stores it in the building fabric for release back into the building when it is needed.

To perform effectively, the southern face of the building needs to be heavily glazed and the sun's rays must be able to penetrate into the building and on to materials of a high thermal mass.

Building materials with a high thermal mass optimise the amount of energy entering the material (the 'heat capacity') with every degree of temperature change in the air around. In other words, they absorb heat or cold (sometimes referred to as 'coolth'). Typical high thermal mass materials include stone and dense concrete blocks. These store the radiant heat from the sun during the day and release it back into the building when the air temperature drops at night. The overall effect is to level out the variation in internal temperature and reduce the need for heating and cooling.

An alternative approach allows the winter sun to enter a dedicated sun space that is separated, or 'buffered', from the main habitable area of the building by internal doors. The heat stored in the sun space can then be let into the main part of the building when the air temperature starts to drop.

At Great Bow Yard the sun enters a sun space that is separated from the main habitable area of the building. Note the solar thermal panels at high level and the fixed external shading to prevent summer overheating.

The ability of passive solar architecture to reduce winter heating demands will always depend on the availability of sunshine. Clearly, when the sky is overcast the strategy is undermined. It will therefore always be necessary to have some form of back-up heating system in place.

The strategy will also perform less well in urban locations, where other buildings are likely to interrupt the sightline between the low winter sun and the southern elevation.

Summer overheating

It is probable that cooling appliances such as air conditioning will become one of the most significant energy demands for existing commercial buildings in the future. Particular attention should be given to this area when planning a new building.

This growing emphasis on cooling is due to the growing number of 'heat gains' that affect commercial buildings. These include:

- solar heat gains through the building fabric (walls, windows and roofs) during the warmer months
- the possibility of increased thermal heat gains through the building fabric as a result of global warming
- the increased use in the workplace of heat generating appliances such as computers and lighting
- the heat generated by people as they work.

A typical UK office building constructed from lightweight materials such as cladding and glass on a steel frame would already overheat in the summer (because lightweight materials allow heat to transfer through into the building) were it not for energy intensive air conditioning systems.

Traditionally there have been four main design strategies that help prevent buildings from overheating in summer: orientation, shading, thermal mass and natural ventilation. More recently the importance of reducing heat gains from appliances such as computers has emerged as a fifth strategy. Best results will be achieved through a combination of all these strategies. In summary:

- **Orientation**

In northern hemisphere countries such as the UK, the south-facing side (elevation) of a building is the most exposed to the radiant energy of the sun throughout the year. As noted above, the sun can help warm buildings in the winter, but it can also lead to overheating in the summer.

As a rule of thumb commercial buildings with heavily glazed southern elevations are likely to overheat in the summer because of the combined heat gains noted above, but particularly because of the solar gain through the windows. A study for the Building Research Establishment (BRE) by AG Louden in 1968 (see *Useful information p37* concluded that if the ratio of window area to floor area on the southern elevation of an office building was greater than 20%, summer overheating would be likely; this still holds true today.

As the client, you should be aware of your building's existing or proposed orientation. If there is a high proportion of south-facing windows proposed on a new and regularly used commercial building, questions should be asked about the likely summer cooling loads. If the windows already exist, thought should be given to how the areas adjacent to those windows could be used. For example, intermittent uses such as meeting rooms or circulation spaces (which have fewer heat generating appliances) would be more appropriate than heavily used office space with computers, photocopiers and heat gains from occupants.

- **Shading**

Given that the sun position is high during the summer months when overheating is most likely, the key design strategy is to shade windows (particularly south-facing windows in commercial buildings) from the high summer sun. This can be done by designing roofs that overhan the windows or by using fixed or adjustable horizontal louvers (much like a venetian blind, as shown in Figure 1). Both approaches limit the amount of solar radiation passing through windows into the building in summer, but have the benefit of admitting solar radiation in winter when the sun position is low, to assist in passive solar heating strategies.

Figure 1
Great Bow Yard by Ecos Homes
(formally South West Eco-Homes) showing the fully glazed southern elevation

- **Thermal mass and night-time cooling**

The use of thermally massive materials to keep the interior of buildings cool is regularly used in warmer climates and is increasingly used in the UK as a low energy approach to cooling. A good example in the UK is the BRE's own Environmental Building in Garston near Watford (see Figure 2).

At Garston, the ceilings are made from exposed pre-cast concrete. During the day, when the heating loads from people and appliances in the offices are at their highest, the ceiling absorbs the excess heat, so tempering the internal air temperature. At night, mechanical ventilation at ceiling height is opened to force cool air over the ceiling, thus removing the stored heat. The next day the process restarts, with the cooled exposed concrete ready to absorb excess heat.

Effective absorption of excess heat by thermally massive materials will only happen efficiently if the thermally massive material is directly exposed to the air. If the material is covered with insulation or ceiling tiles, these will function to insulate the thermal mass from the air.

Figure 2 shows the interior of an office space at the BRE Environmental Building at Garston. Note how the wave of the ceiling increases the surface area and thus the amount of material exposed.

Note also the high level windows to help direct cool night over the exposed concrete ceiling.

Figure 2
BRE Environmental Building
Photograph taken from the BRE website listed under *Useful information* p37.

Natural ventilation

Although ventilation will only cool a building down to the outside air temperature, ventilation passing through a room can improve the occupant's perception of the thermal environment and may reduce the reliance on more energy intensive cooling systems. There are three ways that a room can be naturally ventilated:

- single sided ventilation (windows on one side of the room)
- cross ventilation (windows on both sides of the room)
- stack ventilation (as warm air rises it can be directed out at high level)

Reducing other heat gains

The reduction of internal heat gains in commercial buildings will be another key strategy in reducing the need for energy intensive cooling. Methods might include replacing filament light bulbs with cooler and more energy efficient fluorescent bulbs, turning off appliances when they are not in use, and ensuring management strategies are in place to support these approaches.

Watch out for water

Increased winter rainfall

If the IPCC projections prove to be correct, the UK will be subjected to increased winter rainfall. There is also concern that the UK will suffer from more intensive summer rainfall. Recent events (2007) in northern and central England have revealed the vulnerability of buildings to this.

There are two potential consequences of increased rainfall for the built environment:

- **Damage to buildings through water penetration**
  This can harm brickwork and structural elements such as supporting timbers and steels. Damp can also undermine the performance of insulation.
- **Increased flash flooding**
  As more hard surfaces are constructed, so rainwater will pass more quickly from them to the mains sewers. This increases the volume of water in the sewers when it rains and increases the chance of overflow and flooding.

Protection from rain

In the UK the south western elevation of any building is the most exposed to driving rain because the prevailing winds come from that direction. Obviously all elevations need to be well built and maintained, but particular attention should be given to the south westerly elevation.

Once constructed, the best way to achieve this is by regular building inspections. All pointing and brickwork should be checked for soundness. If you have a cladding system, junctions and seals should be examined at regular intervals. Internally, signs of damp should be noted or reported to the responsible person.

As added protection, consideration could also be given to the inclusion of planting in front of the exposed elevations to act as a natural barrier against driving rain. This may have other consequences, such as loss of natural light, which will need to be considered before a decision is made.

