Sustainable Hotel
Siting, Design and Construction

The industry guide to good practice

Conservation International

International Tourism Partnership

1 INCEPTION

First published 2005 | Digital Release 2014

This report was published in 2014 when Sustainable Hospitality Alliance was known as International Tourism Partnership (ITP), part of Business in the Community (BITC).

1.1 Finance

Finance is important throughout the life of a hotel and is particularly important during the design and initial development phase. Various financing services are available for different requirements and stages, including development, leasing, working capital needs, refurbishment and insurance. These services are made available through providers such as investment funds, banks, mortgage and leasing companies.

Financiers are increasingly incorporating environmental and social performance into their investment decision making in order to minimise their risk and exposure to liabilities.[8] This is likely to have a number of implications for hotel siting, design, construction and operation.

Machu Picchu Sanctuary Lodge, Peru. In the refurbishment of the Lodge, Orient Express Hotels looked to blend the property visually with the surrounding UNESCO World Heritage Site with the support of the IFC, who helped to finance the project. The new roof matches the colour of the surrounding vegetation (previously it was red) and the gardens have been planted with indigenous rather than exotic species.

1.1.1 Risk management

The financial sector now actively considers environmental and social risk in its investment decision making.[9] This move has been driven by several factors but, in the tourism sector, it relates particularly to:

- Minimising **reputational risk** to banks by exercising caution over investing in projects that may create adverse environmental and social impacts.

[8] As evidenced by publications such as 'Clear Advantage: Building Shareholder Value' and 'Financing the Future: The London Principles—The Role of UK Financial Services for Sustainable Development'

[9] See the Equator Principles (www.equator-principles.com), the Association of British Insurers (ABI) publication 'Risk Returns and Responsibility' and Swiss Re's publication 'Environmental Management Systems and Environmental Impairment Liability Insurance'

- The recognition that environmental and social issues such as climate change and community unrest can have a direct and significant impact on **investment performance and returns**.

Evidence of capacity and commitment to manage environmental risk, environmental impact assessments (EIAs) and audits are increasingly required as part of loan and investment decisions. Over 25 leading commercial banks have adopted the Equator Principles, which provide a common framework for commercial lenders to ensure that the projects they finance 'are developed in a manner that is socially responsible and reflects sound environmental management practices'. The principles apply to projects with a capital cost of US$50 million or more and are intended to become an important element of lender due diligence and borrower compliance and part of the project management process, extending over the life cycle of a development.

Developers and hoteliers that can demonstrate that they understand and can manage their environmental and social impacts will be at an advantage. Access to capital will become increasingly difficult for hotel companies and developers who cannot demonstrate good environmental practices or whose facilities are sited in areas likely to experience environmental or social risks.

1.1.2 Opportunities

The financial sector will increasingly look to invest in projects and operations that can demonstrate higher levels of environmental and social performance. This trend began with the introduction of Socially Responsible Investment (SRI)[10], but other forms of finance are following suit. The insurance sector in particular is paying considerable attention to environmental liabilities and risks associated with the poor siting of facilities, largely as a result of increasingly stringent legislation and planning policy.

As the requirement for more comprehensive and informed reporting of environmental and social performance becomes more commonplace, leading-edge companies will be able to capitalise on the commercial advantages of sound environmental performance. In the case of **developers** this means providing evidence that siting and development planning has addressed local environmental and social needs such as the protection of natural habitats and appropriate consultation with local communities as part of the EIA or planning process. **Hotel companies** can benefit by demonstrating energy and water efficiencies and other environmental initiatives. Sophisticated approaches to environmental management have direct financial benefits to hoteliers (for example, reduction in energy and water consumption by even 20% can have a significant impact on bottom line profits over the lifetime of the building), but they may also create new markets for financial products and services. For example, in the UK the introduction of 'green' mortgages[11] enables businesses that contribute positively to the environment (by addressing issues such as climate change, resource pressures and pollution) to benefit

[10] For example the Dow Jones Sustainability Index and the FTSE4Good Index Series which measure the performance of businesses that meet globally-recognised corporate responsibility standards with the specific purpose of facilitating investment in those companies.

[11] Following the launch of a green mortgage for home buyers in 1998 and the Carbon Neutral® mortgage in 2000, the Norwich and Peterborough Building Society introduced the first green commercial mortgage for businesses in 2004, developed with the UK Centre for Economic and Environmental Development.

from a discount on the interest rate. A recent report by Building Operating Management[12] suggests that pooling green mortgages into securities and showcasing their value in the financial market is likely to create a step change in investor interest in such buildings.[13]

1.1.3 Public policy and incentives

Incentives for more appropriate siting and the development of more sustainable buildings are becoming more common as planning and regulatory agencies begin to address national commitments made at the World Summit on Sustainable Development (WSSD), the Kyoto Protocol and other international commitments.

National responses will vary, but tax breaks, expedited planning approvals and other public incentives that encourage more sustainable hotel siting, design and construction seem set to increase. As these are implemented, the financial sector will begin to refine its products and services.

- **Legislation** to avoid or buydown risk, such as the EU Environmental Liabilities Directive,[14] will make companies whose activities have caused environmental damage financially liable for remediation. Banks will begin screening to avoid the likelihood of investing in companies with latent or active liabilities.
- **New financing opportunities** such as tax breaks or capital allowance schemes will encourage developers and owners to incorporate resource-efficient technologies into buildings. For example, the UK's Enhanced Capital Allowance Scheme[15] enables businesses to claim 100% of first-year capital allowances on qualifying plant and machinery such as cogeneration or combined heat and power (CHP) systems, heat exchangers, energy-efficient lighting and water conservation equipment. Businesses can write off the whole of the capital cost of their investment against their taxable profits of the period during which they make the investment.
- Assistance in the form of **technical support** or **construction materials** may be available to developers. For example, in the US, the New York State Energy Research and Development Authority (NYSERDA) offers technical and financial incentives to accelerate the incorporation of energy-efficient and renewable energy sources into the design, construction and operation of commercial buildings.[16] Other forms of technical assistance are likely to become available and the Internet is a good source of information.

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[12] 'Green CMBS', A report prepared on behalf of the Institute for Market Transformation to Sustainability by Building Operating Management, October 2004 issue, **www.facilitiesnet.com/bom**

[13] In Europe and the USA the growing market for commercial mortgages provides both liquidity and diversification for large commercial real estate investors, including insurance companies and large pension funds. This has led to the creation of commercial mortgage-backed securities (MBS) for green buildings, because such buildings represent higher value and lower risk to investors. The popularity of commercial MBS is expected to increase as investment bankers become more aware of the higher value of green buildings from lower operating costs, greater occupant satisfaction, increased tenant retention and greater access to capital.

[14] EU Environmental Liabilities Directive (Directive 2004/35), **www.europa.eu.int**

[15] See **www.eca.gov.uk**

[16] NYSERDA New Construction Financial Incentives – PON 815, **www.nyserda.org**

1.1.4 Implications for hotel companies and developers

- **Accessing capital** will get harder unless developers and hoteliers can demonstrate high levels of environmental and social risk management.
- **Partnerships** within the industry will increasingly address the challenge of improving environmental performance, which will open up new financing opportunities and services.
- **Reporting and demonstrating higher levels of environmental and social performance** will become more important to investors. With this expectation will come a growing need to develop reporting[17] and benchmarking tools that demonstrate company commitments, capacities and track records.
- **Engaging and communicating with other stakeholders** including investors, local communities and civil society will be the norm for most large developers and hotel operators.
- The **wider environmental and social impacts** of the sector 'beyond the footprint' will start to be tracked by investors through, for example, supply chains and the cumulative impacts of individual operations (since risk will be recognised and attributed to financial service clients). This will increase and deepen the need for more sophisticated environmental and social management within the sector.

More information

Clear Advantage: Building Shareholder Value
A tool to enable businesses to measure, manage and communicate EHS value to the financial community.
Global Environmental Management Initiative, 2004
www.gemi.org

Environmental Management Systems and Environmental Impairment Liability Insurance
Swiss Re, 1998
www.swissre.com

Financing the Future: The London Principles: The Role of UK Financial Services in Sustainable Development
Forum for the Future for the UK Department for Environment, Food and Rural Affairs (DEFRA), 2002
www.cityoflondon.gov.uk/services/environment-and-planning/sustainability/sustainability-and-the-environment/Documents/SUS_financingfuture.pdf

Funding Green Buildings Toolkit (formerly the EnergyWi$e Construction Funding Directory)
A guide to grants, technical assistance, creative financing and private-public partnerships for commercial green buildings.
The McAdams Group, 2004
www.fundinggreenbuildings.com

Global Reporting Initiative (GRI) Sustainability Reporting Guidelines:Tour Operators Sector Supplement
GRI and Tour Operators Initiative, 2002
www.globalreporting.org

Green CMBS
A report prepared on behalf of the Institute for Market Transformation to Sustainability by Building Operating Management.
October 2004 issue
www.facilitiesnet.com/bom

Is Biodiversity a Material Risk for Companies?: An Assessment of the Exposure of FTSE Sectors to Biodiversity Risk
F&C Asset Management (formerly ISIS Asset Management), 2004
www.businessandbiodiversity.org/publications.html

Risk Returns and Responsibility
Association of British Insurers (ABI), 2004
www.abi.org.uk

[17] 'Global Reporting Initiative (GRI) Sustainability Reporting Guidelines: Tour Operators Sector Supplement', GRI and Tour Operators Initiative, 2002,

1.2 Project team formation and objective setting

Success in achieving a more sustainable hotel building can only happen if all parties are aware of the importance that will be placed on sustainability from the outset and what is expected from them in helping to achieve it. This should be reinforced throughout the course of the project. The client needs to demonstrate a clear vision of the outcome, take a strong leadership role over the supply chain and remain committed to adhering to sustainable principles throughout the development process, even when presented with obstacles. Capacity building and awareness-raising programmes, using induction tools such as The Natural Step,[18] may be valuable in creating a cultural shift, both within the client organisation (from board level downwards) and to help bind the supply chain together.

Though some compromises may be inevitable, time and effort spent defining and communicating the 'mission' at inception will repay itself as the project progresses. It will also help to keep the building project on track and facilitate assessment of its success on completion.

A. The first step is to **define the mission**. In setting objectives, consider the economic, environmental and social aspects of the project (in all its phases) and define the acceptable limits of change for the area and community where the development will be situated.

B. **Assemble a multidisciplinary project team**. It may be sensible to enlist the services of a specialist consultancy to help with this if sustainability concepts are new to the client or developer. In selecting architects, engineers, designers, contractors and suppliers, it is important to ask about their previous experience on environmental development projects and examine the credentials of potential team members carefully. Do they operate an environmental management system (EMS) such as ISO14001 or EMAS?[19] Do they have their own sustainability policy? It should be explained to all of them that sustainability will be a key part of the project.

C. Ensure that '**sustainability clauses**' are incorporated into all contracts and legal agreements and that you are aware of the legal and regulatory framework of the country in which the project is to be located. It is advisable to consult someone with expertise in environmental and sustainability matters to ensure these issues are properly covered.

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[18] The Natural Step framework sets out ways to achieve a sustainable society and states that nature should not be subject to systematically increasing: 1) concentrations of substances extracted from the earth's crust, 2) concentrations of substances produced by society, 3) degradation by physical means and that 4) human needs are met worldwide. **www.naturalstep.org**

[19] ISO 14001—the standard issued by the International Organisation for Standardisation, www.iso.org , EMAS—Eco-Management and Audit Scheme, **www.emas.org.uk**

D The **procurement process** and effective **supply chain management** will play a deciding role in whether the project retains its sustainable objectives. Develop a policy for procurement that defines the sustainability criteria to be met by suppliers and products (for example, using life cycle analysis and identifying resource efficiency targets). Decide what the tolerances will be and how much extra you may be prepared to pay for goods and services that will help you meet the project objectives. There are many tools and sources of guidance on how to arrive at the most sustainable solution, especially where it comes to the selection of materials.[20]

E Develop **reliable forms of measurement**, such as Whole Life Costing (WLC),[21] with which to measure capital and operating costs and benefits and deliver a 'value for money' and a sustainable project. WLC considers not only the initial capital costs of construction (including the costs of planning, design and acquisition), but also the operational costs of the building over its lifetime (running costs, maintenance and disposal less any residual value). The cost and business benefits should be quantified for each component and each phase of the building's life cycle and minimised wherever possible without sacrificing quality. The aim is to deliver 'the optimum combination of whole life cost and quality (or fitness for purpose) to meet the customer's requirement'. *See also **Section 3** Creating the Design Brief.*

F Ensure that **linguistic and cultural differences** are taken into account in dealings with the community, contractors and the general public.

