UNIT 5
THE SUSTAINABLE SITING, DESIGN AND CONSTRUCTION OF TOURISM FACILITIES

The tourism and hospitality industry invests heavily in building new structures and renovating and converting existing ones. This unit introduces the key features of sustainable building siting, design and construction (information on renewable energy is also included). These features make buildings more durable, comfortable, and cheaper to operate and maintain, while facilitating the implementation of EMS during occupation.

Unit Outline

The unit is organised as follows:

Section 1 An Introduction to Sustainable Design
1.1 What is sustainable design?
1.2 Why is sustainable design important in tourism and hospitality?
1.3 The benefits of sustainable design.

Section 2 Sustainable Siting of Buildings
2.1 Site selection.
2.2 Carrying capacity considerations.
2.3 Environment impact assessment.
2.4 Building placement.

Section 3 Sustainable Design of Buildings
3.1 Architectural Features of Buildings
  3.1.1 Passive solar design
  3.1.2 Day Lighting
  3.1.3 Renewable Energy Use
  3.1.4 Renewable energy technologies for tourism and hospitality
  3.1.5 Architectural Features to Reduce and Reuse Water
  3.1.6 Landscaping
3.2 Environment Consideration for the ‘Building Shell’
  3.2.1 Windows
  3.2.2 Insulation
  3.2.3 Environment-Friendly Building Materials
3.3 The Use of Resource-Efficient Technology, Fittings and Appliances During Occupation

Section 4 Reuse of Existing Buildings

Section 5 Sustainable Construction of Buildings

Section 6 Conclusion
Learning Objectives

At the end of this unit, students should be able to:

• appreciate the importance and benefits of sustainable building siting, design and construction;
• identify some features of sustainable design;
• appreciate how sustainable siting and design will facilitate the implementation of EMS;
• discuss the potential for incorporating sustainable design features into existing buildings and how it will facilitate EMS; and
• discuss sustainable siting and design for new buildings and how it will facilitate EMS.
UNIT 5

THE SUSTAINABLE SITING, DESIGN AND CONSTRUCTION OF TOURISM FACILITIES

SECTION 1: AN INTRODUCTION TO SUSTAINABLE DESIGN

1.1 What is Sustainable Design?

- Sustainable design involves buildings that need fewer resources and materials to build, occupy and maintain, and are more comfortable and healthy to live and work in.

- Buildings have significant impacts on the environment. Worldwide, 30-40% of all primary energy is used in buildings contributing to global warming. In most industrialised countries, carbon-dioxide emissions from buildings account for half of total national carbon emissions, while construction waste amounts to 35-40% of national annual waste output. In the UK, 6,000kg of building materials are used every year per head of the population.

- We all pay the costs of unsustainable buildings. Employees working in badly ventilated and illuminated offices perform poorly and register high levels of occupational illness. Companies and homeowners face rising bills for heating damp, draughty buildings. Multiplier effects go even further – tropical forests are logged to provide timber for buildings in Europe, Japan and North America, and large rivers are being dammed to generate hydro-electricity for energy-intensive homes, business and other sites.

Useful Resources:
Buildings and Climate Change: Status, Challenges and Opportunities, 2007, UNEP

Sustainable building and construction, Industry and Environment, 2003, UNEP

1.2 Why is Sustainable Design Important in the Tourism and Hospitality Industry?

- The tourism industry is a catalyst for construction and notorious for erecting buildings that ruin the beauty and integrity of their surroundings. With the expansion of the nature, adventure and rural tourism markets, more and more structures are being built in remote and fragile environments where it is vital that impact be kept to a minimum. Tourism and hospitality buildings need to be regularly repaired and refurbished. Sustainable design results in durable, attractive buildings, reduced operating and maintenance costs, improved comfort and convenience and low environment impact.
1.3 The Benefits of Sustainable Design

- Facilitates Environment Management:
  Sustainable design greatly facilitates the implementation of EMS. Some of the greatest challenges for EMS are finding ways to reduce resource use and waste output in buildings that offer very little scope for low and medium cost improvements. However, a building constructed to maximise day lighting, lower heat loss or gain, use diverse energy sources including renewables, provide plumbing for the reuse of grey water, and lower watering needs through thoughtful landscaping, makes it quite easy to implement a highly successful EMS.

- Reduces Resource Intensity:
  As discussed in Unit 4, repair and retrofit options can reduce energy consumption by 30-50% in most residential and commercial buildings. This can be increased to 80% if coupled with sustainable design features.

- People Prefer ‘Green’:
  There is an increasing demand for airy, comfortable homes and offices in neighbourhoods with open spaces, parks, trees and greenery. Sustainable design demonstration projects in the USA, Canada and Western Europe report that people are willing to pay a premium for ‘green’ homes and buildings.

- Improves Productivity and Enhances Corporate Image:
  Improving employee productivity is a strong incentive for ‘green’ offices. Salaries account for the highest proportion of operating costs, and the business benefits of increased productivity can make a substantial contribution towards offsetting payback periods for building improvements. ‘Green’ buildings can also improve corporate image.
SECTION 2: SUSTAINABLE SITING OF BUILDINGS

2.1 Site Analysis

- Site selection is the first step in the sustainable design process. The site must be compatible with the purpose of the proposed development and be suitable for building.

- A site selection checklist for hospitality and tourism businesses is given below. The developer alone will not be able to provide all the answers. A pluri-disciplinary approach with input from ecologists, architects, construction engineers and environment specialists will be needed to determine the appropriateness of the site.

<table>
<thead>
<tr>
<th>Site Analysis Checklist</th>
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</thead>
<tbody>
<tr>
<td>1. What are the ecological characteristics of the site?</td>
</tr>
<tr>
<td>✓ An overview of the hydrology and geology of the site is needed to determine the rate of erosion and if soils are stable enough for building.</td>
</tr>
<tr>
<td>✓ How fragile and valuable is the topography? To what extent will it be disturbed or destroyed by the proposed development?</td>
</tr>
<tr>
<td>✓ Has the site been degraded by previous building, industrial or agricultural uses? To what extent can the proposed development restore the productivity and biodiversity of the site?</td>
</tr>
<tr>
<td>✓ A record of the climate and natural habitat should be taken.</td>
</tr>
<tr>
<td>2. Does the site have special cultural significance?</td>
</tr>
<tr>
<td>✓ Is the site of cultural, religious or archaeological significance?</td>
</tr>
<tr>
<td>✓ Are there structures on the site that are of cultural, religious or historical importance?</td>
</tr>
<tr>
<td>✓ Will there be social conflicts if the land is used for the proposed development?</td>
</tr>
<tr>
<td>✓ To what extent can existing structures be preserved and enhanced by the proposed development?</td>
</tr>
<tr>
<td>3. Are their better uses for the site?</td>
</tr>
<tr>
<td>✓ Given the ecological and cultural significance of the site, should it be used for the proposed development?</td>
</tr>
<tr>
<td>4. Is the site near existing infrastructure such as roads, power lines, water supply and waste disposal sites?</td>
</tr>
<tr>
<td>✓ This question is crucial to determine the multiplier impacts. If the site is remote from existing infrastructure, what will be the impacts of extending essential infrastructure to it?</td>
</tr>
<tr>
<td>✓ Will the proposed development contribute to the expansion of urban sprawl?</td>
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<tr>
<td>✓ Can the proposed development be built as a self-contained unit in terms of water, energy and waste disposal?</td>
</tr>
<tr>
<td>5. What is the state of the environment of the site?</td>
</tr>
<tr>
<td>✓ Has it been used for industrial purposes?</td>
</tr>
<tr>
<td>✓ Have water and soil contamination tests been carried out?</td>
</tr>
<tr>
<td>✓ Are strong electromagnetic fields present?</td>
</tr>
<tr>
<td>✓ Is the site clear of plumes and deposition from surrounding industrial sites?</td>
</tr>
<tr>
<td>✓ Does the vegetation on the site show any signs of stress?</td>
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</tbody>
</table>
| ✓ What is the potential for passive solar design and renewable energy? This is especially
important if the site is far from the grid.
✓ Have important surface or groundwater resources been identified? Have the potential for violation of ambient water quality standards, drinking water or degradation of water been considered?