Further protection to walls can be given by designing roofs that extend beyond the line of the wall. Many flat roofs have no overhang, leaving walls exposed to rain. In contrast, overhanging roofs ensure that rainwater runs off roofs at a safe distance from the wall, so keeping it relatively dry.

The roof itself should also be looked at regularly, with broken tiles and damaged gullies repaired or replaced when necessary.

Guttering and downpipes should also be regularly checked and maintained to ensure they do not become blocked and overflow onto brickwork. Drains should be kept free from leaves to ensure that water runs away from buildings quickly.

In summary, protection from rain is best achieved through sound construction and good maintenance.

Slowing the passage of water

We can't stop the rain, but we can slow the speed at which rainfall passes from buildings into drainage systems. By doing this we can reduce the volume of water that passes into the sewers at peak times, so relieving pressure on them; this in turn reduces the chance of flash flooding.

Slowing the passage of water also increases the time available for water to evaporate; this in turn reduces the volume of water, with the consequent benefits noted above.

Slowing the passage of water

Examples of these strategies include:

- Channelling rainwater from the roof to retaining rainwater butts.
- Storing rainwater in tanks that feed appliances such as WC cisterns. Figure 3 shows the rainwater storage tanks at Great Bow Yard – the stored water feeds washing machines.

Single sided ventilation

The BRE has published a number of Good Practice Guides (GPGs) on specific building approaches (see *Useful information* p37). The GPG for Natural Ventilation in Non-Domestic Buildings suggests that single sided ventilation is only effective if the floor plan of the room requiring ventilation is less than ten metres deep (from windows to back wall). Beyond this thermal comfort may not be improved.

Cross ventilation

is more effective, but can lead to increased internal wind speeds. The BRE estimates that cross ventilation enables a room depth of up to five times the ceiling height to be adequately ventilated. Assuming a typical ceiling height of three metres, a fifteen metre depth floor plan can therefore be naturally ventilated. The important point to note is that the greater the depth of a room, the less effective natural ventilation will be. So by designing room depths to be relatively shallow we can potentially reduce heating requirements.

Stack ventilation

works by drawing cool air into the room at low level, which in turn forces warm air in the room to rise and exit at high level. For this to work both low and high level vent openings are required.
Stack ventilation will be more effective in buildings where higher ceiling heights are possible. Examples could include theatres, buildings with the potential for internal atria (such as shopping centres or sports halls) and lecture halls. Good examples include the Queen's Building at De Montfort University in Leicester and the Bedales School Theatre.
Choosing stack ventilation to cool a building will require specialist help from a qualified mechanical and electrical engineer. The work will involve calculating wind pressures, the sizes and heights of stack vent openings given their ratio to internal floor areas, and the ventilation rates required, given the building use and the heat gains present. It should also be noted that local building regulations will normally require certain rooms, such as toilets and kitchens, to have mechanical ventilation.

- Green roofs, which are also helpful in slowing the speed at which water drains from the roof to the drainage system below. Green roofs refer to the planting of grasses, sedums or other short-rooted species on a soiltopped, protective roof covering with incorporated drainage channels. Here rainwater slowly percolates through the top growing medium layer of the roof system, before being filtered through a second layer.
  The filtered rainwater then makes its way to standard downpipes and descends to the drainage system below. There are four main benefits:
  - the passage of rainwater is slowed, so relieving pressure on the drainage system
  - the retention of rainwater in the growing medium allows for a degree of evaporation, so reducing the total volume of water
  - the green roof improves the biodiversity of the immediate environment
  - green roofs can provide additional insulation to buildings.

Sustainable urban drainage systems (SUDS)

Water retention and evaporation can also be incorporated into the landscape design. This strategy is known as sustainable urban drainage systems, or SUDS. It's a simple approach that guides rainwater to areas where it can slowly filter back into the ground, while optimising the rate of evaporation in the process. An example would see rainwater from the roof directed over open rills or gravel paths at ground level to planting areas where it passes through the soil back to the aquifers below. Excess water volumes can be collected in retention ponds that double up as landscape features. The overriding design principle is to increase the permeability of external surfaces to allow the slow percolation of water back into the ground.

The Environment Trust and Thom White from the Heeley Development Trust have designed a SUD system for the Environment Trust's Green Homes development in Sheffield.

Flooding

Along with the risk of flash flooding as a result of sudden and increased volumes of rainfall, there is also the possibility of flooding as a result of sea level rises, with coastal regions most vulnerable. Natural flood plains and buildings located near to tidal rivers will also be at risk.

Improving the adaptability of buildings to flooding will help reduce their vulnerability to it. The main design decisions relate to the ground floors and basements of buildings located in areas susceptible to flooding.

The Environment Agency (see *Useful information p37*) recommends extending concrete footings to new buildings and adding a waterproof membrane to the foundations. It also highlights the benefits of a raised damp proof course.

Consideration should be given to less vulnerable uses on lower level floors. Parking, if required, could be located at ground floor level, with the added benefit that it frees up hard landscaped land outside for more permeable coverings that will help slow run-off. If office space is to be located on the ground floor, consider tiled flooring rather than carpeting and use water resistant paints. Solid wood desks and kitchens will also fare better than those made from laminate or composite materials such as MDF.

Wherever possible, ground and basement floors in flood-prone areas should be constructed from water resistant materials such as dense block work, concrete or brickwork. Partition walls should also be constructed from block work, and solid insulation materials such as extruded polystyrene should be used in closed cell cavities.

Electrical wiring, sockets and switches should be located high enough to prevent damage from rising water levels. The Environment Agency recommends that all meters, panels and sockets are located at least 900mm above ground level.

Attention should also be given to drains, sewers and air bricks. The latter should be supplied with removable covers for installing during floods, while drains and sewers should be installed with anti-backflow valves to stop contaminated floodwater backing up into the property.

To establish if your building is in a flood-prone area go to the Environment Agency website, where a postcode search is available.

Drought

If summer droughts do occur with greater frequency, as the IPCC predicts, rainwater harvesting and water economy will become increasingly important.

Common strategies for reducing the amount of water consumed within buildings include:

- reducing the volumes of WC cisterns
- installing waterless urinals
- incorporating spray taps that aerate water to create the impression of water volume
- installing taps that turn off automatically
- where shower facilities are provided, using gravity rather than pumped water pressure.

Rainwater harvesting and greywater recycling offer two other approaches to water conservation. The former collects rainwater in butts or tanks to be used for watering landscaped areas or, once filtered, for feeding appliances internally such as washing machines or toilet cisterns (see Figure 3). Greywater recycling refers to systems that collect used water from washbasins and baths and reuse it for filling toilet cisterns and other uses where high quality water is not required, such as watering gardens.

Reduce heat loss

The European Commission estimates that buildings account for 50% of European energy consumption, with space heating accounting for around 60% of this total.

There are essentially two ways to reduce this consumption:

- reducing the heat loss from the building
- using more energy efficient space heating systems (see the following section).

Heat can be lost through the building's fabric (fabric heat losses) or through ventilation (ventilation heat loss).