More information

Achieving Excellence in Construction Procurement Guide 07: Whole Life Costing
UK Office of Government Commerce, 2003
www.ogc.gov.uk/sdtoolkit/reference/achieving/ae7.pdf

BRE WLC Comparator
Tool to calculate the whole life costs of building components.
Building Research Establishment
www.bre.co.uk/page.jsp?id=48

Envest 2
Software tool designed to simplify the process of designing buildings with low environmental impact and whole life costs.
Building Research Establishment
http://envestv2.bre.co.uk

EQUER
A life cycle simulation tool for buildings.
Centre for Energy Studies, Ecole des Mines de Paris
www.cenerg.ensmp.fr

Green Guide to Specification: Third Edition
A quick and easy way to access the environmental performance of over 250 construction specifications.
Building Research Establishment, 2002
www.brebookshop.com

Norwich and Peterborough Building Society
www.npbs.co.uk

The Costs and Financial Benefits of Green Buildings: A Report to California's Sustainable Building Task Force
California Integrated Waste Management Board, 2003
www.ciwmb.ca.gov/GreenBuilding

The Natural Step (TNS)
www.naturalstep.org

Whole Life Cost Forum
The UK National Initiative on Construction Whole Life Costing
www.wlcf.org.uk

[20] For example the 'Green Guide to Specification' and 'Envest 2' published by the Building Research Establishment, www.brebookshop.com

[21] More information from the Whole Life Cost Forum (the UK National Initiative on Construction Whole Life Costing), www.wlcf.org.uk

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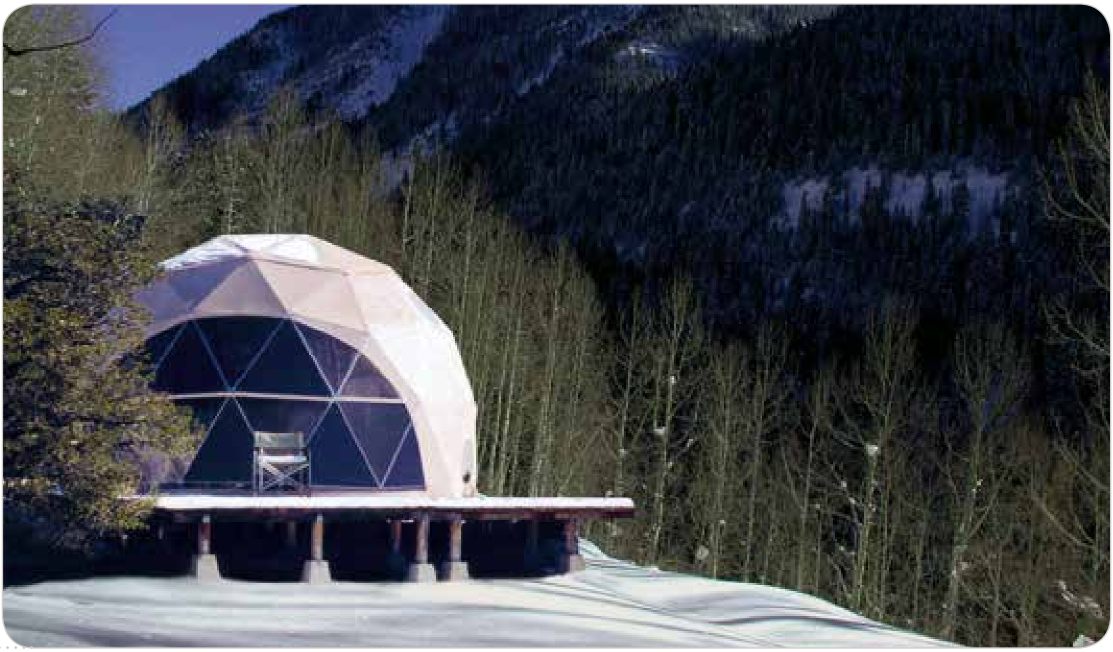
2 PRE-DESIGN

First published 2005 | Digital Release 2014

PRE-DESIGN

Before the design phase of the project can commence, there are a number of steps to be completed that will have a major bearing on the sustainability of the building. These include selecting the most appropriate site for the development, consulting fully with stakeholders in the local community, conducting an environmental impact assessment and creating an overall design brief and sustainability 'master plan' that takes these factors into consideration.

2.1 Site selection



Whitepod, Villars, Switzerland, designed to be in harmony with nature and its surroundings. Come spring it 'melts away with the snow.'

See Case Study 1, Appendix 1.

In selecting a suitable site, one of the most important considerations is whether the proposed scale of the development is appropriate for and compatible with current and future land use policies.

Hotel developers should not imagine they are starting with a blank piece of paper during the site selection process. Analysis of the unique natural and cultural features of any site needs to be carried out in order to maximise the benefits of these features during the design and construction phase. Nearby ecosystems and wildlife and the potential impacts caused during the development process should also be taken into account. For example, in coastal ecosystems, development projects that destroy mangroves can often lead to subsequent beach erosion and negative impacts on marine habitats and wildlife.

A It is essential that **wildlife** (particularly threatened or endangered species) and sensitive ecosystems, including protected areas, are not disturbed. If there is any disruption, it must be kept to an absolute minimum and full rehabilitation undertaken to restore the balance after the construction phase. This is increasingly a pre-requisite of planning consent.

B Choose a location that is sheltered and **away from high-risk areas** such as hurricane zones. If this is not possible, then ensure that the potential future effects of climate change (such as rising sea levels, flash floods and tidal waves) are factored into the design brief. In locations where extreme climate change episodes are becoming more common, ensure that additional caution is exercised over issues such as the distance of the site from any high water mark (100-year flood).

C If possible select a location that is **close to existing local public transport** networks and that these are of reasonable frequency. The presence of a hotel facility may increase the viability of an existing service or provide an opportunity to expand it.

D Where access to mains services already exists, consideration needs to be given to the increased demand that will be placed on **water and energy supplies**, as well as **waste** and **sewage disposal** facilities, and whether the existing facilities will need to be upgraded.

E Where possible consider renovating, restoring or re-using **existing buildings** in order to reduce the required input of new resources.

F Look at whether the building can be situated on **previously developed land** in order to reduce development pressure on prime virgin land. 'Brown field' sites that have had a prior industrial use may require specialist clean-up and remediation if the land is contaminated with toxic waste, which may be expensive. However, redevelopment of this kind can be highly valuable in helping to re-invigorate the local economy and regenerate blighted areas. The long-term sustainability benefits can far outweigh the initial costs of cleaning up the land.

G Consider the likelihood that the presence of a hotel may increase demand for more recreational activities, and whether these can be supported, especially in ecologically sensitive areas and cultural and heritage sites.

2.2 Community consultation and involvement

The development of hotel accommodation of any size can be a contentious issue within a community. The building itself and the visitors it attracts will inevitably impact on the surrounding community. It is the responsibility of the hotel development team to manage the process of consultation with the community to mitigate any negative impacts and to maximise the benefits to and acceptance by community members of the new establishment. If they are not involved early on, important considerations may be overlooked. These may be costly to address at a later stage and will not foster the climate of consent within the community that will help the business to flourish. Establishing a participatory planning process involving comprehensive stakeholder dialogue at the earliest stage will be critical to the success of the enterprise.

Although it may not be possible to win over every member of the community, dialogue is the best way to build consensus and manage expectations.

A Consider the potential effects of the hotel development on the **local economy** and the **dynamic of the local community**, such as its cultural heritage and traditional activities. These elements must at all times play a central role in the design and development strategies, particularly in emerging economies.

B **Anticipate issues which will be emotive** among community members, for example: relocation of homes (which should only be considered if completely unavoidable), potential impacts during construction and operation such as noise, emissions, overshading, light pollution, odours etc. Make sure you address these as a priority in any communication with community members.

C **Research and document** the lifestyles of the surrounding communities so that this information can be shared with other members of the project team. Understand their values, traditions and beliefs, and how they are organised politically, economically and socially.

D **Create mechanisms and opportunities** (such as face-to-face meetings with community leaders and public forums) so that community members can participate in the hotel development process by sharing their concerns and showcasing their own strengths.

E Be **open, honest and transparent** in your communications with all external parties and avoid creating unrealistic expectations.

F Involve residents both as **participants** and **beneficiaries**. Consider the opportunities for **ownership** (by community members or the community as a whole) of all or part of the project.

G **Understand the community's needs**, and ensure that primary resources and services (i.e. water, energy and waste management) will be adequate to service the hotel development without encroaching upon the needs of the community. Explore opportunities for helping to establish facilities that can be shared by the community, for example, waste water treatment plants and recycling schemes.

H Seek to provide quality, meaningful **employment opportunities** for residents and workers in nearby communities during all phases of the project development and operation. Aim to employ a representative number of local staff at all levels of the organisation and provide appropriate recruitment and training opportunities. Ensure that the **employment standards** you practice locally meet with international company standards.

I Commit to providing **adequate staff housing** for hotel and support services staff within a reasonable distance from a property. This is of particular concern for new developments in rural areas where the secondary impacts of inadequate staff accommodation can have significant negative environmental and social implications.

J **Purchase materials and other supplies ethically**[22] **and, wherever possible, locally.** Identify economic activities in the community that can support the hotel, or that could be grown and developed in tandem with the hotel operation. For example, explore options for developing small businesses by sub-contracting selected hotel services, such as tours, laundry services or local transport.

K Promote an appreciation among local residents for their cultural values and lifestyle and the value of the site's characteristics, to encourage a **sense of local pride**.

L Create opportunities to **integrate with the community** such as offering access to the hotel's recreational facilities.

M Ensure that you comply with **local and national regulations** as a minimum standard.

[22] See 'Guidelines for European Companies on the Ethical Procurement of Goods World-wide', EuroCommerce and the Foreign Trade Association, 2001, www.fta-eu.org/doc/unp/opinion/en/social.pdf

Anangu Tours in Australia's Northern Territory provides a cultural learning experience for visitors. The company is owned by the local Aboriginal people.

See Case Study 3, Appendix 1.

More information

Guidelines for European Companies on the Ethical Procurement of Goods World-wide
EuroCommerce and the Foreign Trade Association, 2001
www.fta-eu.org/doc/unp/opinion/en/social.pdf

The Natural Step (TNS)
www.naturalstep.org

Pollution Prevention and Abatement Handbook: Part III Tourism and Hospitality Development
World Bank Group September 2001
www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/ifc+sustainability/publications/publications_handbook_ppah__wci__1319577543003

2.3 The Environmental Impact Assessment

Once the systematic integration of environmental values into the decision-making business process has been established, pre-planning traditionally involves the identification of environmental impacts by conducting an Environmental Impact Assessment (EIA). In many countries, an EIA is a formal legal requirement.

Some organisations, notably the World Bank Group, require an environmental assessment to identify and minimise and/or mitigate the potential impacts for any new tourism or hospitality project.[23] Where the project is in a remote or sensitive location, developers are required to address issues relating, for example, to power supply, habitat management (such as the provision of water to wild animals in the dry season), the construction of airstrips and the involvement of local communities in the project design and operation.

[23] 'Pollution Prevention and Abatement Handbook: Part III Tourism and Hospitality Development', World Bank Group, 2001,

It is worth noting that in some countries it is possible to obtain an EIA through corrupt government officials. Companies should avoid this temptation at all costs as it is not worth the potential risks to their reputation or license to operate should the fact later be uncovered. Increasingly, environmental pressure groups and other organisations are tracking the validity of the EIAs of major developments.