6. Reuse of existing structures:
✓ Can existing structures be reused or upgraded as part of the development?
✓ If the structures are beyond repair, can some building materials be recovered and reused for the new development?

7. How will future land-use plans for the areas surrounding the site influence the proposed development?
✓ Are industrial and commercial developments planned for surrounding areas? Will this increase or decrease the value and aesthetics of the site?
✓ Will these developments affect the site’s access to sunlight, water or power?
✓ Might these developments cause air and water pollution, or increase noise levels or congestion?

2.2 Carrying Capacity Considerations

✓ In tourism, carrying capacity means the limit of tourism activity, the maximum number of visitors and supporting infrastructure, that can be maintained in a given site or destination before environment damage occurs. When the threshold is exceeded, the resources required and pollution generated by tourism begins to degrade the natural environment.1

Box 5.1
Carrying capacity is important in site selection, because it encourages developers to consider:

- Capacity thresholds for buildings and visitor numbers right from the start.
- A range of alternative sites.
- The human and financial resources needed for environment impact mitigation before the final choice of site is made.

2.2.1 Calculating Tourism Carrying Capacity

- Ecological sensitivity differs from ecosystem to ecosystem. Coastal areas and wetlands are, for example, more dynamic and fragile than prairies. Likewise, rocky cliffs are more resistant and less dynamic than mountain forests. Furthermore, tourism is a dynamic business and visitor numbers fluctuate greatly from season to season. Given these factors, the carrying capacity of a site will depend on:
  - number of tourist arrivals,
  - patterns of visitor arrivals and length of stay,
  - tourist activities,
  - number of local people living in the area,
  - facility design,

1 Carrying capacity also implies limiting visitor numbers on the basis of the social and cultural sensitivities of the host population.
• destination management strategies, and
• characteristics and quality of the surrounding environment.

• While the concept of carrying capacity works well in theory, its practical application can be challenging. When determining the levels at which the threshold should be set, it is necessary to consider **what level of activity can be considered too much, and what level of environment modification can be regarded as acceptable.** Natural resource management researchers often use the ‘Limits of Acceptable Change’ principle, which attempts to set measurable limits to human-activity-induced changes in natural areas. This principle is widely used in the management of natural parks and protected areas.

2.3 **Environment Impact Assessment (EIA)**

- The next step is to study the potential impacts on the environment of the proposed development, and how they could be avoided or reduced. The tool used for this is known as the Environment Impact Assessment (EIA).

- EIA is a procedure to forecast and assess the environment implications of proposed developments. It provides the opportunity for:
  - identification and accounting for direct and indirect environment impacts before a decision is made as to whether the proposed development is to proceed as planned, and
  - modification of development proposals in order to avoid and reduce the potential environment impacts.

- EIA is about identifying environment impact that is the change in environment conditions that will be **induced by the proposed development.** This change is compared with the environment situation as it would be if the development did not occur. The natural environment is not static: there are different processes and rates of change in all ecosystems, and assumptions must be made as to the natural changes of the site being considered.

<table>
<thead>
<tr>
<th>Box 5.2</th>
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<tr>
<td><strong>Example:</strong></td>
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<tr>
<td>In an EIA of a beach resort, it would be necessary to study the rate of natural change of the shoreline, the ecological succession of the coastal vegetation, patterns of erosion and deposit, etc. In contrast, in an EIA for a visitor centre on a rocky cliff, generally a far less dynamic ecosystem than a coastline, a description of the present state of the environment may be sufficient.</td>
</tr>
</tbody>
</table>

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2 An EIA assesses both direct and indirect impacts of a proposed project. For example, when building a beach resort, the clearing of coastal vegetation on the immediate hinterland can have direct impacts on the beach ecosystems. It can change the natural patterns of deposit and erosion, and increase the silting of shallow waters. This may in turn increase silting in nearby lagoons and estuaries that will reduce the growth of fish and shellfish. An indirect impact of the proposed development could therefore be the losses encountered by the local coastal fisheries industry.
### Box 5.3

**Examples of the Issues to be Forecast and Assessed in an EIA for a Marina:**

- How the proposed tourism facilities might contribute to growing recreational demands.
- Alternative sites for the proposal.
- The structures in relation to the natural landscape.
- The existing environment and proximity of dwellings, including physical site characteristics, hydrographic and meteorological information, biological conditions and present lands uses in the area.
- Sand movements and places where increased accumulation and coastal erosion are likely to occur.
- The general character of the proposal including the structure of the breakwater and depth of water.
- Prospective future developments in the same locality, which might suggest cumulative impacts.
- Adverse effects on marine plant and animal life.
- Changes in existing habitats.
- The impact of barriers to movement of migratory species.
- Risks of sea pollution inside and outside the marina by uncontrolled sewage, surface run-off, oil and petrol, paints and anti-fouling materials.
- The proponent’s contribution to the provision of public facilities necessary for the marina.
- Drainage and sewerage systems.
- Solid waste disposal.
- Means for the disposal of sewage waste both on land and at sea.
- Visual impacts during the construction and operational phase.
- Emergency services and responses.
- The measures proposed to prevent, reduce and mitigate negative effects of the proposal.

### 2.3.1 The EIA Process

- The main stages of the fully-fledged conventional EIA process, often recommended in national EIA legislation, are:

  1. Screening: Establishing the need for an EIA.
  2. Scoping: Determining the scope of the EIA.
  3. Conducting the EIA, which includes:
     - identifying direct impacts,
     - forecasting indirect impacts,
     - assessing the significance of direct and indirect impacts,
     - identifying measures to avoid and reduce impacts, and
     - outlining strategies to monitor the success of impact avoidance and reduction measures.
  4. Preparing the environment impact statement, which reports on the findings and recommendations of the EIA.
  5. The environment impact statement is submitted together with the overall building application to the building authorising agency for review and approval. Simultaneously, the environment impact statement is also:
     - subject to external checks by experts commissioned by the authorising agency, and
     - made available for public consultation.
  6. The environment impact statement is finalised on the basis of the outcome of point 5.
7. The final version of the environment impact statement is then re-reviewed by the authorising agency.
8. The development application is approved or rejected.
9. If the application is approved, environment impact avoidance and reduction measures are implemented and monitored during specification and construction.
10. Periodic environment impact audits are conducted to verify that impacts are being minimised as planned.