The most effective method of preventing fabric heat losses is to increase the insulation in the building. Insulation helps slow down the speed at which warm air leaves the building interior by decreasing the 'thermal transmittance' of the overall building fabric. Thermal transmittance is measured in u-values: the lower the u-value, the slower the thermal transmittance and the longer warm air will remain in the building.

The performance of insulation can be undermined by breaks in building construction where lower u-value materials are breached by materials with a higher thermal transmittance – this is known as 'thermal bridging'. A common example is where double glazed low u- value windows are specified, but the frame is manufactured from a higher transmittance material such as aluminium. Here the warm air transfers out from the building via the metal frame despite the performance of the glazing. As a client, the key is to ensure that the architect is aware of the importance of construction detailing to prevent this.

The rate of heat loss will always be dependent on the building's air-tightness. A building with low u-value wall and roof construction but badly fitting windows or badly detailed junctions between, for example, walls and window casing, will not perform as well, simply because heat will be lost through excessive ventilation. The UK is full of old buildings that suffer from air-leakage and it is a key issue to be addressed when seeking to improve their energy efficiency. A client can achieve this by insisting on robust detailing in design and air-tightness testing at the end of the project. If the project is the refurbishment of an existing building, window replacement may well be the area to focus on.

Figure 3
Rainwater harvesting

Controlled ventilation and heat recovery

Buildings generate heat from a range of sources other than traditional heating systems, for example from the people who occupy them, solar gain and the operation of appliances within the building such as cookers, lights and hot water. If buildings are constructed so that they are airtight it becomes possible to control the ventilation routes and recover the heat from the internal air as it passes out of the building.

A basic form of heat recovery system would see a fan pull old air out of the building over a metal plate. The high thermal conductivity of the metal means that the heat in the extracted air is transferred to the metal as it leaves the building: as fresh air is drawn into the building it passes over the metal plate and a proportion of the heat is transferred back to the air, so retaining internal warmth.

Use energy efficient heating systems

If an old building is being renovated, ventilation systems with heat recovery systems are unlikely to perform well because the ventilation routes cannot be controlled. In such instances it would be more appropriate to focus on improving insulation and employing more efficient heating systems, such as efficient gas boilers, biomass boilers, passive solar heating or even small to medium-sized combined heat and power.

Gas boilers

The efficiency of gas boilers is determined by how well the boiler transfers heat from the combustion of gas into the heating system. It is not possible to reach 100% efficiency because heat is lost through pipework, casing and the flues that remove harmful combustion gases. Helpfully, there is now a UK standard for boiler efficiency known as SEDBUK (see *Useful information,* p 37), which rates boilers from A to G (A being the most efficient).

If your existing boiler is still working well, it may not be cost effective to replace it even if the new boiler would be more efficient. A small but new energy efficient boiler could cost up to £2000 installed. If your boiler has come to the end of its life or if you are developing a new building, it will always make sense to install an energy efficient boiler.

Woodburners and biomass boilers

If you have access to a renewable source of wood, woodburners can provide an efficient and independent form of heating for many buildings, provided they are not located within a smokeless zone as defined by the Clean Air Act (1956). They do, however, require space for safe fuel storage.

If a building is located in a smokeless zone such as a city, higher efficiency fanned flue woodburning boilers fuelled by either woodchip or wood pellets can be used. These burn dried wood or pellets, produce lower particulate emissions and do not require full draught chimneys. Grants of up to 50% of the capital and installation costs are available for pellet burners under the Low Carbon Buildings Programme (see *Useful information p*37).

In more detail, woodchip boilers use waste cuttings from trees and other timber processes to fuel boilers. They are therefore a potentially useful form of heating supply if you are planning activities that will generate this type of waste by-product. Historically, the use of woodchip boilers has been restricted to large-scale applications; however it is now possible to purchase relatively small 25 kilowatt (kW) boilers that would suit smaller commercial projects. The combustion efficiency of any boiler will depend on the level of moisture content in the woodchip: the lower the water content the more efficient the combustion. Typically woodchip is supplied at 25% moisture content. If you are planning your own woodchip production you will need to factor in the cost of drying the fuel.

When considering the design of a building with a woodchip boiler it will also be important to include a dry storage facility close to the boiler.

Wood pellets are made of compressed sawdust, wood shavings and reclaimed timber. They have a higher combustion efficiency than woodchip due to their lower moisture content (typically 5-10%). Pellets are usually gravity fed into the boiler at a rate determined by the desired output of the boiler. Wood pellets have been difficult to source in the UK, but are now available from Welsh Biofuels in one to ten tonne deliveries (see *Useful information p37*).

Along with the Low Carbon Building Programme grants, Enhanced Capital Allowances are also available for wood pellet boilers. The Community Energy Programme (see *Useful information p*37) has also provided up to 40% of the funding required for public buildings to switch to wood energy. The programme closed in March 2007, but may re-open soon.

As a guide, a 75kW woodchip boiler suitable for a small commercial development would cost around £10,000 exclusive of VAT and installation charges.

Combined heat and power (CHP)

Unlike electricity generated at power stations, where only 30% to 40% of fuel (often coal) is converted into power, with the remaining 60% being lost as waste heat, CHP's efficiency is achieved by recovering the heat produced during the electricity generation phase of the process. The overall effect can improve efficiency from 40% to 90%.

The UK government is promoting CHP as an energy efficient way of producing both electricity and heat, and has set a target of 10,000 megawatt of CHP power by 2010. Therefore, subject to the size of the system, grants are available. CHP plant also benefits from Enhanced Capital Allowances (100% in the first year).

CHP efficiency is optimised if the CHP plant operates for between 4000 and 5000 hours/year (about 12 hours/day). To achieve this year-round function it must be designed to meet only the base heat demand, the 'base load'. If it operates above the base load, excess heat would be generated and this would need to be discarded, therefore reducing efficiency. Given the low heating requirement in summer, the base load is often determined by the level of hot water demand during the summer months. Therefore greatest efficiencies can be achieved where there is a mix of uses on site that require heat loads at varying times: universities, hospitals or mixed residential and commercial developments are good examples. Where there is little or no summer demand, CHP may not prove to be efficient.

It is also important to note that, because CHP is designed to meet a summer base load, there will always be a heating shortfall in the winter months that will need to be met by other heat sources.

If you are interested in pursuing CHP for a smaller commercial development, it is suggested that you consider a closed cycle (generically known as a 'Stirling Engine') micro-CHP system that will have outputs of up to 8kW. These are about the size of a microwave and use mains gas to generate heat and power.

Reduce electrical energy consumption

As well as lowering running costs, reducing electricity consumption will reduce greenhouse gas emissions.

In commercial buildings the main areas to focus on are lighting and appliances.

Lighting

The simple way to reduce the need for lighting is to optimise the amount of natural light entering the room. Where rooms cannot be located near windows and roof lights are not an option, you may want to consider the use of sun pipes.

Sun pipes use a highly reflective aluminium tube to pass sunlight into the building from a protective opening on the roof. The level of light admitted will be lower than that from a traditional roof light; however, they can serve a useful function in small internal spaces such as toilets and corridors.