A

Ideally, an EIA should consider not only the environmental impacts of a new development but also the **broader sustainability agenda**. A number of sustainability 'checklists'[24] have been developed as self-assessment tools to encourage dialogue between developers, planners and the community and allow performance to be scored. These are often designed for whole areas and communities, rather than for individual buildings, but much of the content can be applied when considering hotel developments. The environmental, social and economic issues that need to be taken into account are:

- **Land use, urban form and design** (including local area plans and the opportunity for re-use of existing structures or sites).
- **Transport** (proximity to public transport, consideration of vehicle emissions and provision for parking).
- **Use of energy, water** and other **natural resources**.
- **Impact of buildings** such as emissions from boiler flues and kitchen exhausts, noise originating from the hotel roofs or facilities such as nightclubs and bars, overshading (where the building casts a shadow on other buildings), loss of daylight, obstruction of views and light pollution at night.
- **Impact of associated infrastructure** such as roads and lighting.
- **Biodiversity** and the effect the development will have on local ecological systems.
- **Community** (social and economic effects).
- **Business** (such as whether it will hinder or encourage existing or new enterprise development).

B

Within the sustainability agenda, **specific environmental criteria** should be investigated and evaluated including:

- **Vulnerability of resources**, ecosystems, and human communities to changes.
- Compatibility with existing, other or forthcoming **land use policies and plans**.
- **Compliance with environmental standards** for noise, air, surface water, ground water, and soil quality.
- Thresholds and **carrying capacities** for resources, ecosystems, and human communities.
- The effect on land and marine **protected areas** and sensitive or threatened **ecosystems**.
- Compatibility with **sustainable development principles**.
- **Disagreement among experts** as to the significance of anticipated effects.
- The **level of public concern** regarding the effects.
- **Added value of additional information** to the decision-making process.

C

The **EIA/sustainability review** process needs to be:

- **Comprehensive** (with an integrated approach to all major aspects and an assessment of alternatives).
- **Transparent**. Not only should the EIA identify strengths but also any weaknesses of the development. It is better to identify these and demonstrate efforts towards mitigation than for another party to 'uncover' them at a later stage. Supporting material should be made publicly available, should be in agreement with typical approaches and should include an assessment of what is not working so that lessons can be learned from previous errors.

[24] See particularly those of BRE, LEED and SEEDA listed at the end of this section.

- **Inclusive of involved stakeholders** (all appropriate and applicable bodies, authorities, specialists should be listed and consulted).
- **Credible** (i.e. decisions must be objective and the scope and results of the EIA should be independently verified).

D Procedures will vary by country but usually increase with the **size and complexity** of the building and the **sensitivity** of the site and surrounding areas. While environmental impacts may be comparatively low within cities, especially when existing structures are being reused, they become sizeable and controversial in ecologically sensitive areas, such as in tropical rainforests, coastal marshes, coral reefs, and where fauna and wildlife would be affected.

E Often there are **difficulties** with interpretation, evaluation, assessment methods, applicable legislation and conclusions which can cause controversy with special interest groups. An effective stakeholder dialogue can help to prevent or at least mitigate against these problems.

F An **overall feasibility study** will help to establish baseline requirements for the project, which include, but are not limited to, whole life costing, taking into account operational cost savings, potential future regulatory changes and non-tangible savings (such as gains from community support and satisfaction).

More information

A Sustainability Checklist for Developments: A Common Framework for Developers and Local Authorities
Building Research Establishment (BRE), 2002
www.brebookshop.com

Canadian International Development Agency Environmental Assessment & Compliance Unit
www.iaia.org

Conducting Environmental Impact Assessment for Developing Countries
United Nations University Press, 1999
www.earthprint.com

Environmental Impact Assessment
UNEP Production and Consumption Branch Environmental Management Tools.
www.uneptie.org/pc/pc/tools/eia.htm

Environmental Impact Assessment Handbook: A Practical Guide for Planners, Developers and Communities
Thomas Telford Ltd, 2002
www.ttbooks.co.uk

Environmental Impact Assessment (EIA) tool
The Global Development Research Centre website tool.
www.gdrc.org/uem/eia/impactassess.html

The European Eco-label for Tourist Accommodation Service
European Commission, Commission Decision 2003/287/EC, 2003
http://ec.europa.eu/environment/ecolabel/products-groups-and-criteria.html

Leadership in Energy and Environmental Design (LEED)
Green Building Rating System.
Developed by the US Green Building Council
www.usgbc.org/leed

Green Guide to Specification: Third Edition
A quick and easy way to assess the environmental performance of over 250 construction specifications.
Building Research Establishment, 2002
www.brebookshop.com

Guidelines For Environmental Impact Assessment
Institute of Environmental Management and Assessment, 2004
www.iema.net/shop

The Green Host Effect: An Integrated Approach to Sustainable Tourism and Resort Development
Conservation International, 1999
http://nsgl.gso.uri.edu/washu/washuw99003/7-Bruner_et_al.pdf

World Bank Group Environmental Assessment website
www.worldbank.org/environmentalassessment

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3 CREATING THE DESIGN BRIEF

First published 2005 | Digital Release 2014

CREATING THE DESIGN BRIEF

The design brief should be developed by the architect working in partnership with the client, the supply team, key stakeholders and any external specialists who may be called upon to advise upon the sustainability of the project. The design brief should develop and expand the project brief, providing greater detail but remaining sufficiently open-ended to allow for alternative solutions to be incorporated.

During the design phase, the client and the supply team can greatly influence the sustainability of a development. The key areas of focus should include the identification of preferred materials and identification of quantifiable benchmarks for issues such as energy and water efficiency and accessibility. All will have a significant influence on the final design and future performance of the building.

Al Maha Desert Resort in Dubai, United Arab Emirates, has assisted with the repopulation of its surrounding desert ecosystem with native animals and flora including two endangered species of oryx, an Arabian gazelle. The resort's design is based on a traditional Bedouin camp, with rooms made of canvas and stone.

Picture © Emirates, courtesy Al Maha Desert Resort

Successful buildings must achieve the following objectives:

- Functionality—how the space is to be managed for optimum use by its occupants.
- Build quality—the engineering performance of the building, which includes its structural stability as well as the integration and robustness of the systems, finishes and fittings.
- Impact—the ability of the building to create a sense of place, and to have a positive effect on the local community and environment. This also encompasses the wider effect its design may have within the design and construction community.[25]

[25] Design Quality Indicators, Construction Industry Council, www.dqi.org.uk

3.1 Key criteria

In addition to the above goals, there are several key criteria that need to be met both in the outline and detailed design briefs if the building aspires to be 'sustainable':

3.1.1 Protection and enhancement of the site

Every effort should be made to **limit the impact** of the development on local ecosystems and to **preserve and protect** biodiversity wherever possible. This should be addressed during the Environmental Impact Assessment *(see **Section 2.3**)*. Physical aspects of the development—such as the provision of water and energy resources, as well as effluent treatment emissions and their affect on the air quality, light, soil and surface and ground water quality—need to be considered in relation to the surrounding flora and wildlife. This is particularly important if any endangered or threatened species are present or the project is in or close to an area of high biodiversity. Plans should be drawn up to mitigate and offset any environmental impact caused by the development in consultation with key stakeholder groups (including conservation non-governmental organisations) and the opportunity taken to enhance local degraded areas.

3.1.2 Socio-economic effects

Consideration must be given to how the development can **positively** rather than negatively affect the neighbourhood, its inhabitants and the local economy and how to mitigate any potential negative impacts. This involves addressing issues such as additional traffic pollution, possible displacement of local residents, cultural or archaeological implications, ease of access and use for those with physical impairments, provision of recreation and sports facilities, tourism opportunities, sanitation and public health and consulting with members of the local community for their perspective on how they will be affected.

3.1.3 Aesthetics and building efficiency

It is important that the hotel building is **in harmony with the environment**, both in terms of being aesthetically pleasing and resource efficient. How it sits on the site, its orientation and layout, the use made of existing buildings and infrastructure, consideration of other purposes for the building and the materials from which it is made will all have a bearing on its aesthetic appeal. The project team needs to design for optimum operational performance and durability as well as factoring in what may happen at the end of its life. Could the materials and components be disassembled and reused or recycled rather than discarded? The quantity of materials used should be kept to a minimum and waste avoided as far as possible. The choice of materials should be guided by what is local and appropriate to the site, whether they are renewable or sustainably produced and taking into account any environmental impacts.

3.1.4 Quality of indoor and outdoor environment

Provision of a **high quality internal and external environment** will affect the way the hotel is perceived locally, the productivity of its staff and the general satisfaction of guests and visitors, all of which is important for business. Consideration needs to be given to the amount of daylight or shading that should be provided, opportunities to use natural ventilation, views from the building and making the development a pleasant place to be and use.

Indoor air quality can be improved dramatically through the use of **non toxic and non-VOC-emitting[26] materials**. Thermal comfort will be enhanced by the extent to which the building's occupants can control temperature, light and windows. The building itself and the equipment it contains should be well-insulated to cut down on noise. Health, life safety and environment issues such as air emissions, water quality, waste water control, prevention of Legionnaires' disease, fire extinguishing systems and avoidance of hazardous substances and waste all need to be factored in.

3.1.5 Energy efficiency

The aim should be to **reduce the development's environmental impact both globally and locally** by minimising the building's contribution to global warming, and its depletion of non-renewable energy sources and atmospheric ozone levels.[27] The aim should be to build using natural systems rather than replacing or working against them. This involves making good use of daylight (depending on the climate) and using natural ventilation, passive solar gain and passive cooling techniques. Consider whether energy can be supplied wholly or partially by renewable energy technologies such as photovoltaic solar panels, solar hot water collectors or wind generated electricity. Specify minimum efficiency levels for equipment, systems, fixtures and appliances and ensure that variable demands for air, water, lighting, energy and refrigerant can be met through the use of building automation systems. Provision should be made for energy (and water) consumption to be sub-metered by major department to enable monitoring to take place once the building is operational. It will also be important to plan in sufficient time for commissioning to ensure optimum equipment and systems performance.

3.1.6 Water efficiency

Assess by what means the hotel's requirement for water will be met, and whether the location will be able to support the additional demand without detriment to the **supply to the surrounding community**. Reduce the strain on local resources by establishing maximum demand and consumption levels. Consider water recovery techniques such as rain water harvesting, grey water recycling and xeriscaping (low water-use landscaping). Specify low water-use technologies and equipment.

3.1.7 Construction and development impact

If possible use a **design and construction team** with experience of 'green' development and suppliers with a proven environmental track record. It may be necessary to implement a training and awareness programme to ensure that all parties are at the same stage of the learning curve and aware of the sustainability goals.

Make it clear that in **preparing the site** for construction it should not be completely cleared or all vegetation removed, rather, existing vegetation should be catalogued and viewed as a potential asset for the development of the site. It may need to be screened with boarding, perhaps depicting an artist's impression of the hotel building, which creates an opportunity to explain the sustainability objectives to the community. Temporary infrastructure needs and impacts such as waste and waste water handling, storage, facilities and machinery, noise, transportation and the impact on local traffic will need to be assessed. Consider how storm water will be contained, erosion and sedimentation prevented and topsoil retained for landscaping the site.

It will also be necessary to **communicate with the local community** at each stage regarding what is happening, when they might expect high noise levels from activities such as pile driving or vehicles delivering building materials to the site.

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[26] Volatile Organic Compounds, found in some paints and varnishes.

[27] Ozone depleting substances include refrigerants such as HCFCs, the use of which is increasingly restricted around the world under the terms of the Montreal Protocol. More information is available from the UNEP Division of Technology, Industry and Economics (DTIE) OzonAction Programme, **www.unep.org/dtie/Branches/OzonAction/tabid/29688/Default.aspx**

3.1.8 Performance monitoring

It is important to **design and build in systems** that will facilitate operational aspects such as control of energy and water consumption, waste separation, recycling and composting and the storage and disposal of hazardous substances. Systems should be easy to operate and maintain and should also incorporate devices to enable performance monitoring so that targets can be set.