Most countries require the developer to conduct the EIA and submit the environment impact statement as part of the overall application for development authorisation. Questions arise as to how objective the EIA will be if it is conducted by the developer, who of course has every interest in ensuring that the proposal is authorised. The issue is that if external experts or the authorising agency conducted the EIA, it would remove the EIA process from the conception and formulation of the project. But since it is unrealistic to expect the developer to be completely objective, an external review is required to ensure that the environment impact statement does not become a means to obtain authorisation by presenting only the positive findings.

Common Question: What is Public consultation?

Development proposals cannot fully succeed if those who are most likely to be affected by them do not support them. Following the principle of public participation, discussed in Unit 3, public consultation means that all interest groups (local communities, environment groups, non-government organisations, etc) can review the environment impact statement and officially record their comments.

For tourism, public consultation is perhaps the most critical component of the EIA process. Local communities and businesses are an integral part of the tourism experience. They are also likely to know the local environment better than the developer or the authorising agency. Co-operating with them may greatly facilitate forecasting impacts and selecting measures to mitigate them. It is therefore useful to involve the local public and learn about their concerns as early as possible. Some concerns may well be ill-founded but, if not identified at the start, they could present serious and expensive difficulties later on.

The procedures for public consultation (sometimes called public participation) differ from country to country. National legislation on EIA should be consulted for further information.

2.3.2 Methodologies

- An EIA can be conducted through a range of methods, including:
  - Impact checklists: The simplest approach. The disadvantage is that checklists must be exhaustive to ensure that no impact is overlooked, and an exhaustive checklist with 45-50 sub-categories can be cumbersome to work with.
  - Network and system flow diagrams: Useful for revealing indirect impacts, and those that can occur through more than one pathway.
  - Impact matrixes: One is the commonly used ‘Leopold Matrix’, designed to identify around 8,800 impacts, although only 25-30 would apply to any one project.
• The ‘Quantitative Index Method’: Involves the weighting, standardising and aggregating of impacts to obtain a composite score index of positive and negative impacts. Long-term irreversible impacts are given a greater weighting coefficient than short-term reversible ones.
• Other pluri-disciplinary approaches involving geographical information systems, mathematical and computer models, pollution studies and land suitability analysis.

❖ Quick-Track EIA

• For smaller-scale projects the ‘conventional’ EIA process is often condensed. This so-called ‘Quick-Track’ EIA is conducted using currently available information and uses checklist methodologies with some input from impact matrixes and simple network flow diagrams. Quick-Track EIA also makes substantial reference to carrying capacity studies. In the case of tourism, carrying capacity studies are a prerequisite for Quick-Track EIA.

Useful resources:
http://ec.europa.eu/environment/eia/home.htm
http://www.gdrc.org/uem/eia/impactassess.html
http://www.ceaa.gc.ca/index_f.htm

Environmental Impact Assessment and Strategic Environmental Assessment: Towards an Integrated Approach, 2004, UNEP
http://www.unep.ch/etb/publications/EnvImpAss/textONUBr.pdf

2.4 Building Placement

❖ Once the site has been selected and ways to minimise environment impacts have been identified, the developer needs to determine where on the site the buildings should be placed:

• They should be placed on the ecologically and culturally least interesting part of the site.
• They can be placed and oriented according to annual sun cycles and shadow patterns from surrounding buildings, to optimise passive solar design potential and lower overheating during summer.
• They can be placed to maximise aesthetic views, but still provide privacy and security.
• Placing should take advantage of natural land formations. For example,
  • existing trees might be used to provide cooling and reduce solar gain in summer and increase it in winter; or
  • the building might be terraced to suit natural grading patterns, rather than having the site flattened and levelled; an earth berm can be a valuable buffer against winds and facilitate passive solar design.
SECTION 3 THE SUSTAINABLE DESIGN OF BUILDINGS

3.1 Architectural Features of Buildings

3.1.1 Passive solar design

- Passive solar design means designing a building to take the best advantage of natural sunlight and airflow in order to create a comfortable, energy-efficient indoor environment. This means optimising the hotel’s siting, orientation, form, openings, assemblies and systems to reduce lighting, heating and cooling loads.

- In cold climates, it is important to maximise heat gain. A building should be elongated on its east-west axis, with the parts needing the most heat facing south. Areas that need less heating can be located on the other side. Deciduous trees can be used to reduce heat gain in summer and increase it in winter.

- In hot climates, the goal is to reduce heat gain and increase airflow and cooling. This can be achieved through passive design features such as prevailing winds for ventilation and cooling. The building should be elongated on an axis perpendicular to the prevailing wind. Cross-ventilation can be maximised through the proper alignment of doors and windows. High internal ceilings will facilitate air circulation whilst balcony and window overhangs and deep reveals will increase shading.

- In temperate climates, solar gain needs be reduced in summer and increased in winter. An east-west-elongated rectangular building with well-calculated roof overhanging (based on latitude, sun patterns, and climate) is the most suitable.

- Solar gain storage requires thermal mass, i.e. using materials with a longer thermal release time than others. For example, it takes much longer for heat to move through brick than through fibreboard. So a brick house with more thermal mass will yield more moderate changes in indoor temperature compared to the outside air, remaining cooler during daytime and warmer at night, than a lightweight structure of fibreboard, which heats up and cools down more quickly.

- Windows and vents can be used either to reflect the sun, or to trap solar heat inside a building. In combination with the insulation of walls, roofs and floors, windows and vents can be used to direct natural ventilation, heating or cooling interiors as required. Natural physical features such as earth berms, soil gradings, trees and vegetation are invaluable in increasing the efficiency of passive solar features.
Box 5.4
If passive solar features are designed in a holistic, integrated manner, the energy intensity of buildings can be lowered by 30-40%.

Diagram: Elements of passive solar design, shown in a direct gain application.
Source: U.S. Department of Energy
http://www.eere.energy.gov/de/passive_solar_design.html

3.1.2 Day lighting

Day lighting means using natural light to light interiors through large windows, glass panels, skylights, atriums, courtyards and light-coloured furnishings. There are various day lighting techniques:

- Light shelves: A reflective, horizontal shelf is fixed along the inside or outside of windows, either along the windowsill or at the top to light inwards and upwards, enabling it to reach further inside the building.
- Light monitors and light reflectors: Can be used to operate skylights and window shades to increase or decrease the quantity of daylight entering the building.

Good Practice Tips:
- Inexpert day lighting will increase glare or gloom.
- Day lighting must be considered as an integrated part of passive solar design.

Useful Resources:
http://www.eere.energy.gov/de/passive_solar_design.html
http://www.greenbuilder.com/sourcebook/PassiveSol.html
3.1.3 Renewable Energy Use

Renewable energy is energy that can be produced at the same rate as or faster than it is consumed. It therefore does not contribute towards the depletion of natural resources. It also avoids carbon dioxide and other greenhouse-gas emissions. Renewable energy sources include solar, hydro, wind, bio-fuels and geothermal energy.

‘Renewables technology’ has gained much ground in the last ten years:

- The deregulation of energy markets gives renewables open access to national electricity grids. Power companies are offering businesses and homes the choice of using ‘green’ electricity generated from renewables.
- There have been significant improvements in the efficiency of renewable-energy technology.
- Related capital costs have dropped.
- Equipment and appliances are becoming ever more energy-efficient. This makes the use of renewable energy increasingly feasible.
- Concerns about air quality, global warming and the implementation of the Kyoto Protocol (discussed in Unit 1) provide added impetus to reducing both our dependence on fossil fuels and greenhouse-gas emissions. This is increasing the focus on renewable energy sources.