Where you do use artificial lighting, it is important to install low energy compact fluorescent light fittings. Compact fluorescent bulbs significantly reduce the energy consumed when compared with traditional filament bulbs and last far longer. Light emitting diode (LED) bulbs are another alternative; these last even longer than compact fluorescents and use less energy. However, they are small so may work best if you are thinking of illuminating signage.

To reduce electrical consumption from lighting further, lighting control is crucial. As a general rule lighting should only be on when it is needed and then only to the level required. When buildings are empty, lighting should be off; when natural daylight is insufficient, lighting should only be on to the extent that it brings the daylight factor up to that required for the task. There are several available technologies:

- daylight sensors
- occupancy detection
- switch timers

There are a number of Good Practice Guides for lighting, notably GPG 245, 160 and 272 (see *Useful information* p37).

Appliances

If you are purchasing electrical appliances for your development, you should make sure that they are A or AA rated. The rating refers to the European Union's Energy Label system, which rates appliances from AA to G (with AA being most efficient). The Energy Saving Trust (see *Useful information p*37) also has a labelling system. In offices, computers and photocopiers are highly energy intensive. Flat screen monitors are more energy efficient; further improvements can be achieved by turning screens or computers off or to 'sleep' when they are not in use.

There is also a growing number of web-based storage companies that allow individuals or businesses to store and share information securely, so limiting the need for storage space in the workplace (see *Useful information p37*). While all companies involved in this champion their security credentials, consideration should also be given to the risks involved – data can be lost, companies can go out of business and servers may crash.

Daylight sensors
These use photocells to calculate the amount of light in the room. If the light level is above that specified as sufficient, the sensor will turn the lights off.

Occupancy detection
This uses passive infra-red (PIR) detectors to sense occupation through body heat. If heat is detected the lights will be switched on; when the person leaves the space the light is turned off. These are very useful for external spaces and for intermittently used internal spaces such as bathrooms, storerooms and kitchens.

Switch timers
These are simple devices that turn lights off at a particular time. A basic model could see the lighting system for a whole building wired to a single circuit controlled by a timer switch. This could ensure, for example, that in an office building the switch could shut off at, say, 10pm, to act as 'lights out'.

Building management systems (BMS)

BMS use computerised control systems to ensure that buildings function optimally. This is done by setting a range of agreed limits, such as maximum and minimum air temperatures, humidity levels, air quality indices and lighting requirements, and then installing sensors around the building that monitor the particular quality. If the sensor passes information back to the computer that suggests room temperature is too high, the computer will pass a signal to the ventilation system to open vents into the warm area.
Even greater control can be achieved by zoning buildings into separate areas. This allows for a variety of limits to be set according to the specific function of the zone, for example a sports hall might have a different temperature limit to the reception area.

BMS are always open to human interface to ensure adaptability and control. They also enable the BMS supervisor to generate data relating to specific zones. This can help building managers to assess whether specific areas of buildings are functioning less optimally than others. It therefore functions as a monitoring, as well as a control, system.

Monitoring building performance will be a key component of accurate environmental assessment.

A BMS can be expensive to install and requires the building manager to understand the system properly. Training, staff and maintenance costs must also be factored into any whole life costing of the BMS.

Waste and waste treatment

The Environment Agency (EA) estimates that the construction industry uses 420 million tonnes of materials every year, with 13 million of these delivered to site but never used. The EA also claims that 90 million tonnes of construction and demolition waste is generated by the industry every year. These figures suggest that there are serious inefficiencies in the construction sector that have both financial and environmental implications. So how do we reduce waste in construction?

Rethinking waste

Sir John Egan's 1998 report for the Construction Task Force, *Rethinking construction*, is a good place to start (see *Useful information* p37).

The main point Egan made was that architects and builders tend not to deliver buildings efficiently because they often work in isolation, rather than collaboratively. Because of this, architects design, builders build and clients pay, and as a result, buildings are designed that are difficult to build and often the client's initial needs are not met. This invariably leads to wasted time, money and materials.

Egan therefore proposed a partnering approach to construction, where builders are brought into the design process earlier to help architects and clients design with construction in mind, so eliminating waste and developing trust between what have traditionally been seen as competing interests. A simple outcome of this process might see a building designed to be constructed from multiples of standard lengths of timber and plasterboard, so reducing off-cuts.

Egan also stressed the importance of efficiencies on site:

- Materials should only be delivered when they're needed and not left on site to deteriorate
- Recycling facilities should be made available
- Consideration should be given to coordinated deliveries, so reducing transportation costs.

These efficiency principles, which try to view construction as an integrated system from design to delivery, are often referred to as 'total quality management' (TQM) or 'lean construction'. Quality management has become codified under the International Standard ISO 9000. As a client you can play an important role in reducing waste by encouraging collaboration, adherence to lean construction standards such as ISO 9000 and monitoring how the site is being run.

SMARTWaste
The Building Research Establishment (BRE) has also introduced a simple SMARTWaste toolkit designed specifically for the construction industry (see Useful information p37). This will enable you to judge your project against national benchmarks and key performance indicators for waste in construction. It will also allow you to develop a waste plan for the construction phase that will help you consider how waste can be reduced, reused and recycled.

Hidden waste

However, it's not just the physical volume of the waste that's an issue, it is also the energy embodied in the wasted material.

The embodied energy refers to the amount of energy used in the extraction, processing and transportation of the material to site. The EA estimates that 10% of the UK energy output is embodied in building materials. Some materials have more embodied energy in them than others. The basic rule is that less-processed building materials such as timber have less embodied energy in them than more-processed materials such as plastic or concrete.

Of course, the strategy with the least environmental impact will always be to reuse what you have. It's therefore always worth asking the following questions:

- do we really need to demolish and replace this building?
- if we do, is the proposal capable of adaptation to meet future needs?
- what are our possible future needs?
- can we reuse or recycle any of the building materials from the old building in the new building?
- if we are going to bring in new building materials, how can we ensure they have a low environmental impact?

To help answer this last question, the BRE has published the *Green guide to specification* (see Useful information p37), which rates building materials from A to C (A having the least environmental impact). The guide assesses materials over a 60-year life cycle and evaluates them against a range of factors, including the toxicity of the material, the effect of production on water resources, the pollution generated by transport of the material, and the impact of the material on climate change and air quality. This methodology is known as 'life cycle analysis'.

The BRE's *Green guide to specification* breaks the construction process down into categories such as roofing materials, external wall construction and insulation materials. It tends to recommend the use of less-processed materials, such as:

- slate roofing tiles rather than composite concrete tiles
- timber rather than UPVC windows
- timber frame rather than concrete and steel frame construction.

Despite the guide's recommendations, it's always worth bearing in mind that over a building's lifetime, the energy used in heating, lighting and cooling is likely to exceed the energy embodied in the construction materials. It is therefore important to note that using A-rated materials will not result in an environmentally friendly building if the construction design fails to pay attention to the other principles of sustainable construction, for example the role of thermal mass or airtight construction.

Consideration of future waste can also be incorporated into the design by ensuring that buildings are adaptable to future needs. As a simple example, internal partitions should be designed for easy dismantling and reassembly so that new occupier demands can be met.