3.1.9 Ensuring high sustainability standards

Various methods can be used to help ensure high standards of sustainability and to keep the project on track. The most widely adopted are outlined below.

a **Life Cycle Assessment (LCA)** is the systematic identification and quantification of inputs and outputs of the project over its entire life cycle, from 'cradle to grave'. It is particularly useful in assessing the environmental performance of materials introduced into the building and can be integrated into the procurement process and in supply chain management.

b **Whole life costing** (also referred to in *Section 1.2*) is arguably the best way to quantify 'the financial value of a structure over its whole life, balancing capital with revenue costs to achieve an optimum solution.'[28] It involves the systematic consideration of all relevant cash flows associated with the acquisition and ownership of an asset and can be applied to an entire built structure or to any individual component. In a typical office building, for every unit spent on design, five are spent on construction, 20–50 units on operating costs over its lifetime and 200–500 units on the occupants' salaries. If the building is designed and constructed to halve the operating costs, the savings would be 10–25 units. If the design makes the occupants just 5% more productive, the savings would be a further 10–25 units. To achieve these savings requires more input at the design and construction stages, but there is a clear business case for the developer to justify spending up to five times more on both design and construction, without increasing the life cost of the building.

c **Design Quality Indicators (DQI)** developed by the Construction Industry Council in the UK. DQI is an online tool for use by stakeholders such as the client, members of the design team, users of the building, contractors and facilities managers who are guided through the process by a trained DQI facilitator. It can be used at any stage in the development of a building project and can be used repeatedly at successive stages such as briefing, mid-design, ready-for-occupation and post occupancy. The questionnaire automatically adjusts the questions displayed so they are relevant to the particular phase of the project that is being assessed.

More information

Achieving Excellence in Construction Procurement Guide 07 Whole Life Costing
UK Office of Government Commerce, 2003
www.ogc.gov.uk/sdtoolkit/reference/achieving/ae7.pdf

American Society of Landscape Architects
www.asla.org

BRE WLC Comparator
A tool to calculate the whole life costs of building components.
Building Research Establishment
www.bre.co.uk/page.jsp?id=48

Design Quality Indicators
Construction Industry Council
www.dqi.org.uk

Green Building Advisor
A software program designed to help architects and other building professionals design occupant-friendly and environmentally-friendly buildings.
www.greenbuildingadvisor.com

Sustainable and Secure Buildings Act 2004
Amends the existing Building Act to enable building regulations in the UK to address sustainability for the first time.
www.legislation.gov.uk/ukpga/2004/22/contents

[28] 'Achieving Excellence in Construction, Successful Delivery Toolkit', UK Office of Government Commerce, **www.ogc.gov.uk/sdtoolkit/reference/achieving/index**

Sustainable Hotel
Siting, Design and Construction

The industry guide to good practice

Conservation International

International Tourism Partnership

4 ARCHITECTURAL AND PHYSICAL DESIGN

First published 2005 | Digital Release 2014

ARCHITECTURAL AND PHYSICAL DESIGN

Communicating the overall sustainable vision to members of the planning, design and construction teams will help them to think of the hotel as a complete, interdependent system with specific features and performance requirements and not as a collection of electrical, mechanical and structural engineering disciplines.

The design process requires an interactive approach where everyone involved in the use, operation, construction and design of a hotel interacts closely to understand the issues and concerns of all the other parties, and then makes decisions based on the sustainability principles that have been defined for the project.

A sense of place: The **Kasbah de Toubkal** in the High Atlas, Morocco, appears to have always been part of the landscape despite the fact that most of it is only ten years old.

See Case Study 6, Appendix 1.

4.1 General considerations

A

The **main factors** which affect the sustainability of a hotel property at the design stage are described in Section 2 and include:

- Whether the **design and scale** of the development are appropriate when assessed using economic, cultural and ecological criteria.
- The **layout** and orientation of the buildings on site and the **aesthetic** sensitivity with which they are designed.
- The priority given to preservation and enhancement of **natural and cultural elements** of the location, including external landscaping.
- The extent to which all **stakeholders** are considered and the quality of the consultation process. This will involve ensuring that the building is **inclusive and welcoming to all visitors and guests** including those with visual, hearing and dexterity impairments and other disabilities,[29] not only through wheelchair accessibility in public areas, but also in the ease of use of room features.

[29] Between 10 and 20% of every country's population are disabled and many more people, including friends and carers, are affected by disability. Source: World Bank, www.worldbank.org/disability. In the USA alone, disabled travellers take 31.7 million trips, spending $13.6 billion annually. Source: Open Doors Organisation, www.opendoorsnfp.org

- How the design will affect **water, energy, waste, indoor air quality, chemical and noise** management both during construction and operation.
- The design of **general service requirements**, including HVAC, plumbing, electrical services.
- The selection and use of **materials** including the ability to reuse or **recycle** selected materials and reduction of the total volume of materials required.
- The impact of the design on **construction requirements** including access issues and existing infrastructure.

B The overall design, materials and building systems should be all evaluated for **capital and operational cost, future flexibility, efficiency, environmental** and **societal** impact and **quality of life** for the building's occupants. *See* ***Section 3.1.9.b*** *Whole Life Costing.*

C **Multi-functional use** of parts, features and systems will maximise cost effectiveness, efficiency and building functionality. This ranges from simple multi-use of cables, grouping a building's infrastructure into single trenches and tunnels, to more complex multifunctional use of structural features and technical equipment.

More information

European Institute for Design and Disability
www.design-for-all.org

Business Disability Forum
http://businessdisabilityforum.org.uk

UN Global Programme on Disability
www.un.org/esa/socdev/enable

World Bank
www.worldbank.org/disability

4.2 Promoting a sense of place

The hotel building should be designed to promote a 'sense of place' which sits comfortably with cultural and historical features of the region and local traditions so that the establishment blends into its surroundings and reflects the identity of the local culture and environment.

A Identify **appropriate environmental and social design standards** from the first stages of the design process.

B Where possible use **local cultural motifs** and **traditional styles and materials** both in the construction and for interior design.

C **Follow the main features** and contours of the surrounding landscape. Limit the height of buildings so they fit within the topography. In coastal developments ensure that developments are set well back from the shoreline.

D Build from the natural features and **ecological services** (fresh water, air quality, etc.) provided by the site.

E Employ **local crafts people** to advise on concepts and make use of **traditional skills** they possess.

F **Honour local traditions** by 'designing-in' areas within the property that can, for example, cater for traditional ceremonies and religious events where appropriate.

G Seek to **reuse and adapt** existing buildings where possible. Consider allowing for façade preservation and the reuse of existing structures during renovation or redevelopment.

4.3 Conserving biodiversity

Insensitive hotel development can destroy vegetation and wildlife and the ecosystems that sustain them. Biodiversity is the term used to describe the variety of all forms of life, from genes and species to ecosystems, and protecting these natural assets is increasingly recognised as an important element of sustainable development.

If the hotel development is in an area of high biodiversity, it is most likely that this is a prime reason why people are visiting. It is therefore in the hotel developers' best interest to protect the biodiversity as a key part of the product.

Biodiversity depends upon the ecological integrity of the entire site and its relationship with the surrounding ecosystems. Ecosystem processes generally operate on a large scale and maintaining their integrity requires linkages between on-site and off-site natural systems. Biodiversity protection therefore requires regional and site-wide analysis.

Many businesses have an impact on biodiversity, either directly or indirectly through their supply chains. The development of more sustainable tourism is recognised as a way of providing significant benefits in biodiversity conservation.[30]

A

Identify **sensitive habitats** and incorporate protection measures such as buffer zones or corridors to maintain linkages of natural systems within and beyond the site and **avoid disturbing** irreplaceable ecological areas at all costs.

B

Design to **avoid unnecessary fragmentation of large habitat blocks** and to maintain natural processes and cycles.

C

Preserve existing species diversity and habitats by retaining and **integrating natural vegetation features**.

D

Buildings should be connected by **elevated walkways** (boardwalks) and, in highly sensitive areas, **electrical wiring and water pipes** should be secured to the underside of the decking to reduce soil disruption.

E

Use vegetated surfaces such as **open-grid paving** instead of hard surfaces for parking lots, pavements and patios in order to lessen the building's footprint, absorb rainwater peaks and help retain groundwater.

F

Consider incorporating a **roof garden** or **green roof** *(see **Section 4.4**)* to create an additional habitat. This technique can be particularly beneficial in urban developments.

G

Minimise the creation of **linear features** such as roads and firebreaks in the natural landscape.

H

Reduce the impact of the hotel development on **nocturnal environments** by avoiding lighting that extends off site or into the night sky.

I

After construction, restore habitats through use of **native plants** in landscaped areas and avoid the introduction of new species.

30 'Decision VII/14: Biological Diversity and Tourism', Seventh Meeting of the Conference of the Parties to the Convention on Biological Diversity (COP 7), 2004, **www.cbd.int/decisions/cop/?m=cop-07**

More information

Business & Biodiversity: The Handbook for Corporate Action
Earthwatch Institute (Europe), World Conservation Union, WBCSD, 2002
www.wbcsd.org/pages/edocument/edocumentdetails.aspx?id=26

Guidelines on Biodiversity and Tourism Development: Decision VII/14: Biological Diversity and Tourism
Seventh Meeting of the Conference of the Parties to the Convention on Biological Diversity (COP 7), 2004
www.cbd.int/decisions/cop/?m=cop-07

The Green Host Effect: An Integrated Approach to Sustainable Tourism and Resort Development
Conservation International, 1999
http://nsgl.gso.uri.edu/washu/washuw99003/7-Bruner_et_al.pdf

4.4 Green roofs

The green roof at the **Seattle City Hall**, Seattle, USA, consists of low-maintenance plants, lightweight soil, storm water collectors, insulation, root barrier, and waterproofing. The City Hall is a LEED registered project and also includes a rainwater harvesting system and an under-floor HVAC system.

Courtesy greenroofs.com

Consideration should be given to the use of a green roof to maintain biodiversity and enhance building performance whilst linking the building visually with surrounding green areas. Green roofs usually take one of the following forms:

- Intensive, where the aim is to provide garden space for people. This requires intensive management and usually irrigation of some kind. These are heavy systems and can have major structural implications for the building.
- Extensive, where the aim is not usually recreational and the planting style is more naturalistic in order to establish a self-sustaining plant community. Plants (such as sedums) should be chosen that will succeed with only minimal intervention and modification of the normal roof conditions. These systems are based on a much thinner layer of soil or substrate making them comparatively lightweight, with minimal structural implications for the building.

Green roofs offer a number of benefits for use by hotel and resort buildings including:

A Low maintenance with little or no artificial irrigation requirement.

B Improved rain water management by dramatically reducing the volume and rate of rainwater run-off from the roof.

C — Improved **building thermal performance** as the building is insulated from heat loss in the winter and heat gain in the summer.

D — **Air quality improvement** through removal of CO_2 and the release of oxygen and water vapour. The plants also provide a greater surface area to contain deposits of particulate pollutants and absorb organic volatiles which makes them particularly suitable for use in cities.

E — **Reduction of the 'urban heat island effect'**.

F — Provision of a **habitat** for wildlife.

G — **Reduction in sound transmission** through the roof.

H — **Visually attractive** means of blending the building in with the local environment.

I — Provision of a novel '**talking point**' for guests and visitors.

More information

Centre for Green Roof Research, **Pennsylvania State University**
http://plantscience.psu.edu/research/centers/green-roof

Earth Pledge Green Roofs Initiative
www.greenroofs.com/projects/pview.php?id=17

greenroofs.com
www.greenroofs.com

4.5 Grounds and landscaping

4.5.1 Built areas

a — Built surfaces, particularly dark, non-reflective surfaces such as those used in parking lots and walkways, absorb heat from the sun and radiate it back to surrounding areas. This creates '**heat islands**' which can significantly elevate the temperature around built areas. This will increase cooling demands in summer or hot climates, requiring more HVAC equipment and resulting in increased energy use. The effects of heat islands can also be problematic for wildlife and migration corridors. Heat islands can be minimised by the use of reflective materials, light colours and shading and vegetated areas.

b — While ensuring safe lighting levels, **minimise the lighting profile** for the exterior of buildings; adjust illumination levels by using spotlights, low-reflective surfaces and shielding. Avoiding unnecessary outdoor lighting and the resulting light pollution will reduce the intrusive effect of a hotel on the surrounding environment and provide energy savings over the lifetime of the building.

c — Design to accommodate **sustainable forms of transport**, for example buses and mini-vans that can carry several people at a time. Make provision for transport that uses renewable energy and non-polluting technologies (such facilities to recharge electric vehicles). Provide a covered area with racks for bicycles so that hotel staff can cycle to work and consider creating a facility so that bicycles can be hired out by guests.

Taj Lake Palace, Lake Pichola, Udaipur, India, is one of Taj Hotel's most majestic formal royal residences and has undergone complete and sympathetic restoration based on thorough research into traditional architecture and using local and traditional building skills.