Many governments and power companies provide loans, grants and subsidies to promote the use of renewable energy. For tourism and hospitality businesses in rural areas, including those more than a kilometre away from the national grid, renewable energy is usually a good cost-efficient alternative, especially in view of the financial and environment costs of extending the grid. Applications such as rooftop photovoltaics, solar water-heaters and wind turbines can also be useful to urban businesses for water heating and meeting peak power demands.

3.1.4 Renewable energy technologies for tourism and hospitality

- Solar Water Heating

  - Solar water-heating is well established as a cost-effective and sustainable energy source for hot water supply. The technology consists of:
  - a collector surface heated by the sun, over which the water to be heated passes;
  - a heat-transfer medium;
  - a storage tank; and
  - back-up water heaters to meet peak demand periods, to heat water to higher temperatures, or to provide hot water when there is no sun.
Box 5.5

Solar water heating is already widely used in hospitality businesses requiring a constant supply of hot water. As water heating in an average hospitality business accounts for approximately 12% of total energy costs (20% of energy use), solar water heaters can lower fuel and electricity bills, provide a buffer against rising energy prices and compensate for unreliable power grids. Solar water heaters can work up to 20 years with relatively little maintenance. Consequently, they can be very cost-effective.

**Source:** Switched On: Renewable Energy Opportunities in the Tourism Industry, 2003, UNEP

- To optimise exposure to sunlight, collector panels are usually put on the roof, either flush on the surface or up on brackets. If roof space is not available, the panels can also be installed at ground level, with the disadvantage that if the building is more than one storey high, the hot water will have to be pumped to higher levels, using additional energy (e.g. an electric pump).

- For best performance, collector plates should face true north and be inclined at an angle from the horizontal equal to the latitude, although this may vary with latitude. The most efficient systems include collector panels with special coatings which absorb direct solar radiation (visible light) and radiate little direct heat (infrared radiation) back into the surrounding air. This enables the collector to reach much higher temperatures, meaning smaller collectors to heat larger amounts of water, which in turn can greatly reduce the space required.

- In colder climates, it is necessary to have a freeze protection on the panels to prevent damage from the expansion of water in the collector pipes. Anti-freeze solar technology includes cells with anti-freeze liquid, panels fitted with small electric heaters, or anti-freeze valves.

**Illustrations**

**Source:** Switched On: Renewable Energy Opportunities in the Tourism Industry, 2003, UNEP
Common Question:

How much do solar water heaters cost?
Experience in Australia, the Mediterranean and the Caribbean show that the payback period is usually 2-5 years. An important consideration is the price of the fuel-powered backup water heaters. Solar water heating systems are generally guaranteed for 10 years.
Components of Solar Water Heaters:

**The Collector**
Absorber plates are made of a stainless steel or copper plates tubes painted with a special black paint to maximise heat absorption and bonded to copper tubes. The absorbers are covered with a single or double sheet of glass (called ‘glazing’) and placed in an insulated metal casing. Some collectors are double glazed where the additional glazing is made of UV resistant plastic. Evacuated tube collectors are made of a number of heat-pipes, which are each soldered to a copper plate and placed in an evacuated tube.

**Water tank**
Tanks are made of stainless steel or mild steel with an enamel lining and are insulated to keep the water warm at night and during periods of low solar energy.

**Heat exchanger**
Some systems include a heat exchanger, which is usually located in the hot water storage tank.

A backup electric or gas water heater. This is often needed to heat water at times when there is no sunlight or to raise the temperature of the water heated by the solar water heater. In some tropical climates, electric or gas backup heaters are not needed.


**Photovoltaics (PV)**

- As the name suggests, photovoltaic cells convert light into electricity. They are made of a semi-conductor material, typically crystalline silicon\(^3\), formed into thin wafers or ribbons. One side of the cell has a positive charge, the other side a negative. When sunlight hits the cell, the electrons on the positive side activate those on the negative side to produce an electric current.

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\(^3\) Other types of semiconductor materials such as amorphous silicon and cadmium telluride may also be used.
• PV cells are electrically connected to each other, packaged in a transparent cover (usually glass or plastic), and encased in a watertight seal to form a panel or module. The panels are wired together to form a larger array, the size of which will depend on the power requirements of the user.

• PV can be used as a stand-alone system or a grid interface system. A stand-alone system consists of:
  • PV array;
  • structure to mount the array;
  • batteries to store power;
  • converter to turn the stored direct current (DC) into alternating current (AC) (most household appliances work on AC);
  • electric cables that enable electricity to move between cells, batteries and usage points; and
  • backup diesel generators to ensure a reliable supply of energy when there is no sunlight.

• Grid interface systems do not store energy. Instead they supply PV-generated power to the grid when excess power is being produced (i.e. when the sun is shining), and use power from the grid when no energy is being produced. The interface between the PV system and the grid can be metered in such a way that when power is being supplied to the grid the meter will run backwards. When power is drawn from the grid, the meter will move forward in the usual manner.

❖ Mounting PV Cells

• PV only works when the sun is shining, so optimal exposure is crucial. The panels should face true north, at about the angle of the latitude. The minimum angle is 20° from the north horizon (this will also enable the panels to be cleaned when it rains). For large installations it may be wise to invest in a tracker, which will move the panels according to sun patterns throughout the day.

❖ Geothermal Heat Pumps

• Geothermal energy is heat from the interior of the earth, the same heat that rises naturally in geysers, hot springs and volcanoes. It can be used directly as hot water or steam, or used for the production of electricity. High-temperature geothermal sites are not widespread. But low-temperature sites in many parts of the world can be used to provide heating and cooling for buildings. The technology used for this purpose is the geothermal heat pump.

• Geothermal heat pumps are like two-way refrigerators; they move heat from outside to inside the building or vice-versa according to the season. They are located inside the building, with its essential components – sealed plastic pipes – installed vertically in boreholes (30-100m deep) or horizontally in trenches, in which water or an antifreeze solution circulates. In winter, the heat pump extracts heat from the hot water or steam in the interior of the earth, brings it up through the water or antifreeze liquid that circulates inside
the plastic pipes sunk in the ground, and transfers it inside the building. In
summer, the pumps move heat from the building into the earth. The same
plastic loop is used as in winter, but the direction of flow is reversed. This
technology takes advantage of the fact that the temperature in the ground
varies less with the seasons than does the temperature of the atmosphere.

- As geothermal heat pumps use electricity to move heat and not generate it,
  they are extremely efficient and generate three to four times the amount of
  energy they consume. Buildings using this technology have lowered
  heating/cooling-related electricity consumption by 50-80%.

- Geothermal resources with temperatures as high as 648°F can be used to heat
  water as well as produce electricity. Large resources can be used to produce
district heating. In Iceland for example, the entire city of Reykjavik is heated
by geothermal energy. The USA, Switzerland, Austria, Germany, Sweden
and Canada are pioneers in geothermal technology. Many hotels in these
countries operate individual geothermal wells, and even use them to melt ice
on driveways. In Sweden, the construction of two nuclear power plants has
been abandoned in favour of geothermal technology.