Thought should also be given to the ease with which electrical trunking systems can be redirected to meet new spatial requirements. Light fixtures should also be moveable to meet the same ends. The failure to provide adaptability in building services installations will always result in large future costs. It is also worth noting that the materials used to manufacture such elements (such as plastics and metals) often contain high levels of embodied energy.

Don’t throw it away

It’s inevitable that waste will be created by occupants at some point in a building’s life, so make sure you consider how this will be dealt with when it happens.

The guiding principle should always be reduce, reuse or, as a last resort, recycle waste. To achieve this, good management and a supportive organisational culture will be crucial.

In addition, at the design stage you can ensure that there is adequate space for both recycling and waste facilities on site. You could also ensure that access to these facilities is easy for everyone.

If your organisation is producing organic waste, perhaps because there is a café or catering facility on site, it will also help reduce waste if you incorporate composting facilities on site. Even if you do not have a garden where you can use the waste, many local authorities will collect such organic waste for composting off site.

If you produce cooked food waste and want to compost it, it will not compost on its own and will need to be treated through anaerobic digestion. Anaerobic digestion harnesses the natural degradation processes within a confined man-made space such as a tank and uses the by-product (either biogas or a digestate (a material that can be used as compost)) either to produce power (see Energy and energy generation) or improve soil quality.

A wormery is a simple anaerobic digestion process, but the worms will not be able to digest certain foods such as citrus, onions, cooked meats and bones.

Energy and energy generation

Carbon neutral?

There has been a lot of press coverage recently about the ‘carbon neutral’ building, but what does it mean?

The simple answer is that, to be carbon neutral, a building must produce as much energy as it consumes. Problems start when one begins to take into consideration the energy embodied in the building materials as well as the energy used in running the building. Further complications emerge if one takes into account the source of the energy used in either running the building or manufacturing materials – as we have seen, coal fired power stations are only 40% efficient whereas combined heat and power (CHP) power stations may be closer to 90%.

If all factors are considered, assessing carbon neutrality accurately becomes very difficult; but working towards it as a goal will always lead to a building with a lower environmental impact.

Going neutral?

The first thing to do is to find ways to reduce the energy used. As we have seen, this could involve:

- using less-processed materials in construction
- increasing the levels of insulation to reduce heat loss
- passive solar heating
- specifying energy efficient appliances
- just turning off lights and heating when they are not needed

The next stage is to start generating power on site from sources that do not depend on the burning of fossil fuels. The most common sources are the wind and the sun, but there are also geothermal sources that help power ground source heat pumps and earth tube cooling systems.

Wind power

The amount of power a wind turbine will generate depends on its size and the average wind speed in the vicinity. In urban locations, where turbine

Useful information p37 includes links to websites where you can find average UK wind speeds.

sizes are limited by planning constraints and where wind speeds are slowed by the proximity of other buildings, wind turbines will not perform as well as those located in rural areas.

It's also worth noting that when there's no wind, there's no power; so an alternative power source will almost always be required.
Before specifying a wind turbine for your building, the first thing to consider is the average wind speed in the area you plan to place it. In the UK the average is around six metres/second, with a wind speed range of three to sixteen metres/second.

The next stage is to consider the rated power output of the turbine given your power requirements. Typically a small office will use about 4000 to 10,000 kW hours of electricity per year. Note that the rated power output of any turbine will always assume a rated wind speed that determines the rated power output. As a word of caution, these rated wind speeds tend to be well above the average wind speed for the area in question, so the actual output is likely to be lower.

A small to medium-sized commercial building is likely to need a mid-range, 10 to 25 kW, wind turbine.

Once the power requirement is established you will need to ask an independent mechanical and electrical engineer to assess the power output, given both the rated power output of the turbine and the average wind speeds for your area, by plotting a 'power versus wind speed curve'.
Despite the variability of wind power, it remains a clean source of renewable power that can help meet some of a building's energy requirements. It is also supported by government grants, details of which can be found in *Useful information p37*.

Biomass

Biomass is the material created through the collection or processing of plant or animal waste. As with any material it has a potential energy that can be released.

The direct way to release energy from biomass is by burning it to generate heat. If you were planning a project that involves maintaining parks or woodland, it would be worth considering how you could use chippings and waste wood to fire burners that could provide heating and hot water to buildings.

If your project is on a larger scale, you may be considering using biomass to fuel medium-sized CHP systems. Please note that this remains a relatively unproven technology and care should be taken. In particular, previous installations have suffered because the condensation from the moisture content of the biomass has caused working parts to corrode. The management and maintenance of such systems have also proved problematic.

If your project is going to generate quantities of animal and food waste, these will need to be processed before they can be used as a biomass fuel. One approach could use anaerobic digestion to break down the waste and transform it into another fuel such as methane. This transformation is achieved by mixing bacteria with the waste in a sealed unit. The methane gas by-product can then be compressed and potentially used as a fuel.

The economic viability of processing animal and plant waste into biofuel will depend on the scale of the operation because of the high start-up costs and necessary maintenance regimes. However, as traditional fuels costs rise and technology becomes cheaper this will change.

Geothermal energy or ground source heating

The molten core of the earth is thought to be between 3000 and 7000 degrees Celsius. Some of this core heat is transferred to the earth's surface. The earth also absorbs a high proportion of solar radiation that ensures that the surface remains a relatively stable temperature of around 10 degrees Celsius.

Useful information p37 includes a number of links to Good Practice Guides and organisations that can provide more detailed advice.

It is possible to tap into this geothermal and ground source heat store using a heat pump that transfers low temperature heat from the source and upgrades it to a more useful temperature to use in a building's heating distribution system.

Heat pumps work by passing a liquid refrigerant (such as a water and glycol mix) through piping buried under ground. The liquid takes on some of the heat and is then passed through a heat exchanger where the heat captured in the refrigerant is passed to a secondary heat pump circuit. Here the refrigerant is moved through a compressor, which causes the refrigerant vapour to condense, so releasing the heat it absorbed during the evaporation phase into the heating distribution system.

Because of the constant, but relatively low-level heat generated (when compared with a gas fired boiler), the technology is most efficient when it is used to feed a low temperature heating system such as underfloor heating. As well as reducing energy consumption and therefore greenhouse gas emissions, ground source heat pumps have a long life expectancy (around 25 years), have few moving parts so are relatively reliable, and require no combustible gases in the heating process.

Care should be taken when sizing a system as inefficiencies will emerge from incorrectly sized systems. As with CHP, designing to a base load is recommended. Specialist advice from a mechanical and electrical services engineer should be sought.

Piping can be buried either vertically or horizontally, so consideration should be given to how practical this may be. In an urban location, where other cabling and pipework are present, statutory consents may be required.

Solar thermal water heating
Solar water heating systems collect heat from the sun and transfer this to water as it is passed over the solar collector. Collectors should always be located on a south-facing roof.

Solar thermal water heating is a mature, low cost and well-understood system and should always be seriously considered.

The process takes place in a sealed unit. The unit's outer layer is made from sealed glass; this optimises the amount of solar radiation entering the unit and slows reflected heat loss back out – like a greenhouse. The solar radiation then hits a collector plate; the plate is coated in a high absorption layer such as metal oxide and insulated underneath to prevent heat loss. Water pipes then pass closely over the collector and the heat is transferred from the collector to the water.