See Case Study 8, Appendix 1.

4.5.2 Plants and irrigation

a Use **existing and new vegetation** to provide shading, a barrier from noise and undesirable views, protection from wind and rain, to minimise erosion, to create privacy barriers between rooms or between guest spaces and work places, and to filter waste water.

b Always use **indigenous and native plants** and avoid the introduction of alien or intrusive plant species. Native landscapes provide a sense of place and attract animal and bird life, which is not only important for biodiversity but is often attractive for guests. Native plants often require less irrigation, less fertiliser, fewer pesticides and less maintenance. This reduces maintenance costs and any potentially negative impacts on water quality.

c **Select species** that root vertically and deeply rather than species that root horizontally to avoid damage to foundations, walkways and other structures. Note that purchasing mature root-balled trees is not a good alternative to leaving trees in place. They are expensive to transplant, are subject to sudden death and can take many years to establish themselves.

d Integrate **water re-use strategies** into the landscaping design. Recycled grey water or captured rain water and storm water can be used for irrigation. Check that the local legislation permits this and that the system to be used for waste water treatment will provide water of a sufficiently high quality not to pose a danger to health.

e Use **water-efficient technologies** such as moisture sensors, weather database controllers or micro-irrigation systems for watering the grounds. These can be up to 35% more efficient than conventional irrigation systems depending on the climate.

f **Reduce irrigation requirements** through mulching and composting.

4.6 Golf courses

The development of golf courses involves a wide range of environmental issues particularly with regard to their interaction with biodiversity, landscape and cultural heritage. Their management involves the use of water resources, chemicals, machinery and energy and creates waste disposal and noise issues. There are also health and safety, working environment, training and education considerations as well as the relationship with the community to take into account.

4.6.1 Design

a In recent years, **ecology** has become a key consideration in golf course development and management throughout the world. No new golf course development should be carried out without first undertaking an **EIA**.

b The guiding principle should be to **protect and improve** the natural amenity. Properly planned courses can provide valuable habitats for a variety of flora and fauna, especially birds and support and enhance rather than detract from the natural ecosystem.

c Where possible, ensure that the design involves no **net loss of woodland**.

d Seek advice from recognised and **specialist organisations** (see sources of more information listed below) and national golf associations which may be able to suggest proven designers with an established **environmental track record**.

e Design to interconnect areas that will form **natural habitats**. There should be areas of natural vegetation which are 'out-of-play' and extensive deep rough. Keep maintained and 'manicured' areas to a minimum.

f Golf courses generally require large amounts of water for irrigation. Choose varieties of turf grass and other vegetation which require **less water** and are best adapted to the local climate. Limit irrigation to where it is absolutely necessary to maintain the playing turf and avoid using mains water for irrigation wherever possible.

g The design should incorporate various methods of **capturing and retaining water** so that as little needs to be drawn off the grid as possible. Open bodies of water such as reservoirs or lakes are not necessarily the best option for climates with very high rates of evaporation.

h Consider whether **grey water** from the hotel guest bathrooms, laundry or cooling towers can be treated on site and re-used for irrigation. Alternatively, find out if it can be brought onto the site from elsewhere. It is most important to ensure that the grey water has been treated properly and meets internationally recognised standards.

i Ask the course designer to consider **soil improvements** that will reduce water consumption.

j Associated facilities, such as the **club house**, should be sited with care and built **with traditional materials** so that they blend into the landscape. Use timber that has been produced **sustainably** or source **reclaimed** wood.

k Create **walkways for non-players** and provide opportunities to educate them about wildlife protection and nature conservation. The course should be a hotel amenity for all guests, not only golfers.

Over a seven year period the Duke's Course near St Andrews, Scotland has transformed former agricultural land into a variety of natural habitats.

Picture courtesy Scottish Golf Environment Group

See Case Study 9, Appendix 1.

4.6.2 Construction

a Construction is a critical time when damage to existing sensitive habitats can occur and care should be taken to protect them while work is in progress. For example, **avoid felling trees and earth-moving** during the months when birds are nesting and rearing their young.

b **Stop work** when the weather conditions deteriorate to avoid soil damage.

c **Control traffic** to ensure that areas where construction is not taking place are not affected.

d Plant **indigenous trees** and, for colour and interest, use **wild flowers** instead of bedding plants.

e Areas to be left **undisturbed** should be cordoned-off so that building contractors do not enter them by accident.

4.6.3 Operational management

a The principles of energy and water conservation and waste management are just as important on the course and in the club house as they are in the hotel itself. Establish an **environmental management** programme at the design stage.

b Staff should be trained and guests, golfers and walkers informed about **'no go' areas** so that wildlife can thrive. Make sure they are clearly signed.

c Chemical and pesticide use should be kept as low as possible, carefully controlled and confined to greens and tees. Adopt a biological rather than chemical-based approach to keeping down pests. Strive to achieve a year-on-year reduction in the amount of pesticides applied while maintaining or improving the quality of the course.

d Golf carts should be solar or battery powered rather than petrol-fuelled.

e Consider using solar-powered lawn mowers for the greens.

f Composted waste from turf clippings and the hotel's kitchens can be used as a soil enhancer in planted areas.

More information

An Environmental Management Programme for Golf Courses
European Golf Association Ecology Unit, 1996
www.golfecology.co.uk

Audubon International
www.audubonintemational.org

Committed to Green Foundation (incorporates the European Golf Association Ecology Unit)
www.golfecology.co.uk/articles/commit.html

Ecological Approaches Towards Best Management Practice for Golf Courses
European Golf Association Ecology Unit and Audubon International, 1996
www.golfecology.co.uk

Environmental Principles for Golf Courses in the United States
United States Golf Association (USGA), 1996
www.usga.org

Scottish Golf Course Wildlife Initiative
www.scottishgolf.com/environment

Sustainable Golf Courses: A Guide to Environmental Stewardship
Ronald G. Dodson, 2005
www.wiley.com

4.7 Swimming pools

The key environmental issues concerning the operation of swimming pools are water consumption, the energy used to heat the water (and, for indoor facilities, the building itself) and the form of treatment used for sanitising and balancing the water to ensure the health and safety of users.

4.7.1 Water use

In a large hotel, a swimming pool can increase freshwater consumption by as much as 10%,[31] so consideration should be given as to whether it is a necessity. This is particularly the case if the hotel establishment is located where water is not readily available, and where there is a risk of causing shortages for others in the community. Even where water is plentiful, there is no excuse for wasting it:

a Install a water meter to help monitor leaks and for operational practices such as the frequency of backwash, overflow, cleaning etc.

b Design the system in order to capture and reuse backwash water to irrigate the grounds and consider collecting and storing rain water for replacing pool water lost through evaporation and backwashing.

[31] Hotel and Catering International Management Association, www.hcima.org.uk

c In coastal areas, consider installing a **salt water** pool as an alternative to a **reverse osmosis (RO)** plant for converting sea water for use in pools. Although RO plants help to conserve fresh water, they are very energy intensive and the concentrated brine must be disposed of properly. In addition, the acids and caustic substances required to keep the system clean create a waste stream that must be neutralised before being discharged so care should be taken with siting. Most good RO systems incorporate waste neutralisation, making the process simple and efficient.

d Using RO-produced water as a **top-up** reduces the level of total dissolved solids (TDS) in the water and in turn reduces the amount of water that has to be dumped to drain to maintain water quality. It can also reduce heating costs.

e Fit **water-saving** shower-heads, dual-flush toilet cisterns and push button taps in all changing facilities.

4.7.2 Water treatment

Pool water must be sanitised to prevent the growth of micro-organisms that can cause stomach upsets and infections particularly in the ear, nose and throat. Correctly treated water will provide a healthy and visually appealing environment for users and prolong the life of the pool and equipment.

a The pool should have a **bathing load** appropriate to its size, use and turnover and this should not be exceeded. The **circulation rate** should be variable so that it can match the bathing load.

b Bacterial control is achieved by adding a **sanitiser** (usually chlorine-based), a **flocculant** to help mass together particulates and bacteria in the water, and **filtration** to remove them. The sanitiser must leave a '**residual**' in sufficient concentration to continue to protect against and destroy any bacteria entering the water. It is also important to balance:

- The **pH** or acidity of the water.
- **Total alkalinity (TA)**, which is a measure mainly of bicarbonates and carbonates.
- **Calcium hardness**—i.e. the amount of dissolved calcium in the pool.

c Various forms of pool treatment are available, the most common methods being:

- **Chlorine** (sodium and calcium hypochlorite).
- **Chlorinated isocyanurates**.
- **Salt chlorination** (also known as 'in-situ' chlorine generation or electrochlorination).
- **Ionisation** (enables use of chlorine to be reduced).
- **Ozone generation**.
- **Ultraviolet (UV) disinfection**.

Chlorine is a very effective sanitiser and is the traditional treatment for both pool and spa water. However there are health and safety concerns surrounding its use. It is believed to aggravate asthma, particularly in children who use chlorinated pools frequently. Chlorinated water can also contain trihalomethanes, chemical compounds known to be carcinogenic. For this reason it is worth considering other treatment methods such as ionisation, UV disinfection, salt chlorination and ozone generation. These systems enable chlorine use to be reduced (to varying degrees). Reference is made to the end of this section for sources of more detailed information on the environmental, health and safety issues involved in water treatment.

d Disinfection and dosing are best controlled continuously by **automatic systems**. Strict control of bathing load and monitoring every two hours should ensure that combined chlorine levels (chloramines) are minimised. These levels should be ideally zero, or at least under 1mg/litre and certainly less than half the free chlorine figure.

e To **avoid the use of chemicals** completely, consider installing a **natural swimming pool**. Such pools are designed to look like a natural lake or pond and incorporate a wall below the surface dividing the body of water into two zones—one for swimming and the other for water cleaning. The bottom of the pool is sealed with a heavy-duty rubber liner. The 'regeneration' zone includes marsh plants in a substrate of washed gravel, lime (to maintain pH), loamy sand and nutrient bond. The pool water is pumped through the substrate, which acts as a natural filter for small particles. Most of the water cleaning takes place in the micro-organisms and microbes, which break down pollutants into basic elements. The plants use nutrients from the water as food, which helps to prevent algae. The cost to build is roughly comparable with a conventional pool but they can save on operating costs as no chemicals are involved at all. The proportion of the regeneration zone of the total system alters with the size of the pool, and in percentage terms, smaller pools require larger regeneration areas. Technologically-supported pool facilities are more suitable for coping with short-term peak loads such as in hotels and public facilities.

The natural swimming pool at the Hotel Dietlgut, Hinterstoder, Austria.

See Case Study 10, Appendix 1.

4.7.3 Energy

a Whether it is an indoor or an outdoor pool, the choice of **heating system** will have a major effect on both environmental impact and operating cost.

b When designing an **indoor pool**, consider opportunities to save energy such as:

- Using high quality **insulation** and **glazing systems** to minimise heat loss and reduce condensation (this has a direct bearing on the energy required to maintain humidity levels).
- Ensuring that **entrances and ventilation points** are sheltered from prevailing winds.
- The use of **condensing boilers** which are particularly suitable for indoor pools and can provide underfloor heating. For larger pools, a **cogeneration** or CHP plant could be used to supply heat.

c **Solar panels** (in the form of unglazed collectors) are simple and inexpensive and are used extensively for heating outdoor pools. Once the system is installed there is little maintenance and the heating is free. They do however require a large area of panelling to achieve a significant rise in temperature. Typically, this should be equivalent to at least half the area of the pool.

d **Heat pumps** offer water heating and air cooling from one plant. They are mechanical refrigeration devices that upgrade low temperature heat to a useable temperature. For swimming pools, the heat source is usually the ambient air. The smaller the uplift in temperature required, the better the efficiency of the heat pump. Running costs vary according to the pool insulation and weather conditions but heat pumps typically deliver 2–3 kW of heat output for each kW of electricity input. Environmental impacts can be minimised by purchasing **green electricity** generated from renewable sources such as wind power. When purchasing the pump it is important to check that it uses the latest refrigerants, which are less harmful to the ozone layer.

e **Recover heat** wherever possible. An indoor pool's air-conditioning system should recover latent energy from evaporation for reheating. Careful siting of the plant room will minimise routing and ducting of services and increase heat recovery potential.

f A **computer-controlled** boiler management system will ensure optimum performance of the boiler, reducing operating costs and CO_2 emissions. This system should be linked to the ventilation system so that it operates automatically and only when required.

g Ensure that indoor pool halls are **properly ventilated** and that **heat is recovered**. Generally the space temperature should be between 24–30°C and relative humidity kept to 60% although this will depend on the level of insulation. Ventilation should be variable according to occupancy with a potential for 100% outside fresh air. This can be controlled by a carbon monoxide (CO) detector.

h Equate the running hours of the circulation pump with the use of the pool. This can be done automatically with the use of **variable speed pumps** in conjunction with automatic water quality testing equipment.

i Use **energy-efficient** lighting with timer and motion detector devices and label light switches so that only the lights that are required are switched on.

j Most of the heat loss from a pool is from the water's surface through direct conduction and convection to the air and through evaporation. The use of a **pool cover** when the pool is not in use will help to retain heat and save energy. Even indoors, a cover will help to reduce both the ventilation requirement and condensation damage.

k Automatic **door closers** and **draught excluders** will cut heat loss and improve user comfort. They may also help to reduce temperature settings.

l Regular **inspection and preventative maintenance** will help to keep equipment running efficiently and identify areas where perfomance can be improved.