✧ Small and Micro-Hydro Power Systems

- Water flows from high to low points by the force of gravity. There is energy
  embodied in this flow of water, which hydroelectric power systems capture
to produce electricity. Small hydropower systems produce less than 20
megawatts of electricity, while micro-hydro systems typically generate less
than one megawatt of electricity. This technology is best used in tourism
facilities in mountainous regions where waterfalls provide a continuous
source of flowing water.

- The components of small hydro systems are:
  - the dam or weir to block the flow of water in a stream and create a
    reservoir;
  - the feeder canal to allow water to flow from the source stream into the
    reservoir;
  - the reservoir, which holds the water between the feeder canal and the
    intake pipe must be deep enough to submerge the inlet of the intake pipe
to ensure that air does not enter the power equipment;
  - the intake pipe connecting the reservoir and the powerhouse;
  - the powerhouse, which houses the turbine and other power producing
    and controlling equipment; and
  - the outflow canal, which allows water to flow from the powerhouse and
    back into the source stream.

- Hydro-electricity is generated by water entering the intake at a higher level,
  and falling through a pipeline onto blades/buckets of a turbine located lower.
The water (with most of its energy removed) then flows away from the
turbine and is returned to the source stream.

- The power available from flowing water depends on the:
• vertical distance over which the water ‘falls’,
• volumes of water flow,
• pressure of the water entering the power plant via the inset pipe, and
• efficiency of the turbine and generator equipment.

The basic small hydropower equation therefore is:

Power (kilowatts) = 10 x flow ($m^3$) x fall (m) x turbine efficiency
Friction losses can be accounted for by decreasing the fall variable by an appropriate amount.

• The costs of small hydro systems depend on the overall complexity, including type and size of the turbine and control equipment, generator and pipeline. At a good site, where there is an adequate amount of fall, it can be a more cost-effective option than PV or wind.

• The drawbacks are significant environment impacts. The construction of dams, weirs and canals alters the nature of streams and causes erosion, while the diversion of water into the turbine affects volume and flow of water downstream.

• Run-of-the-river-system plants offer some possibilities of minimising impacts. As the name suggests, such a power plant uses the embodied power in the river water as it flows through the plant without causing appreciable changes in the river flow. In addition, such systems usually do not require the construction of weirs or reservoirs.

Good Practice Tip:
To provide for the undisrupted migration of aquatic species, a continuous connecting stream of water between the dam and the outflow canal can be created, known as a ‘fish-ladder’.

Wind

• Wind is air in motion, caused by the uneven heating of the earth’s surface. Wind turbines capture the solar energy stored in the wind and convert it into electricity. They can be used as remote power systems or as grid-connected applications.
Wind power evaluation:

Evaluating the feasibility of wind applications is not simple. A few initial considerations are given below:

- **Wind flow:**
  For maximum efficiency, the wind flow should be reasonably constant and smooth. Turbines are best sited in windy locations with level ground, away from obstructions such as buildings, trees and mountains. Ideal sites for wind turbines are flat open plains, mountain passes and coastlines. Steep slopes and urban areas are not suitable, as obstructions such as mountains and buildings may cause winds that are too strong or turbulent for energy generation.

- **Wind speed:**
  The energy available in the wind is proportionate to the cube of its speed, which means that the doubling of the wind speed will increase the availability of energy by a factor of eight. Wind turbines have a minimum speed at which they begin to rotate and generate electricity, called the ‘cut-in’ speed. The power production increases as the wind gets stronger and the blades rotate faster, and levels off when the system reaches maximum efficiency. Some of the increasing power will not be captured owing to design constraints.

Grid connection applications require a minimum cut-in wind speed of 5 metres a second (18kph), while remote systems require a minimum speed of 3-4 metres a second (11-15kph).
The cut-out wind speed is the speed at which the turbine will shut down to prevent self-destruction of the blades, gearbox and generator.

- Capacity Factor:
  This refers to the expected energy output of a wind turbine per year.  
  \[
  \text{Capacity Factor} = \frac{\text{Actual energy produced}}{\text{Energy produced if the turbine operates at `rated power output'}}
  \]
  The ‘rated power output’ is the maximum amount of power that can be produced from a turbine.
  A reasonable capacity factor would be 0.25 to 0.3. A very good capacity factor would be 0.4. It is important to note that the capacity factor depends entirely on wind speed.

- Blade airfoil shape and diameter:
  The best rough estimate of a wind turbine’s energy production capability is the diameter of the blade, which determines the area ‘swept’ or ‘captured’. The turbine may have a good rated power, but if its blade diameter is too small, it will not be able to capture that power until wind speed increases, and little or no power will be produced during moderate winds. Blade foil shapes are primary factors in determining power production at moderate wind speeds.

- Battery banks:
  Battery banks must be housed in a dry, warm and well-ventilated area and be well maintained to allow maximum efficiency. Anti-freeze and anti-boiling liquids may be required for batteries in extreme temperatures.

**Costs - Wind Energy**
- Capital cost equipment: $600 - 2000 kWh
- Capital costs project: $800 - 2500 kWh
- Maintenance costs: < $0.01/kWh
- Life-cycle Cost: $0.04 - 0.15/kWh
- Operating Life: up to 20 years

**Common Question:**
*How costly are wind power applications?*
The capital costs of wind power may be relatively small, especially in comparison to PV systems. The price of the technology will be based on the rated power output, the cost of inverters and the battery bank.

- **Bio (fuels) biomass**
  Bio-fuels are organic (carbon-containing) matter than can be converted to energy. They include:
  - Plant products:
Plants derived from bio-fuels include oil crops (rape, linseed, sunflower, soya), timber and timber waste, woodchips, and agricultural residues such as grass clippings, shells, and leaves. Oil crops can also be used as fossil-fuel alternatives or in fossil-fuel blends.

- Animal wastes:
  By-products of animal waste such as slurry and chicken litter can be dried and used as fuel blocks.

- To derive energy from bio-fuels, the chemical energy in these materials is converted into heat, liquid fuels or electricity. This can be done through direct combustion, anaerobic digestion, gasification and fermentation.

**Box 5.7**

**Direct combustion** is the burning of materials by direct heat. Wood, woodchips, and dry agricultural and animal waste can be burned to generate heat for cooking and space and water heating.

**Anaerobic digestion** involves a complex process through which organic waste is fed into a digestive tank without air (hence anaerobic), and is converted into a mixture of methane (the major component of natural gas) and carbon dioxide. These gases can be used for cooking or to generate electricity. Animal, agricultural and food-processing waste is usually used for anaerobic digestion.

**Fermentation** refers (in this case) to the process through which fuel alcohol is produced by fermenting carbohydrates to sugar, and sugar to alcohol, and separating the water from the alcohol by distillation. Ethanol, or ethyl alcohol, is a product of fermentation and can be used as an alternative fuel for internal combustion engines. Wheat, barley, potato, waste paper, sawdust and straw (products containing starch, cellulose and sugar) could be fermented with yeast.

- The drawback with bio-fuels is that they emit carbon dioxide and nitrous oxides during combustion. The interest of most renewable energy sources is that they avoid the emissions of carbon dioxide, the most common greenhouse gas. However, as plants absorb carbon dioxide during their growth, they are not considered net contributors to the greenhouse effect.

Ethanol is an alcohol and bio diesel is an ester-similar to vinegar.