There are other available types of collector, but the basic principles remain the same.

During the summer months an appropriately sized solar water heating system can provide most of a building's hot water. In the winter, solar water heating cannot be relied on and alternative water heating measures will need to be in place.

Photovoltaics
Photovoltaic (PV) arrays contain silicon crystals that transform the sun's energy directly into electricity. Electricity generated in excess of the building's requirements can be exported back to the grid provided an export meter is also installed, or it can be stored in batteries for future use.

PVs are becoming increasingly efficient for two reasons. Firstly, mass manufacturing techniques are reducing production costs and, secondly, the price of electricity continues to rise. Costs can also be reduced if PV panels are used instead of traditional construction components, thus they can be incorporated into glazing or used instead of roof tiles; by doing this the notional cost of the normal roof tile or glass can be deducted from the capital cost of the PV.

However, PVs remain an expensive option given their payback times and will normally require grant subsidy.

Micro-hydro power
If you're lucky enough to be planning a development near a fast flowing river (and have read the Watch out for water section), you may also want to consider a hydro-electric project. The principle of water turning turbines to generate power is well established, but the viability of any project will need to be carefully assessed. Essentially, the power output will always depend on the volume and pressure of the water passing over the turbine; the latter will always require a vertical fall of water to achieve optimum results.

Figure 4
The photovoltaic roof tile installation at the Bootstrap Company in Hackney, London. For further details see *Useful information* p37.

Payback times
Renewable energy generation technologies are often criticised for their long 'payback' time. This refers to the time it takes for the cost savings of producing your own power to offset the capital cost of installing the technology.

As an example, if your wind turbine costs £5000 to install and generates the equivalent of £200 of power every year, it will take 25 years for the cost to be paid back. Of course this calculation does not take into account the costs of maintaining the turbine or the projected life of the technology (for example if the turbine will only last for 20 years, the economics will never work).

To calculate the payback time of the technology you are considering, you will need to ask an engineer to provide you with a realistic annual power output for the system in kilowatt hours. Once you have this, you can estimate your annual saving, given current electricity prices, and then assess this against the capital cost of the product.

Grants will also shorten the payback period so make sure you have researched their availability. The Department for Business Enterprise and Regulatory Reform's Low Carbon Buildings Stream 2 grants are of particular note to community organisations (see *Useful information p37*). You should also contact your local authority to see if any other assistance is available.

Energy service companies (ESCos)
We all assemble packages that we hope will improve the energy and cost efficiency of our buildings. For example, we select boilers, choose electricity suppliers and shut windows when it's cold. In practice, it's difficult to assess all these variables accurately in a way that guarantees optimal efficiency. To overcome this it may be appropriate to turn to an ESCo.

ESCos are experts in identifying the most effective mix of measures needed to secure efficiency. They also develop, install and finance projects designed to improve energy efficiency. The energy is then sold back to the consumer as part of a package that will also include maintenance, advice and energy improvements.

By purchasing the services from an ESCo you reduce the risks inherent in setting up your own system; however you continue to benefit from the improved efficiencies.

There is a useful Energy Services Directory on the Energy Savings Trust website (see *Useful information p37*).

Useful information p37 includes some weblinks and recommended reading should you want to explore this further.

- If you occupy a building on a ten-year lease or less, it will almost certainly be more cost effective to use energy saving techniques such as improved insulation and low energy lighting rather than renewable energy technologies.
- If you own the building, or have a long lease, there will obviously be more time for the payback to happen.
- If you are subletting parts of the building, or developing it for sale, you may find that you achieve higher rental and capital returns because of the renewable technology installed.

Management for improved environmental sustainability

Regardless of the architecture or technology employed to reduce the environmental impact of a building, bad building management will always undermine its effectiveness.

Do you know how your building works?

Buildings are regularly handed over to occupiers with limited information on how to optimise the performance of the technologies and architecture used. If, for example, you've commissioned a building that relies on thermal mass for summer cooling, or combined heat and power (CHP) for efficient heating, good information will be crucial to their effective operation.

In large commercial buildings, this information is often held by a computerised building management system (BMS) which might, for example, automatically control vents, fans and shading devices to ensure optimum occupant comfort levels. However, in smaller buildings computerised BMS systems often prove too expensive and it will be necessary to rely on people instead.

It may sound obvious, but the simple way to understand how a building's architecture and technology works will be to insist that the designers of the building provide you with clear written instructions. Once you have these it will then be important to make someone responsible for ensuring that the instructions are adhered to and understood by other occupants.

Greening the workplace

Once the architecture is working to reduce the environmental impact of the building, you can then focus on reducing the day to day impacts.

There are plenty of things you can do such as:

- turning off lights when they're not in use
- printing double sided
- recycling waste
- cycling or walking to work (and encouraging all building occupants to do so)
- composting food waste
- turning off computers and appliances at night
- growing plants in the office
- checking the outside of your building for possible damage and carrying out repairs as soon as practically possible.

Such a common sense approach to environmental management is now codified and formalised by the International Standard ISO14000 and referred to as an 'environmental management system' (EMS).
An organisation can seek ISO14000 accreditation, but you may feel this is an unnecessary expense when you can work towards the goals yourself. However, there are some useful elements of EMSs that can be incorporated into the day to day running of a building.

Firstly, you should try to view the running of your building as a system. An office system will have inputs such as power, paper and other materials that feed processes such as printing and lighting; these processes then give rise to outputs such as excellent reports or wasted energy. A system should always have a goal – in this case, reduced environmental impact – but how do you measure the effectiveness of the system against the goal you have set?

The best way is to introduce targets against which you can monitor the system performance. A simple example would be to aim to reduce the units of electricity used to a particular level each quarter. If the target is not met, this should be fed back to the other occupants and improved performance encouraged.

Generally, the effectiveness of any EMS will depend on everyone agreeing with its goals and understanding how their actions can help achieve them. To encourage 'buy in' into the process, organisational culture and the ability of key members to communicate the importance of the system effectively will be crucial.

Green travel plans

Planning applications increasingly require travel plans to evidence that the new development will not create extra pollution on the roads.

Before you undertake any development, you could therefore give consideration to how people will travel to it. The obvious point to consider is how close your building is to public transport links. If it is close, you may wish to pursue the idea of a 'car free' development with the local authority.

Where a development is not well connected to public transport, other strategies such as a car sharing scheme could be proposed that might see staff and other occupants coordinating lifts to the workplace. See *Useful information p37* for more on this.

Good cycling facilities will also help encourage greener travel. Care should be taken to ensure that bicycle parking facilities are designed to be secure and dry. Showers should be provided with adequate changing facilities.

Tax breaks

Cycle mileage to meetings is now an allowable expense against your income. If you do cycle check that your tax code reflects this.

There is also a tax efficient cycle purchase scheme run by the government that enables employees to purchase bicycles through their employer (see *Useful information p*37 for further details).

HM Revenue and Customs offers businesses tax breaks for supporting green travel plans. These include incentives for office travel buses to bring people into work.

Employers can also offer their employees a free or low-interest season ticket loan up to £5000 per year. There is no tax or national insurance to pay on the loan, provided the full amount is repaid to the employer.