4.7.4 Health and safety

a The **future operational management** of the pool with regard to health and safety will be made easier if these issues have been addressed at the design stage. Slippery pool surrounds and sharp tiles and edges can present serious hazards, so care should be taken in the **choice of materials**.

b An **effective ventilation sytem** is important to provide good indoor air quality so that bathers do not become drowsy or succumb to asthma attacks where they are susceptible.

More information

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Sustainable Hotel
Siting, Design and Construction

The industry guide to good practice

Conservation International

International Tourism Partnership

5 OPERATIONAL DESIGN

First published 2005 | Digital Release 2014

5.1 Energy

Harnessing the power of nature to provide sustainable energy, the High Hedley Hope wind farm, County Durham, UK.

Picture courtesy EDF Energy.

Energy, in its various forms, is essential for heating, cooling, lighting and circulating water around buildings, and for ensuring a comfortable internal environment. However, its generation and consumption are not without environmental impact, the global effects of which are becoming more widely understood and increasingly legislated against.

Extracting energy from conventional fossil fuels such as oil, gas and coal for fuel or to generate electricity is in itself an energy-intensive process. Habitats can be disrupted or destroyed by pollution in the extraction, refining or transportation processes and the landscape spoiled. The burning of fossil fuels releases emissions of CO_2 which is a major contributor to global warming and is also responsible for the creation of smog and acid rain. Alternatives such as hydroelectric power and nuclear generated power also have their critics as they have significant environmental impacts.

As global awareness of these issues grows, so does the demand for energy efficiency and the use of renewable energy. This is increasingly reflected in legislation around the world. For example, the new EU Energy Performance of Buildings Directive (EPBD)[32] requires incorporation into national legislation by member states by January 2006.[33] The directive will ensure that building standards across Europe place a high emphasis on minimising energy consumption and are a vital component of the EU's strategy to meet its Kyoto Protocol commitments and beyond.

A hotel building designed with sustainability in mind should operate at optimal operational performance efficiency. In order to design energy efficiency into the establishment it is important to make use of available natural systems as much as possible. The choice of energy supply and careful consideration of materials will also reduce energy use, as will investment in appropriate technology and the adoption of cost-effective practices. Most energy efficiency measures will provide relatively rapid returns on investment (a payback period of typically less than three years) which will improve if energy costs then rise. There can also be additional benefits such as a reduction in the size of plant and its requirement for space.

32 Directive 2002/91/EC, OJ L1 of 4.1.2003, http://ec.europa.eu/energy/efficiency/buildings/buildings_en.htm

33 Key provisions of the EPBD are: minimum requirements for the energy performance of all new buildings and of large existing buildings subject to major renovation; energy certification of all buildings (with frequently visited buildings providing public services being required to prominently display the energy certificate); and regular mandatory inspection of boilers and air-conditioning systems in buildings.

5.1.1 Energy efficiency

Depending on the climate, expenditure on energy typically represents 30–35% of a hotel's total operating costs, so any energy efficiencies that can be designed into the building will reduce CO_2 emissions and operational costs over the life of the building.

a. Make provision for **departmental metering** of water and energy consumption in the overall design. This will enable realistic **targets** for annual energy consumption to be set early in the design stage, together with aspirational five and ten-year targets. *See* ***Section 9*** *Monitoring performance.*

b. Professional **commissioning** of building systems will be essential to ensure that all major systems perform in accordance with design. Plan the commissioning process to take place from the design phase through to completion.

c. **Link final payments** for the architect, designers, contractors and building systems suppliers to the actual overall demand and consumption once the building is operational.[34]

d. **Specifications for guest rooms** should include key-card activated master switches so that the HVAC, lighting, TV and other services are only turned on when the guest enters the room and are automatically shut down when the room is vacated. Energy-saving minibars and energy-efficient and standby functions for televisions should be specified.

e. **Office equipment** should also have energy-efficient and standby functions.

5.1.2 Energy sourcing

a. When looking at how energy will be supplied to the new development, consider whether all or some of the energy can be provided by **alternative or renewable resources** such as solar photovoltaic or passive solar systems, biomass or waste-to-power systems, geothermal, wind or water (e.g. wave power).

b. If power can only be sourced from conventional resources, consider purchasing **electricity** from a utility supplier that uses renewable resources to generate it.

c. **Natural gas** is preferable to other fossil fuels as it has lower overall CO_2 emissions and does not produce the toxic chemicals and particulates that are a result of oil combustion *(see* ***Table 1****).*

5.1.3 Use of natural systems

Consider heat gain issues and heat transmission losses when deciding upon the orientation of buildings, facilities and windows. Capitalise on 'free energy' by meeting as much of the energy requirement as possible through sources available on the site such as sun, wind and light.

[34] The building must obviously be capable of achieving its efficiency criteria and the actual resource consumption will depend on how it is operated. The UK implementation of energy labelling under the EU EPBD is likely to have two values for building energy consumption—the design capability and actual consumption.

Use of Natural Systems

Table 1: CO_2 emissions from different energy sources

Note: these values are approximate. For example, grid electricity rates will differ depending on the type of coal, oil or gas that is used to generate it.

ENERGY SOURCE	Kg CO_2/kWhr
Natural gas	0.19
Liquefied petroleum gas (LPG)	0.21
Gas/diesel oil	0.25
Heavy fuel oil	0.26
Grid electricity*	0.43
Renewables (solar, wind, wave)	0.00

*Calculated from UK grid fuel mix 1998–2000

Source: DEFRA Guidelines for Company Reporting on Greenhouse Gas Emissions

Below:

The city of Yazd in Iran uses the ingenious principle of wind towers or 'badguirs' (wind catchers) to cool hot air from the desert in summer. The towers suck air into an area below the roof where it is cooled by a pool of water around which is a lounge area where people can relax and entertain. In modern Iranian buildings this technique has been replaced by air-conditioning units but Western 'eco-architects' still make special trips to Yazd to see how the towers work.

Picture courtesy R. Dehdashti, IranPIX, www.iranpix.com

a Solar gain from the hotel's roof, walls and windows can benefit or detract from the building's energy performance. Optimising the hotel's siting, orientation, form, openings, assemblies and systems will reduce lighting, heating and cooling loads. Well-insulated walls will help offset heat from solar gain.

b In hot climates, advantage should be taken of passive design features such as using prevailing winds for ventilation and cooling. Specify louvered doors and window shutters to ensure a through draft. High internal ceilings will facilitate air circulation whilst balcony and window overhangs and deep reveals will increase shading.

c Windows, when properly located, provide views, daylight, ventilation and solar gain at appropriate times. Determine the size and positioning of windows, doors and vents according to lighting, heating, cooling and ventilation requirements and select window glazing to balance lighting requirements with insulation and shading needs.

d Thermal mass is the ability of a material to absorb heat and different materials are suited to different climates. Concrete, masonry and water have a much better storage capacity for heating and cooling than the surrounding air. The use of materials with good thermal mass is best suited to climates where there is a difference in temperature between day and night. Ventilating at night using cool air removes the heat stored in the mass during the day.

e Heat can be **recovered** from waste water, ventilation and refrigeration equipment and used for heating the building.

f Reduce the overall hotel **floor area** to limit the total space that will require temperature control.

g Locate **areas of low occupancy** (such as storage areas and toilets) towards the centre of the hotel and position areas of higher occupancy in perimeter areas with access to natural lighting and ventilation.

h If there is little natural light available, light levels can be improved through the choice of interior finishes (such as light coloured or mirrored surfaces) to **maximise daylight**.

5.1.4 Building management systems

Building management systems (BMS) perform many functions. They can monitor and control equipment and lights, interface with other computer systems such as those for the fire alarm, front office, preventive maintenance or security and alert staff to critical conditions before breakdowns occur or guests complain.

BMS systems are specialist computer systems that require an appropriate amount of knowledge, understanding and training to operate them correctly and for the full potential of the system to be realised.

The **energy management** functions of BMS are sophisticated and powerful. Among other functions they can:

- **Monitor consumption** of main and sub-meters for electricity, energy and water.
- **Set operating times** in accordance with occupancy.
- Change from **summer to winter mode** and vice versa.
- **Reset kitchen supply and exhaust fans** to different air volumes based on time of day and activity.
- **Provide free cooling** by using up to 100% outside air before engaging mechanical systems.
- **Float set points within the comfort range**, for example between 21–24°C.
- Be programmed to **reduce temperatures at night**.
- Modulate **chilled and hot water temperatures**.
- **Reset air supply temperatures** in multi-zone systems to the area with the highest load and reduce air volumes to the others **according to their load**.
- **Modulate fresh air quantity with actual occupancy** by monitoring CO_2 concentration.
- Combine air handling units and fan coils with motion detectors to **operate only when an area is physically occupied**.
- **Interface with front desk computer systems** to run fan coils only when occupied.
- **Optimise start/stop sequences** by using adaptive control sequences.

- Use **dynamic controls** by changing static pressure in variable air volume systems in accordance with actual load conditions.
- **Control peak demand** for electricity, district heating and cooling.
- **Pre-cool selected areas** at night.

5.1.5 Heating, ventilation and air conditioning (HVAC)

Operating expenditure on HVAC systems can range from 20% of the building's total utility costs in moderate climates to as much as 50% in tropical areas. However, the potential to create efficiencies within HVAC systems is, in most cases, very high.

a SYSTEM SELECTION

- HVAC systems vary widely in their **capital, maintenance and utility costs**. **Professional advice** will be necessary in order to select the most appropriate system for the needs of the building and to deliver optimal energy efficiency and comfort.
- A **variety of systems** are available including fancoil, induction, re-heat, dual duct, single zone, multi-zone, variable volume, heat pump and individual units. The selection of systems with variable volume control in preference to those which run at constant volumes will considerably reduce emissions of both CO_2 and sulphur dioxide (SO_2) and can cost up to 70% less to operate through the energy saved.

b MATCHING SOURCE TO LOAD

- The basic rule is **not to move more air, water, steam, or refrigerant than is needed** to satisfy demand (the load condition). As a result, the greatest efficiency improvements can be made by matching the operation of all major equipment to the actual load conditions.
- Ventilation, heating and cooling loads can vary greatly throughout the day (by between zero and 100%). There are constant changes in climate, season, solar load, time of day, internal loads such as occupancy, lighting and equipment operation etc. Therefore, equipment such as chillers, boilers, pumps, cooling towers, air handling units, fan coils and heat pumps should have **variable speed drives** and **operate efficiently over their entire load range**.

c REDUCING LOADS

- Energy efficient **compact fluorescent lights** radiate much less heat than incandescent ones, creating less strain for the air-conditioning system.
- **Match the supply of fresh outside air** to the number of persons actually present in an area. This is done through sensors that monitor the amount of CO_2 present.
- **Divert loads** to other sources.
- **Control peak demand**.
- **Reduce solar load** by installing internal blinds, curtains, and/or reflective glass.
- **Locate heat-generating equipment** such as vending machines and dishwashers away from air-conditioned spaces as it will force them to work harder than necessary. Where this is not possible, fit an extractor or use a curtain or other barrier.