**RETSscreen**

A software program called RETScreen can be used to assess different renewable energy technologies. The software can be downloaded free of charge

http://www.retscreen.net/ang/home.php

### 3.1.5 Architectural Features to Reduce and Reuse Water

This sub-section will consider:

- collection and use of rainwater,
- grey and black water (sewage) treatment and reuse, and
- composting toilets.
Rainwater Collection

Rainwater from roofs, patios, driveways and other paved areas can be collected through a network of gutters and pipes and channelled into a cistern or a catchment basin. In larger buildings and areas where there is much rainfall, downspouts in gutters should be located every 20 feet (instead of the usual 40 feet) to ensure that they do not overflow. Catchment areas can be landscaped to look like ponds or marshes, which will increase the aesthetics of the landscaping effort.

Rainwater can be used for irrigation as well as a number of in-house uses such as washing and flushing, in evaporative cooling equipment and, after purification, in swimming pools.

Good Practice Tip:

Rainwater can contain many forms of impurities, especially in areas where rainfall is not frequent. If it is used for purposes other than irrigation, the quality of the water may need to be monitored.

Grey Water Reuse

- In hotels, grey water is wastewater from bathrooms, laundries and kitchens; black water is wastewater from toilets. Black water contains pathogens and almost 10 times more nitrogen than grey water. It therefore needs to go through a two-or-three-stage biological treatment process before it can be reused. Grey water treatment can be treated or re-used for toilet, flushing, irrigation, cleaning floors and in cooling towers.

- A suitable system is most easily incorporated into the initial design of properties, as separate drains and septic tanks have to be built. In the case of existing buildings, the feasibility and costs of retrofitting drainage systems and tanks within the existing structure must be studied closely. Lower water bills and effluent disposal charges will offset investments.

- The level to which grey water needs to be treated will depend on the level of biological oxygen demand (BOD) of the wastewater and the purpose for which the water is to be reused. The level of BOD refers to the level of oxygen extracted from the water by bacteria when the pollutants decompose. The more organic materials present in the wastewater, the higher the amount of oxygen needed to support the decomposition of the pollutants.

- In most hospitality businesses, grey water is reused for irrigation or flushing toilets. In this case, passing the wastewater through a sand filter may be sufficient. To maximise the efficiency of sand filters, it is important to minimise the suspended solids in the wastewater. Bathroom and laundry outlets should therefore be fitted with filters and grease traps should be added to kitchen outlets. But if the grey water is to be used for
drinking purposes, it must go through a complete biological treatment process.

❖ **Black Water or Sewage Treatment**

- Hospitality businesses, especially in remote areas, coastal regions and on small islands, are sometimes required by law to build sewage-treatment facilities.

- Sewage is a mixture of suspended and dissolved organic matter. The strength of sewage effluent is described in terms of suspended solids (SS) and biochemical oxygen demand (BOD). Conventional sewage treatment is a 3-stage process: preliminary treatment, primary sedimentation and secondary (biological) treatment.

- During preliminary treatment, the effluent is passed through large screens which filter out the larger floating particles and objects. This does not significantly reduce the pollution load of the effluent, but makes it easier to treat, as the large particles, which can block and damage equipment, have been removed.

- The next step is primary sedimentation. The effluent is piped into specially designed sedimentation tanks where the suspended solids are allowed to settle. The floating scum and the settled sludge is then removed. Over 55% of suspended solids are removed during primary sedimentation.

- The effluent goes through a secondary biological treatment process, which involves a reactor containing micro-organisms which oxidise the pollutants. The effluent is then pumped into a secondary sedimentation tank in which the micro-organisms are separated from the final effluent. The treated effluent is then discharged into a watercourse.

- The treatment of sewage sludge (from the primary sedimentation and secondary biological treatment process) is an integral part of sewage treatment. Sewage sludge has an offensive odour and is a health hazard as it contains bacteria and pathogens. It requires anaerobic digestion treatment during which the organic matter present in the sludge is converted into methane (70%) and carbon dioxide. Anaerobically digested sludge is often further de-watered in lagoons prior to disposal at sea or as fertiliser on land.

❖ **Alternative Sewage Treatment**

- These systems are designed to mimic natural wetland ecosystems. The wastewater is passed through a series of plants and micro-organisms to remove solids, bacteria and pathogens present in the sewage. Traditionally such systems required a fair amount of land, but modern

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4 Different terms may be used to describe the stages of wastewater treatment in different countries.
technology enables the wastewater to pass through a series of ponds and tanks where plants, invertebrates, fish and sunlight are used to clean it.

<table>
<thead>
<tr>
<th>The advantages of alternative sewerage systems are that they:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• are cheaper to operate,</td>
</tr>
<tr>
<td>• are less energy intensive,</td>
</tr>
<tr>
<td>• require less capital investment,</td>
</tr>
<tr>
<td>• require low maintenance,</td>
</tr>
<tr>
<td>• reduce chemical use, and</td>
</tr>
<tr>
<td>• provide an attractive and value added feature to the site.</td>
</tr>
</tbody>
</table>

**Composting Toilets**

- Composting toilets allow for the composting of waste in the toilet structure itself and do not require water for flushing. As with all composting practices, bulking material (hay, sawdust, wood shavings etc.) need to be added as regularly as the toilet is used to maintain the carbon and nitrogen balance, and the pile needs to be turned regularly. In cold climates, the toilet chamber needs to be insulated and heated.

- The heat generated from the composting process causes the moisture from the waste to evaporate. Therefore the toilet needs to be aerated through a vent and/or mechanical aerator. If the pile is well maintained, no odours will arise.

- In areas where water is scarce and water treatment is difficult, composting toilets can be an ideal alternative. Even when water is available, composting toilets will eliminate black water, which will greatly facilitate on-site wastewater treatment.

**3.1.6 Landscaping**

- Landscaping greatly improves aesthetics, and can be used to increase and decrease heating and cooling loads, improve air quality, provide a ‘sense of place’, and keep the occupants ‘in touch with nature’.

- The need to air out buildings through the provision of open spaces is now widely accepted, but is all too rarely given consideration until the site has been cleared and the buildings erected. Sustainable design encourages developers to consider landscaping when the buildings are being designed, and to use the existing physical features of the site to enhance and improve the efficiency of sustainable design. For example, large deciduous trees can be used to reduce cooling loads in the summer and increase solar gain in the winter. Natural gradients can be used to facilitate the collection of rainwater and the landscaping of ponds, mini-wetlands and other features.
Box 5.8

Landscaping checklist for tourism facilities:

- Open spaces, gardens and outdoor swimming-pools should be considered as ‘outdoor rooms’. They should be as comfortable and relaxing as the interiors.
- During building and excavation, preserve as much of the original vegetation as possible. Give special attention to mature trees that take years to grow and rare species that may be difficult to regenerate.
- Select new plants that are native species and will blend in with the existing ecosystem.
- Design to promote the composting of kitchen and garden waste, dispensing with chemical fertilisers.
- Make provisions for edible landscaping. Vegetable plots and orchards can be interesting and innovative landscape features; produce can be offered on the menu (as seasonal or home-grown specialities) and used for preserves and marmalades.
- Experiment with permaculture, the growth of different types of fruit trees, vines and ground crops that support each other in a symbiotic manner.
- Water in the evening or morning to reduce evaporation. Where water is scarce, use drought-resistant plant species.
- Collect and use rainwater and grey water for irrigation.
- Resist the temptation to create lawns on parts of the site where the natural vegetation was destroyed. Preserving and restoring vegetation will add landscape features and provide for a series of small lawns that are less resource-intensive to maintain.