If your business needs vehicles to operate, a car pool could be an option. This will simply limit the number of vehicles you have and require a management system to ensure the smooth running of the pool. You may also want to consider vehicles that use non-fossil fuels. Electric and biofuel vehicles are widely available – once again the Energy Saving Trust's website has a great deal of information on this.

There are also government grants to help organisations install electric charging points, ethanol, hydrogen and other alternative fuels (see *Useful information p37*).

If you have a fleet of more than 50 vehicles (more than 20 in Scotland), a free comprehensive review of your transport operation is available through the Energy Saving Trust's panel of independent consultants.

Site ecology

Developing any site will inevitably lead to changes in its ecological value. More often than not, these changes will lead to a degradation of the site ecology, with flora (plants) and fauna (animals) negatively affected. As a responsible developer you can do a lot to ensure that a site's ecological value is maintained or improved as a result of your development.

The first step is to establish, through an ecological survey, which species currently occupy the land you plan to develop. This may often be a planning requirement and will require specialist advice. Once this ecological benchmark is in place, you can start to consider how to maintain or improve on it by creating a new micro-environment around your development. At the same time, you can think about how this new environment might help you meet some of the other challenges noted in the previous sections.

For example, shrubs and hedgerows can function as natural breaks against prevailing winds, so reducing ventilation heat losses. Deciduous trees can be planted in front of south-facing elevations to create shade in summer, while still allowing winter sun through as leaves are shed. Provided brickwork is not compromised, climbing plants can also provide added insulation and weather protection.

If site boundaries need to be well defined you might want to consider a mixed hedgerow rather than a fence. This will absorb CO2 and provide excellent food and shelter for wildlife.

Note that it will always be better to choose plant species that are native to the area in which you are developing. A simple pH test of the soil should help you establish which species will be suitable. By using native species, you are likely to provide a more appropriate habitat for birds and other local animal species.

As the client, you may also want to consider how the external spaces will help you meet the issues raised in the Watch out for water and Waste sections. Can you collect rainwater? Can you include soft landscaping features that will allow rainwater run off to percolate slowly back to the ground? Could a pond be incorporated into the landscape to act as a water retention device for a sustainable urban drainage system and a watering hole for local wildlife? Can you start a compost heap?

Once you have settled on a strategy and completed your development, you will then need to monitor the effect of your approach on local flora and fauna. This can be done by assessing the number and variety of species against your initial benchmark ecological survey.

Useful information p37 suggests some further reading on this topic.

Project planning checklist

You can fill in the form below with your group (some typical questions are included for your guidance). It is designed to help you:

- decide at the start (inception) what you will aim for in your project in terms of its environmental impact.
- consider at the next stage (feasibility) with your professional advisors what is possible or desirable for your project and, perhaps, why it cannot be done.
- decide what will be done in your project given all the other factors you have to consider, for example the capital budget available, the revenue costs you can cover from earning and the availability of grants.
- design the project in detail and choose materials and fixture and fittings that will achieve your aims.
- ensure that the management of your land/building incorporates ongoing environmental considerations (e.g. use of chemicals for cleaning, durability of fittings/appliances, waste treatment/management issues).

It should also include a post occupation evaluation of your project to assess with the occupiers and designers whether your objectives have been achieved – this will help improve future projects.

Project stage	**Issues to be addressed**			
	Climate change	**Water**	**Energy**	**Waste**
Inception What environmental impacts can you address in your project? **With whom?** Bring in a general environmental building consultant to facilitate discussion with your group.	▸ Site/location ▸ Orientation ▸ Ecology	▸ Reducing water use ▸ Treating surface water ▸ Recycling water	▸ Daylight ▸ Lighting ▸ Heating ▸ Appliances ▸ Energy generation potential	▸ Construction waste ▸ Waste treatment ▸ Recycling ▸ Composting ▸ Anaerobic digestion
Feasibility What is possible/ desirable within the context of your project? **With whom?** Develop ideas with an architect and the environmental building consultant. Bring in a contractor to inform on cost and buildability.	▸ Is this the right use for the site? ▸ Can we improve the site ecology? ▸ Does orientation lend itself to particular design strategies? ▸ Is it possible to use passive solar heating strategies? ▸ Where will materials be sourced? ▸ Do we have the budget?	▸ Are there regular water shortages and/or flooding in the area? ▸ How can we reuse water or reduce consumption? ▸ Can we slow the passage of water? ▸ Can we improve management to achieve this or do we need new appliances?	▸ Are there obvious sources of renewable energy nearby? ▸ What about budget and payback times? ▸ Can we reduce energy consumption instead? ▸ Can we maximize natural daylight and ventilation?	▸ How can we reduce waste now? ▸ Do we need a new building? ▸ Can we reuse building materials? ▸ What waste will we produce in the future and will our new building help us manage this? ▸ Recycling facilities. ▸ Composting areas?

Project stage	Issues to be addressed			
	Climate change	**Water**	**Energy**	**Waste**
Implementation What will be done? **With whom?** Full project team: architect, structural engineer, contractor, mechanical and electrical consultant, construction design and management coordinator and quantity surveyor.				
Detailed design What will it look like, how will it work? **With whom?** The full project team.				
Management What do you need to do on an ongoing basis to achieve your environmental objectives? What written guidance is needed for owners, building managers and occupiers? Who will provide it? Who will be responsible for ensuring that guidance is followed? How will it be done? (e.g., through lease or licence obligations). Post occupancy evaluation.				

Regulations and policy

Building Research Establishment Environmental Assessment Method (BREEAM)
BREEAM provides standardised assessment methods against which you can measure the environmental performance of your building.
The assessment is building type specific and covers:

- residential (Code for Sustainable Homes)
- retail
- industrial
- offices
- schools
- prisons

Each building's performance is measured by a registered BRE assessor.

For more information see www.breeam.org or call the BREEAM Centre at Garston on 01923 664462

Code for Sustainable Homes
This has replaced the BRE EcoHomes assessment method. The Code was launched in April 2007 as part of the drive to develop zero carbon housing (see Building a Greener Future, below) and rates the home on a one to six star rating system to convey the overall sustainability of the dwelling. The Code sets minimum standards for energy and water use at each level. For more information contact the BREEAM Centre.

Part L1 of the Building Regulations (2006)
Part L sets out the legal requirements for the minimum standards of fuel and power conservation in buildings. One of the most significant changes has been the introduction of the standard assessment procedure (SAP) for new dwellings that rates them on a scale of 1 to 100, with 100 being the most efficient. Net exporters of power have a rating over 100. Each building also has a target emission rate (TER), reflecting the maximum mass of carbon dioxide emissions that the building should emit. To download a Briefing Note on Part L see the Energy Savings Trust website: www.est.org.uk/housingbuilding.

Building a Greener Future
A consultation document on the government's proposals to reduce the carbon footprint of new housing. It sets out the government's views on moving towards zero carbon housing. It is available to download from the Communities and Local Government website: www.communities.gov.uk/archived/publications/planningandbuilding/buildinggreener.

Useful information and references

The DTA, the Environment Trust and the authors cannot be held responsible for the content of, or advice or products offered by any third party website.