d RECOVERING WASTE ENERGY

- Energy that is normally lost to the exterior can be **recovered and used to preheat or cool** air or water from the exhaust system, boiler flue, flash steam, condensate, condenser water or latent heat from the swimming pool.
- The most efficient exhaust system is the **thermal wheel**, which has an efficiency of more than 60% or much higher if the air face velocity is reduced.

e **HEATING**

- High efficiency **condensing boilers** are the most efficient available. They can convert more than 88% of the fuel used into heat, compared with up to 80% for conventional types. These boilers have either a larger or second heat exchanger which captures the heat that would normally escape up the flue from conventional boilers. This reduces the temperature of the flue gases to a point where water vapour produced during combustion is 'condensed out'. They can run on oil, gas and liquefied petroleum gas (LPG) and can operate either as combination boilers, to heat up hot water on demand, or as conventional system boilers, where a separate hot water cylinder is required.
- Fit **horizontal thermostatic radiator valves** (TRVs) to individual radiators so that each room or area in the hotel can be warmed as required. These are preferable to vertical TRVs which are warmed by the pipe below and can fail to control the room temperature accurately.

f **HOT WATER**

Unless unlimited supplies of solar power are available, the provision of hot water is an **inherently inefficient** process. The major energy losses are standing losses during storage and through pipes before the water emerges through the tap. These losses can be mitigated through:

- **Proper insulation** of pipes and lagging of hot water tanks.
- Ensuring **pipe runs** are kept short.
- Using a local hot water heater close to the point of use for **areas of light use**.
- Ensuring boilers for the hot water service are controlled so that heating takes place **only when large quantities are required**. Stored hot water can satisfy demand for several hours, during which time the boiler need not be operating.
- Use of energy-efficient technologies such as **condensing boilers**.

g **CHILLERS AND COOLING TECHNOLOGY**

Chiller technology is continually improving with recent advances resulting in **improved efficiencies** over the entire load range, reduced maintenance costs and the chiller control's ability to interface with connected equipment such as pumps and cooling towers, thus improving the efficiency of the entire system.

- The **refrigerant** used in the chiller can have a significant bearing on its contribution to global warming through the emission of greenhouse gas. Some refrigerants, notably HFCs,[35] have a high global warming potential (GWP)[36] which needs to be considered. *See **Section 5.6.2** Refrigeration and ozone depleting substances.*
- When cooling is required in moderate climate zones at outdoor air temperatures <13°C, **free (or nearly free) cooling** can be obtained by installing a heat exchanger to bypass the chiller. The cooling tower will then directly satisfy the cooling load.
- Certain chillers can **preheat hot water** for improved efficiency. However, the demand for heating energy fluctuates widely throughout the day and with occupancy. A thorough analysis is required in order to assess feasibility.
- Depending on local energy prices, **gas-fired absorption chillers** can be energy-efficient. However, when taking into account the overall impact on global warming for the energy required to run an absorber machine, the balance becomes less favourable (unless for example it can be provided as a by-product of cogeneration). One benefit is that they create very little noise and vibration. The wide variety of models available increases the options for air-conditioning and many units are available as chiller/heaters, providing cooling and heating from a single unit. Also, their energy requirements can be supplemented directly from CHP plants. *See **Section 5.1.5.i** Combined heat and power (CHP) systems.*

[35] Hydrofluorocarbons.

[36] Global warming potential (GWP) is a measure of how much a given mass of greenhouse gas is estimated to contribute to global warming. It is a relative scale which compares the gas in question to that of the same mass of CO_2 whose GWP is one.

- Where **cooling towers** are installed, the most efficient types are induced draft[37] with variable speed drives. Automatic water treatment and blowdown[38] should also be provided. Maintenance of cooling towers must be kept to a very high standard. See ***Section 5.1.5.h*** *Legionnaires' disease*.
- **Air-cooled chillers** are often preferred to water-cooled types to prevent the spread of Legionnaires' disease although they are generally less energy-efficient. They do not use water or require treatment chemicals but they do create higher noise levels. Corrective measures can be taken to reduce noise so that neighbours or guests are not disturbed. The total operating costs need to be evaluated on an individual basis.

Chiller technology is continually improving with recent advances resulting in improved efficiencies over the entire load range.

h LEGIONNAIRES' DISEASE

Legionnaires' disease is a rare form of **pneumonia** that can be fatal in around 10% of cases. It can be contracted through inhalation of droplets of contaminated water transmitted in the form of spray. The risks are associated with poor maintenance of showering facilities, whirlpool and spa baths, air-conditioning systems and fountains. In order to minimise the risks:

- **Hot water** should be stored above 60°C (thermostatic mixing valves should be installed on showers and taps to prevent scalding).
- The direction of prevailing winds should be considered when **siting cooling towers** and **strict maintenance procedures** observed.
- Ventilation **fresh air intakes** should be located away from cooling towers.
- Care should be taken in the choice of **materials in contact with warm water** to ensure they do not serve as nutrients for the *Legionella* bacteria.
- **Shower-heads** and **spa jets** should be regularly cleaned and flushed through with a 5–10mg/litre chlorine solution.

i COMBINED HEAT AND POWER (CHP) SYSTEMS

CHP or cogeneration plants generate electricity and recover most of the waste heat that is normally lost to the atmosphere. They can achieve an outstanding total efficiency of more than 80% compared with the conventional 35–55% efficiency of most public power plants.

[37] Fans are installed at the top of the tower to pull the air through.

[38] Blowdown is the continuous bleeding of tower water into the drain in order to prevent high concentrations of salt.

- CHP plants are best sited at hotels where **electricity and thermal loads are coincident** on both a daily and seasonal basis. In moderate to cold climate zones this occurs during winter heating periods. However, during summer, a hotel's hot water requirements are often insufficient to absorb all of the available heat. It would then have to be rejected, thus lowering efficiency and payback. However, if a suitable absorption chiller is available, CHP may be viable provided utility rates are favourable.
- The **feasibility** of CHP will depend on the current costs of externally supplied electricity versus fuel oil or gas. Other factors to consider include what the heating and cooling systems will be, the available space, local regulations and load pattern.
- Should the hotel require an **emergency generator**, the CHP unit may provide a viable alternative.

5.1.6 Lighting

Effective use of daylight enables artificial lighting at the **InterContinental Le Grand Hotel**, Paris to be reduced.

Lighting plays an important role in projecting the image and style of the hotel, in safety and in security. The lighting design must create an ambiance that welcomes guests and make them feel relaxed. Depending on the type of hotel, lighting accounts for around 15–25% of a hotel's electricity consumption, so it is important to make maximum use of energy-efficient lighting without adversely influencing comfort.

a Make **maximum use of daylight** to minimise lighting requirements.

b Use **energy-efficient lamps** wherever possible as they consume roughly a quarter of the electricity it takes to power an incandescent lamp. They also last eight times longer and produce less heat. By replacing one incandescent lamp with a fluorescent lamp, production of three-quarters of a ton of CO_2 and 7 kg of SO_2 can be avoided over the lifetime of the lamp. This saves between US$30–50 in energy costs over the lamp's life.

c — The major criterion for light output is not wattage, but **lumens**. Efficacy is expressed in terms of lumen per watt. Other factors to consider are lamp life in hours and colour.

d — Select **reflective light fixtures** and **translucent shades** to increase light output.

e — **Position** lighting correctly and where it is required for working. Install lamps in work areas at the lowest possible height.

f — Decorating walls, ceilings and other surfaces in **light and bright colours** will help to reflect light.

g — **Install timers, motion detectors, dimmers and photo-cells** in order to turn off or reduce lights in accordance with occupancy.

h — Allow for **individual switching** of rooms and zones so that lights can be easily and flexibly operated.

i — Make sure that low energy bulbs have a **low mercury content** (such as ones with a European Eco-label) as this can create a waste collection problem.

j — **Table 2** is a guide to the **efficiency and light output** of fluorescent versus incandescent lamps for interior use and low pressure sodium versus metal halide lamps for exterior use.

More information

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www.caddet-re.org

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Research arm of Natural Resources Canada.
www.cetc-ctec.gc.ca

Centre for Energy Studies, Ecole des Mines de Paris
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Rocky Mountain Institute, 1994
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The Chartered Institution of Building Services Engineers, 2000
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Lighting efficiency and output

Table 2: Comparative efficiency and light output of various lamps

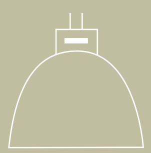
	Lamp type (Watts)	Lamp life (hours)	Lumen 120/240 Volts	Lumen / Watt 120/240 Volts
INTERIOR	**INCANDESCENT**			
	25	2.500	232 / 225	9 / 9
	40	1,500	505 / 420	12 / 10
	60	1,000	890 / 710	15 / 12
	75	850	1,210 / 940	16 / 13
	100	750	1,710 / 1,360	17 / 14
	150	750	2,850 / 2,150	19 / 14
	Watts: lamp only / total (incl. choke)	**COMPACT FLUORESCENT**		
	7 / 12	8,000	400	57
	9 / 14	8,000	600	67
	13 / 16	8,000	900	69
	20 / 24	10,000	1,300 / 1,000	54 / 42
	30 / 35	10,000	2,360 / 2,000	67 / 57
	40 / 45	10,000	3,200 / 2,700	71 / 60
EXTERIOR	**LOW PRESSURE SODIUM**			
	35 / 44	18,000	4,795	137
	90 / 113	18,000	12,690	141
	180 / 225	18,000	32,940	183
	METAL HALIDE (CLEAR)			
	70 / 92	6,000	5,000	71
	150 / 197	15,000	11,250	75
	175 / 210	10,000	14,000	80

Source: International Tourism Partnership working group

Common bulb types

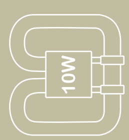
INCANDESCENT

Tungsten filament



Tungsten halogen

FLUORESCENT



Compact fluorescent 2D type

Tube fluorescent

Compact fluorescent PL type

5.2 Water

Water, essential for life, and a vital component in many Hotel systems: from kitchens and laundry to guest rooms and swimming pools. Its careful use, and re-use, can convey great savings.

Picture courtesy The Portland Hotel, Jamaica.

Sustainable tourism growth can only be achieved if the physical and social environment on which the hotel and tourism industry depends is able to satisfy the additional demands that will be placed upon it. Failure to provide reliable and good quality water resources will jeopardise the future of the industry (especially leisure tourism) and the contribution it makes to the economies of many countries. This in turn will undermine their ability to use tourism as a potential means to achieve more sustainable forms of development.

The **availability of fresh water** is already a problem in many areas of the world and, although it is often seen as one that is limited to developing countries, many prime resort areas face potential water shortages over the coming years. One cause of conflict can be the relatively higher water consumption of tourists in comparison to resident populations that are better adapted to living within the natural constraints of their immediate environment.

The **resource requirements of the planned hotel** should not negatively affect the community's access to and requirements for water. Minimum requirements for water efficiency should be set early in the design process and carried through by setting targets in the detailed design and construction documents. Building systems should then be designed, installed and calibrated to meet these targets.

Conserving water reduces the amount that needs to be withdrawn from underground aquifers, reservoirs, rivers and other natural bodies of water. It is particularly important in fragile ecosystems and areas where water is scarce, such as coastal locations where a desalination plant (with its high energy demand) may be the only way of supplying it. Reducing overall water use also reduces the amount of energy to heat, cool and pump it around the building, and the chemicals involved in water distribution and treatment. These will all have a bearing on the future operating costs of the establishment.

5.2.1 Water quality

Guests who are accustomed to a high quality of drinking water in their own country are very likely to suffer an upset stomach with a change of water. It is vital that the hotel is able to provide them with a supply of safe water for drinking, bathing and other purposes and that this is regularly tested.

a Potable (drinkable) water and water used for food preparation, sanitary needs or for other purposes where it may be ingested should be provided according to **World Health Organisation (WHO)** standards[39] as a minimum.

b Drinking water should be stored at a temperature of below 20°C to ensure that water-borne **micro-organisms** cannot proliferate.

5.2.2 Water efficiency

Investment in water conservation measures in hotels can result in a rapid payback. By combining investment at the design stage with good operating practices water usage can be reduced by around 30% or more. For example, if a building has 650 occupants, each using an average of 97 litres of water per day, low-flow fixtures coupled with sensors and automatic controls can reduce this to 80 litres per day, saving a minimum of 4,000 cubic metres (m^3)[40] of water per year (or 17.5%).