Box 5.9

Xeriscaping®

“Xeriscaping” means saving water through landscaping. It involves a range of techniques including soil improvement, practical turf areas and plant selection that allow irrigation water requirements to be met by rainwater and natural water percolation in soils.

Some Xeriscaping tips:

- Plants with similar water requirements can be planted in groups or beds, and not scattered all over the area. This allows irrigation to be zoned according to the plants’ needs.
- Slopes can be terraced to allow water to soak into the soil. Plants with the most water needs should be placed on gradients, which receive the most water. Raised beds should be avoided as they can dry out very quickly.
- Plants that need a lot of water can be placed near buildings where they can be supplemented with wastewater from vehicle washing, kitchens or run-off from paved areas.
- Stronger and more drought-tolerant plants should be exposed to prevailing winds: they will provide a buffer for more fragile species.

\[5\] Xeriscaping is a registered trademark of the National Xeriscaping Council Inc. of Austin, Texas, USA.
3.2 Environment Considerations for the ‘Building Shell’

3.2.1 Windows

- Windows can be used to enhance day lighting, control ventilation and humidity, provide pleasant views and make the building more attractive from the outside.

- There has been great improvement in the design of windows. Among the latest innovations are the diverse models of triple-paned windows, usually made of argon or krypton glass. Some models have low emissivity coatings, which allow varying levels of natural light (short-wave radiation) to enter, and prevent heat (long-wave infra-red radiation) from entering and leaving. It is therefore possible to select window models based on the orientation of buildings as well as the lighting, heating and cooling loads required. Windows with integrated PV technology are also available.

- Architects are working on varying the functions of windows through increasing use of skylights, vents, and glass roofing features, and on the innovative placement of windows in balance with interior and exterior doorways.

3.2.2 Insulation

- Heat transfer through walls, floor and roof occurs through infiltration, conduction and radiation. Insulation is essential to minimise heat loss. Different types of insulation are discussed in Unit 4.

Reminder:
1. The thickness of the insulation is crucial. Ensure at least 200mm for maximum efficiency.
2. The R-values should be a key consideration in the selection of insulation material. The R-value is a measure of thermal resistance. The higher the R-value, the greater the insulating properties.

3.2.3 Environment-Friendly Building Materials

Environment-friendly building materials include:

- products that are stronger and more durable;
- environmentally-certified materials, such as timber carrying a ‘sustainable-felling stamp’;
- products with reduced toxicity such as low VOC\(^6\) paints;
- materials made of recycled materials such as recycled glass insulation and roof systems;

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\(^6\) VOCs are volatile organic compounds that can vaporise into the atmosphere. Examples include chlorine, vinyl chloride, benzene, lindane, dieldrin, and DDT. In Europe and North America, the emission of many VOCs is now regulated with guidelines and maximum-concentration-admissible values.
• products with improved efficiency such as double-glazed and triple-glazed windows;
• locally produced building materials, which are likely to have lower life cycle impacts owing to considerably shorter transport distances; ‘buying local’ also helps promote local industries;
• materials with a lower embodied energy; embodied energy is the total amount of energy needed to produce a given material – the energy needed to grow, log and shape timber, to mine, extract, refine and produce copper, aluminium, steel and concrete, to polymerise and manufacture plastics from petroleum, etc.
• The American Institute of Architects provides the following coefficients of the embodied energy of building materials:

<table>
<thead>
<tr>
<th>Coefficients of Embodied Energy</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>Coefficient</td>
</tr>
<tr>
<td>Wood</td>
<td>1</td>
</tr>
<tr>
<td>Brick</td>
<td>2</td>
</tr>
<tr>
<td>Cement</td>
<td>3</td>
</tr>
<tr>
<td>Glass</td>
<td>4</td>
</tr>
<tr>
<td>Fibre Glass</td>
<td>7</td>
</tr>
<tr>
<td>Steel</td>
<td>8</td>
</tr>
<tr>
<td>Plastic</td>
<td>30</td>
</tr>
<tr>
<td>Aluminium</td>
<td>80</td>
</tr>
</tbody>
</table>

3.3 The Use of Resource-Efficient Technology, Fittings and Appliances During Occupation

Sustainable building design is not the end, just the beginning. Buildings have to be used and maintained to optimise the benefits of the sustainable design features and the technology incorporated in them. This also facilitates the implementation of EMS.

A few examples of resource-efficient technology are given below.

<table>
<thead>
<tr>
<th>Water related technologies:</th>
<th>Heating and cooling equipment:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• grey water reuse systems;</td>
<td>• renewable-energy systems;</td>
</tr>
<tr>
<td>• water-saving products such as low-flow showerheads and tap aerators;</td>
<td>• solar-powered fans, cooling systems and refrigerators;</td>
</tr>
<tr>
<td>• low-flush toilets and vacuum toilets;</td>
<td>• solar space heaters;</td>
</tr>
<tr>
<td>• waterless urinals;</td>
<td>• hydraulic space heating systems;</td>
</tr>
<tr>
<td>• alternative sewage treatment systems;</td>
<td>• heat-recovery systems;</td>
</tr>
<tr>
<td>• dishwashers that operate on 5.3 gallons (as opposed to 12.5 gallons) and 40% less energy than conventional models; and</td>
<td>• building management systems; and</td>
</tr>
<tr>
<td>• washing machines and dryers that use 14 gallons per full cycle; conventional models use 50 gallons of water and 50% more energy.</td>
<td>• combined heat and power systems.</td>
</tr>
</tbody>
</table>

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7 Great care must be taken when interpreting these numbers, as they vary from country to country based on the source of raw materials, production processes and transport distances.
<table>
<thead>
<tr>
<th>Energy-efficient lighting:</th>
<th>Waste management techniques:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• low-energy lighting fixtures,</td>
<td>• paper and plastic compactors,</td>
</tr>
<tr>
<td>• control systems such as dimmers, timers and</td>
<td>• composting vessels,</td>
</tr>
<tr>
<td>photoelectric cells, and</td>
<td>• paper and plastic bailing equipment, and</td>
</tr>
<tr>
<td>• solar-power DC exterior lighting.</td>
<td>• composting toilets.</td>
</tr>
</tbody>
</table>
SECTION 4  REUSE OF EXISTING BUILDINGS

Sustainable design recommends, as far as possible, retrofitting and repairing existing buildings, instead of continuing to build new structures. If existing structures are beyond salvation, it is important to see if any of the materials can be reused in the new buildings.
SECTION 5 THE SUSTAINABLE CONSTRUCTION OF BUILDINGS

If the full benefits of sustainable site selection and building design are to be realised, the construction phase must also be planned and conducted with environment consideration.

In the run-up to the construction phase, it is common practice for some design and material specifications to be revised and alternatives considered. Care must be taken to ensure that the chosen alternatives do not impair the sustainable design features, reduce the energy and material efficiency of the building, or compromise on the use of environment-friendly building materials.

The environment integrity of the site must be preserved at all costs. Bulldozing is to be avoided, vegetation cleared only where buildings are to be erected.

The recommendations of the EIA should provide valuable guidance throughout construction, especially in identifying vegetation that needs to be protected, reducing waste and emissions, the use of prevailing vegetation in landscaping, and preventing the erosion of topsoil and the siltation of nearby waterways.