Climate change
The UK Climate Impacts Programme, information on the likely impacts of climate change in your area: www.ukcip.org.uk/climate_change/by_location.asp

The Intergovernmental Panel on Climate Change (IPCC) www.ipcc.ch.
Houghton, Professor John (2004) *Global warming, the complete briefing* (3rd edn), Cambridge: Cambridge University Press

Louden, AG (1968/1970) *Summertime temperatures in buildings without air conditioning*, Building Research Station current paper 47/68 and Journal of Heating and Ventilating Engineers, 32, 280-292

Roaf, Sue et al (2005) *Adapting buildings and cities for climate change: A 21st century survival guide*, Oxford: The Architectural Press

Good practice guides, general information leaflets and environmental building advice
Originally published by the DETR and Building Research Establishment, these cover a wide range of sustainable building topics. They are available from the Carbon Trust website and are free once you have registered: www.carbontrust.co.uk/publications

The Energy Savings Trust (EST) has a range of guides and good practice information: www.est.org.uk or telephone 0870 241 2089

BERR's website includes useful downloadable material on all topics relating to sustainable construction: www.berr.gov.uk/sectors/construction/index.html

The Environment Trust offers practical advice on all aspects of environmental building: www.envirotrust.org or telephone 020 7264 4660

The CIRIA website has many downloadable good practice guides: www.ciria.org

General reading on environmental building
Thomas, R (1999) *Environmental design, an introduction for architects and engineers*, New York: Routledge

Anderson, J and Howard, N (2000) *The green guide to housing specification*, London: BRE/Construction Research Communications Ltd

Hall, Keith (ed.) (2006) *The green building bible* (volumes 1 and 2), Llandysul: The Green Building Press

Szokolay, S (2004) *Introduction to architectural science* The basis of sustainable design, Oxford: Architectural Press

Littler, J and Thomas, R (1984) *Design with energy, the conservation and use of energy in buildings*, Cambridge Cambridge University Press.

Environmental building in practice
The Great Bow Yard development by ECOS Homes (formally South West Eco-Homes): www.ecoshomes.co.uk

The BRE Environmental Building: www.projects.bre.co.uk/envbuild

Sherwood Energy Village, a 90 acre former mining site transformed into an industrial, leisure, commercial and housing development: www.sev.org.uk

Centre for Alternative Technology (CAT), offers advice and environmental building courses: www.cat.org.uk

The Bootstrap Company, the largest photovoltaic installation by a development trust in England: www.bootstrapcompany.co.uk

Passive solar design, thermal mass and night-time cooling
Yannas, S (1994) *Solar energy and housing design*, London: Architectural Association Publications

Banham, R (1969) *The architecture of the well-tempered environment*, London: Architectural Press. Good practice guide and general information leaflets are also available on the Energy Savings Trust website: www.energysavingtrust.org.uk/housingbuildings/publications/

Natural ventilation
GPR 237, *Natural ventilation in non-domestic buildings*, published by the DETR but available for free from the Carbon Trust: www.carbontrust.co.uk/publications.

Materials
Building Research Establishment, BRE: www.bre.co.uk/greenguide.

Geothermal power/ ground source heat
The National Energy Foundation provides a range of information on all sustainable building topics including specific advice on ground source heat pumps: www.nef.org.uk

Hydropower
The British Hydropower Association has good general information about the topic: www.british-hydro.org.

Wood pellets
Welsh Biofuels sells wood pellets made from 100% recycled wood: www.welsh-biofuels.co.uk.

Combined heat and power (CHP)
The Combined Heat & Power Association has a range of fact sheets and related links on www.chpa.co.uk

SEDBUK, boiler efficiency standards
www.sedbuk.com

Web-based hard drives
www.mangosoft.com for an example of this web-based technology. Mango does not come with any specific recommendation.

Wind
The following link shows average UK wind speeds: www.bwea.com.
Wind speed data for specific grid references can be obtained from www.berr.gov.uk/energy/sources/index.html (click on 'renewables').

Other renewable energy
The Renewable Energy Centre has plenty of all-round information on the various technologies and suppliers of equipment: www.therenewableenergycentre.com.

Water
The UK Rainwater Harvesting Association provides some Useful information p37 on: www.ukrha.org.

The Centre for Alternative Technology in Wales also has a number of fact sheets and courses on: www.cat.org.uk.

Water UK works alongside the UK water industries to develop a sustainable UK water strategy. Advice and guidance: www.water.org.uk.

Sustainable urban drainage systems (SUDS)
The CIRIA website has specific guidance on SUDS: www.ciria.org

The Sustainable Urban Drainage Systems Network is worth looking at: www.sudsnet.abertay.ac.uk

Waste
The Environment Agency website has a useful section on waste: www.environment-agency.gov.uk.

Sir John Egan's report on *Construction efficiency and waste elimination* can be found at the Constructing Excellence website: www.constructingexcellence.org.uk

The BRE's *SMARTWaste* toolkit can be accessed at www.smartwaste.co.uk

The UK government's website www.envirowise.gov.uk also provides excellent information on waste in construction. There is also a telephone advice line 0800 585794.

Green travel plans
Tax free bicycle purchases: www.cyclescheme.co.uk

HM Revenue and Customs has details of all the tax benefits of Green Travel plans for employers and employees: www.hmrc.gov.uk/green-transport/travel-plans.htm.

Car sharing see for free advice: www.liftshare.org or www.carshare.com

Grants for alternative fuel charging points: www.energysavingtrust.org

Site ecology
Baines, C (2000) *How to make a wildlife garden*, London: Frances Lincoln Ltd.
Bird boxes, feed and other useful garden items are available from www.wigglywigglers.co.uk

The Natural England website has good general information on this topic www.naturalengland.org.uk.

If you plan a development in London, a detailed species list for plants and animals in your area can be obtained from www.gigl.org.uk.

The National Biodiversity Network may also be of interest: www.nbn.org.uk

Whole life costing (WLC)
The Building Research Establishment has Useful information p37 on WLC: www.bre.co.uk

The authors

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Development Trusts Association
"continues to promote asset based development as a vital component in the establishment of sustainable community anchor organisations. However, in a post-Stern Report world, green procurement has a vital role. 'We are therefore delighted to have been able to commission the Environment Trust to produce *The Green Asset Guide* to share their undoubted expertise more widely and to complement the existing Development Trusts Association publication *To Have and To Hold*, the guide to asset development for social and community enterprises." Steve Wyler, Director Development Trusts Association

The Environment Trust
has improved the social, economic and physical environment for community benefit for nearly thirty years. Based in London, but working all over the UK, our projects include the award winning Mile End Park and pioneering energy efficient affordable housing schemes – the latest in Sheffield. We have an established consultancy arm called Environment Trust Associates, which provides advice on a broad range of built environment topics including planning, environmental building and the development of community assets.

"Can I generate energy as part of my building project? How will climate change affect my project? Won't reducing my environmental impact make my project very expensive? Our building is not new – can I do anything to improve its environmental performance? What is a ground source heat pump? How do I choose building materials that will make a difference to the environment?"

DEVELOPMENT TRUSTS ASSOCIATION

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£10 or free on attendance at *Viability not liability* seminars