Sustainable construction is also about making the construction site a cleaner and safer workplace:

- Separate areas should be provided for the storage of hazardous and toxic materials.
- Recycling collection points for construction debris, food waste and packaging waste need to be set up.
- Safety equipment and protective clothing should be provided.
- Safety standards on the use of construction equipment and exposure to toxic materials should never be compromised.
- Procedures and safety measures in the case of fire, spills and accidents should be clearly understood and respected.

These criteria also apply to the refurbishment of existing buildings.
SECTION 6 CONCLUSION

Since the early 1990s, there has been a tremendous increase in the application of sustainable design. In many countries, EIA legislation is now mandatory for large and medium scale tourism developments, while passive solar design and energy-efficiency has been incorporated into building codes.

In June 1993, the International Union of Architects and the American Institute of Architects signed a joint Declaration of Interdependence for a Sustainable Future. This declaration makes a formal commitment to place environment and social sustainability at the core of architectural and building design considerations.

Developers should not be discouraged if sustainable design requires extensive budgeting at the onset, for it will bring considerable overall savings later. For example, PV roofing and double-glazed windows may be more expensive to purchase, but these costs will certainly be absorbed by the energy savings made when the building is in operation.

‘In the case of any hospitality business, the attractiveness of the physical structure is vital to its success. In a very real sense, design and ambience have a ‘dollar-and-cents value’. Every hospitality building requires thoughtful design, but resort hotels – which exist only for the pleasure of their users – demand it.’
G.J. Wimberly, Travel and Tourism expert, 1977
### Bibliography and additional recommended resources

#### UNIT 5

<table>
<thead>
<tr>
<th>Title</th>
<th>Author(s)</th>
<th>Publisher/Year/ISBN</th>
<th>Links</th>
</tr>
</thead>
</table>
| A Primer on Sustainable Building                                     | D.L. Barnett, W.D. Browning                                                | Published by the Rocky Mountain Institute, Canada                                   | Fax: +1 (303) 9273420
|                                                                     |                                                                           |                                      | Link: [www.rmi.org](http://www.rmi.org)                                        |
| Building Research Establishment, UK                                  |                                                                           | Building Research Establishment, UK                                                 | Link: [www.bre.co.uk](http://www.bre.co.uk)                                   |
| Carrying Capacity in Recreational Settings                          | B. Shelby, T.A. Heberlein, Oregon State University, 1997, ISBN 0870714260 | Central Rocky Mountain Permaculture Institute                                      | Fax: +1 923 664 010                                                        |
| Eco Architecture-Sustainable Design                                 | Giradet                                                                    | Academy Editions, 2000, ISBN 0 47199 899 0                                          |                                                                        |
| European Association of Renewable Energy Research                   |                                                                           | European Association of Renewable Energy Research                                |                                                                        |
|                                                                     |                                                                           | Link: [www.eurec.be](http://www.eurec.be)                                           |
| Green Development: Integrating Ecology and Real Estate              | A. Wilson, J.L. Uncapher, L.A. McManigal, L.H. Lovins, M. Cureton, W.D. Browning | Rocky Mountain Institute                                                          | Fax: +1-(303) 9273420
|                                                                     |                                                                           | Link: [www.rmi.org](http://www.rmi.org)                                             |
| Green Developments CD-ROM                                           | A companion to Green Development                                            | Published by the Rocky Mountain Institute                                          | Fax: +1 (303) 9273420
|                                                                     |                                                                           | Link: [www.rmi.org](http://www.rmi.org)                                             |
| Working Group on Developing Technology                              |                                                                           | Working Group on Developing Technology                                             | Link: [www.wot.utwente.nl](http://www.wot.utwente.nl)                           |
Photovoltaic Solar Energy - Best Practice Studies
Link: www.europa.eu.int/comm/dgs/energy_transport/index_en.html

Long Terms operation of combined heat and power in a hotel
Link: www.bre.co.uk

International Information on Renewable Energy Technologies
Link: www.cadet.co.uk

2020 Vision: The Engineering Challenges of Energy

WREN- World Renewable Energy Network
Link: www.wrenuk.co.uk

European Association of Renewable Network
Link: www.eurec.be

European Commission DGXVII Energy
Link: www.europa.eu.int/comm/dgs/energy_transport/index_en.html

CHPA- Combined Heating and Power Association
Link: www.chpa.co.uk

Solar Energy Industries Association (SEIA)
Link: www.seia.org

Alternative Technology Association (ATA), Melbourne
Link: www.ata.org.au

Australian and New Zealand Solar Energy Society (ANZSES)
Links: www.anzses.org
www.eco-web.org

American Wind Energy Association
Link: www.awea.org

Florida Solar Energy Center
Link: www.fsec.ucf.edu

Geothermal Heat Puma Consortium, Washington, DC
Link: www.ghpc.org

Geothermal Energy Association, Washington, DC
www.geotherm.org

Brooklyn Union Gas Website, Products and Services
Links: www.bug.com/product/fuelcel.htm
www.thinkenergy.com

U.S. Department of Energy, Office of Utility Technologies
www.eren.doe.gov/utilities/hydrogen.html

U.S. Department of Energy, Federal Energy Technology Center
“Fuel Cells Overview”
Links: www.igc.apc.org
www.maho.org
www.realgoods.com

http://www.uneptie.org/PC/tourism/library/energy.htm

http://www.buildingforafuture.co.uk/summer04/natural_swimming_pools.pdf
http://www.greenlodgingnews.com/HotelSchools.aspx
UNIT 5: Exercises

1. GROUP PROJECT

Develop checklists for environmentally sound:
- siting,
- building design and orientation,
- renewable energy use, and
- construction and selection of building materials

for each of the following hospitality businesses:
- a 1,000-room city hotel,
- a 25-room mountain guest house,
- a 100-room beach hotel,
- a 15-room holiday village bordering a rainforest, and
- a desert campsite for approximately 35 people on desert safari, located a kilometre from an oasis.

2. GROUP PROJECT OR WRITTEN ASSIGNMENT

Develop guidance notes on ‘energy sources and energy efficiency’ for hospitality developers in:
- the northern hemisphere, and
- the southern hemisphere.

3. WRITTEN ASSIGNMENT

Are there trials and demonstration projects for environment-friendly building design in your country or region? (These need not be tourism or hospitality businesses). Arrange a field visit to one of these properties. Include a question-and-answer session with the developers and managers.

Write a report of 1,500 words on the sustainable design features used and the benefits they are bringing to the property.

4. GROUP PROJECT OR WRITTEN ASSIGNMENT

Develop an interior decorating and furnishing checklist for:
- a 500-room city hotel, and
- a 25-room rural guest house,
using materials produced within your region/country, and in keeping with your region/country’s typical and traditional designs and styles.

5. WRITTEN ASSIGNMENT

Critically discuss the following statement:

‘Just as hospitality developers as a group are becoming more sophisticated, travellers are seeking to transform their lives in some sort of way, through education, culture, and recreation. The designing of the resort can enhance this kind of experience. Travellers know the difference between a well designed and a poorly designed resort. As a result, it is much easier now to
appeal to the conscience of the developer and explain why an environment-sensitive design makes sense – because ‘eco’ also stands for economics.’

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