Future legislation, such as the EU Water Framework Directive,[41] will be an increasing incentive for developers to implement improvements in water management.

a Set minimum **water efficiency targets** early in the design process and carry them through in the detailed design and construction documents.

b In areas where water is scarce, **grey water recycling** facilities should be considered to maximise water efficiency. *See* ***Section 5.2.3*** *Recycling and reuse.*

c Ensure that the water system includes **meters** and, more specifically, **sub-meters** in all large water-consuming departments such as kitchens, rooms, staff lockers, gardens and laundry.

d Specify **high water-efficiency equipment** for kitchens, laundry (if there is one) and cooling towers where these are installed.

e Because water **flow rate** is related to **pressure**, the maximum water flow from a fixture operating on a fixed setting can be reduced if the water pressure is reduced. For example, a reduction in pressure from 100 pounds per square inch (psi) to 50 psi at an outlet can reduce water flow by around one third. Lower water pressure can also reduce the likelihood of leaking pipes, water heaters and taps. It can also help to reduce dishwasher and washing machine noise and breakdown in a plumbing system. Note however that it may have a marked effect on the apparent effectiveness of existing shower heads. Limit the pressure of water supplied to taps and bathroom fixtures to a maximum of 3 bar and no less than 1.5 bar.[42]

[39] 'Guidelines for Drinking Water Quality', World Health Organisation, Geneva, 1984, **www.who.int/water_sanitation_health**

[40] 1 cubic metre = 1000 litres

[41] EU Water Framework Directive 2000/60/EC, **http://ec.europa.eu/environment/water/water-framework/index_en.html**

[42] Conversion rates: 1 bar = 14.5 psi and 1 psi = 0.069 bar

Low flow technology

With hotel guests using an average of 97 litres of water per day, opportunities to limit this will not only reduce operating costs, but also reduce the burden on the local environment and infrastructure. Many modern fixtures are flow-limiting: aerators can be fitted to faucets, flow-controllers to showerheads, and simply by lowering the water pressure wastage can be significantly reduced.

f In guest bathrooms and toilet facilities in staff and public areas, the use of **low-flow fixtures, sensors, automatic controls** and **water saving urinals** will reduce water consumption and therefore the amount of waste water that has to be treated.

- **Flow-controllers** should be fitted to all showerheads and consumption limited to 8.5 litres per minute.[43]
- **Faucet (tap) aerators** are small valves that break the flow of water into fine droplets and entrain air while maintaining wetting effectiveness. They can be fitted to all taps except baths, are inexpensive and can reduce the water use at each tap by as much as 60% whilst maintaining a strong flow. Typically, they use 7.5 litres of water per minute but flow can be restricted to 5–6 litres per minute.
- Some shower head models incorporate a **vacuum flow valve** which aerates and compacts the water so it leaves the showerhead in a powerful stream but consumption is only 5.7 litres per minute. If these are fitted, test that they operate effectively throughout the hotel (especially the top floor), as they require a set water pressure to operate effectively.
- Fit **push button**-operated showers in pool and staff areas. **Self-closing percussion or push taps** which close automatically after up to 30 seconds are particularly suitable for cloakroom facilities in public areas. These can be activated by **passive infra-red (PIR) sensors** to further reduce consumption. Some types can be supplied in kit form to fit on to existing standard tap bodies without disturbing pipework.
- **Toilet cisterns** should have dual-flush mechanisms and the maximum flow should be no more than 6 litres per flush.
- **Vacuum toilets**, often used on aircraft and trains, can be very cost effective where the hotel building is spread over a relatively large area. Each flush uses less than 2 litres of water. However they require special maintenance and a reliable supplier of service and spare parts should be identified.
- **Urinals** that flush every 15 minutes can use as much as 150,000 litres of water a year. Set them to flush at longer intervals at off-peak times and to flush for no more than 10 seconds at a time.
- Consider the use of **waterless urinals** where water is only necessary for cleaning.
- Use **proximity devices** for faucets and urinals in public toilets and staff areas. PIR devices initiate a flush only when they detect activity.

[43] 'The European Eco-label for Tourist Accommodation Service', European Commission, Commission Decision 2003/287/EC, 2003, http://ec.europa.eu/environment/ecolabel/products-groups-and-criteria.html

- **Composting toilets** reduce pollution and eliminate water and sewerage costs. They are particularly suitable for operation in remote areas and ecologically sensitive environments where there is no waste water infrastructure and are not suitable for large-scale hotel operations.
- **Faucets on kitchen sinks** should be limited to use no more than 6 litres per minute.
- Use **pedal-operated** valves in kitchens and bars.

g Include systems to **collect rain water** to use for irrigating the grounds wherever possible.

h Install high-efficiency **irrigation systems** in gardens. These may feature humidity controls or moisture sensors located in strategic parts of the grounds so that water is only called for when needed and automatic shut-off devices that activate when it rains.

5.2.3 Recycling and re-use

Non-potable water can be captured in various ways for reuse by means such as rainwater harvesting and collecting storm water run-off from roofs and other hard surfaces on the site.

Thawed water from the ice house is stored in the fish pond and used for irrigating the gardens at the Sandals Negril Beach Resort and Spa, Jamaica.

See Case Study 19, Appendix 1.

a **Grey water** is water effluent recovered from baths, showers, sinks and laundry that does not contain waste from food processing or human waste. This waste water can be treated and re-used for toilet flushing, irrigation, cleaning floors and in cooling towers. Such systems require separate plumbing and treatment equipment. Any areas within the hotel and grounds where properly treated grey water can be used instead of potable water should be identified at the outset of the project and the appropriate systems designed in to the building at that stage.

b **Rinse-water circulation systems** take the water discharged with the last rinse of a laundry washing cycle and re-use it for the first wash process of the next cycle. The payback period of such systems is usually two years or less.

c Water from backwashing the filter from **swimming pools** can be reused for irrigation. *See **Section 4.7**.*

5.2.4 Waste water treatment

The Four Seasons Resort, Chiang Mai in Thailand, **pumps treated waste water into the resort's lakes and to its rice fields.**

Picture courtesy Four Seasons Resort, Chiang Mai

See Case Study 20, Appendix 1.

Raw sewage must undergo primary, secondary and tertiary treatment before it can be reused or discharged to the aquatic environment. Larger hotel facilities will usually require their own waste water treatment plant.

Waste water can be treated on site by a variety of systems, some of which can even double as decorative features and/or can be used near to guest areas where site space is limited. Where possible, preference should be given to treatment systems that use natural rather than chemical processes. Minimising waste water treated through public facilities reduces energy and chemical use and the need for public infrastructure.

Any system will require careful management of inputs into the waste water cycle and careful checking of treated effluent. Chemicals kill the micro-organisms that break down the effluent and many treatment plants cannot break down grease properly.

a TREATMENT SYSTEMS

- The **success** of waste water treatment technologies depends on accurate design information and procedures (taking into account factors such as the level of the water table), adequate safety measures, flow control, correct installation and ongoing maintenance.
- **Raw sewage** should never be released anywhere except to a dedicated local sewage treatment system.
- The World Bank recommends the **stabilisation pond system** of secondary effluent treatment as being effective in meeting health criteria economically, particularly in warm climates wherever land is available at reasonable cost.

- For secondary treatment, consider the use of a **natural wetland system**. Known as 'root zone' or reed bed systems, they comprise a series of tanks or engineered wetlands planted with reeds (*Phragmites australis*) or other plants which treat the waste water in a cascade. The system has an impermeable base to prevent untreated water from leaving the system and to facilitate the reuse of resultant water. By evolving their own ecosystem, root zones effectively reconstruct hydrological, nutrient and mineral cycles that mimic those of natural water courses. As waste water travels through the system, the organic matter is consumed by bacteria growing on the plant roots which convert it into water and CO_2. Root zone systems can be incorporated into the hotel landscape although they do require a relatively large amount of space. The final process is usually a pond of water which can be safely released into the environment or used for irrigation after further, tertiary treatment.

- Various methods of **tertiary treatment** do not involve the use of chemicals including UV disinfection, ionisation and micro filtration with disinfection.

b ISSUES TO CONSIDER

- If the hotel has **large grounds** or a **golf course**, sewage can be treated for reuse in irrigation and as fertiliser. Note that because most golf course irrigation is via sprinklers, the quality of the water must be to virtually potable standards, to avoid the danger of inhalation of contaminated droplets. *See **Section 5.1.5.h** Legionnaires' disease.*

- Treated waste water contains **dissolved salts** which are difficult to remove. The soil type needs to be taken into account if treated waste water is to be used for irrigation as salt build-up can lead to problems over time. Salt is less likely to accumulate in fast draining soils.

- Once the building is operational, liquid effluents should be **monitored** daily for pH and chlorine and weekly for all other parameters. The data should be analysed and reviewed regularly to ensure that it conforms to operating standards and any corrective measures can be taken.

- Changes in alkalinity, temperature and other parameters can upset or destroy local ecosystems when waste water is discharged. **Effluent from treatment plants** should conform to local and national standards or those of the World Bank Group,[44] whichever are the higher. *See **Tables 3** and **4**.*

- Any **temperature increase** in discharged treated waste water should be no more than 3°C at the edge of the zone where initial mixing and dilution take place. Where the zone is not defined, this distance should be taken as 100 metres from the point of discharge.

- All **effluent from kitchens** should pass through grease traps, as grease clogs waste pipes and drains and inhibits the efficient working of all waste treatment systems.

- **Effluent from laundry** must be corrected for pH if it is outside the permissible range.

- **Chlorination** should not be considered as a first option as it is difficult to maintain a uniform and predictable level of disinfecting efficiency. Not only will it be expensive to operate, but chlorinated, organic by-products may be toxic, mutagenic or carcinogenic.

[44] 'Pollution Prevention and Abatement Handbook: Part III Tourism and Hospitality Development', World Bank Group, September 2001, **www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/ifc+sustainability/publications/publications_handbook_ppah__wci__1319577543003**

Table 3: Liquid effluent requirements for direct discharge to surface waters

PARAMETER	MAXIMUM VALUE
pH	6–9
BOD (Biochemical Oxygen Demand)	50 mg/litre
Oil and grease	10 mg/litre
Total suspended solids	50 mg/litre
Total residual chlorine	0.2 mg/litre
Coliforms	400 MPN / 100 ml [45]
Temperature increase	≤ 3°C

Table 4: Water quality guidelines for treated waste water used for irrigation

PARAMETER	MAXIMUM VALUE
Coliforms	< 100 MPN / 100 ml
Helminth standard [46]	<1 viable intestinal nematode egg / litre (99% egg removal)

Sources: World Bank Group Pollution Prevention and Abatement Handbook

More information

Design Manual for Waste Stabilisation Ponds in the UK
Regularly updated Internet-based manual.
Professor Duncan Mara, School of Civil Engineering, University of Leeds
www.leeds.ac.uk/civil

Pollution Prevention and Abatement Handbook: Part III Tourism and Hospitality Development
World Bank Group, September 2001
www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/ifc+sustainability/publications/publications_handbook_ppah__wci__1319577543003

Rainwater and Greywater in Buildings: Project Report and Case Studies
BSRIA, 2001
www.bsria.co.uk

UK Rainwater Harvesting Association
www.ukrha.org

US Environmental Protection Agency Office of Waste Water Management
www.epa.gov/OWM

Wastewater Gardens®
www.idepfoundation.org

Water Collection and Saving
green**hotelier** issue 24, November 2001
www.greenhotelier.org

Water Quality Association
www.wqa.org

Water Reuse Association
www.watereuse.org

Water Saving: Bathrooms and Toilets
Know how number three, green**hotelier** issue 29 October 2003
www.greenhotelier.org

World Health Organisation: Water, Sanitation and Health
www.who.int/water_sanitation_health/en

[45] Most probable number (MPN)

[46] The helminth standard is an indicator for all of the large pathogens (that settle readily) including the protozoa amoeba and *Giardia*.

5.3 Waste

Solid and hazardous wastes levy costs to society and to the environment through inefficient use of resources, the dispersion of toxins into ecosystems, and the collection, transport and disposal of waste. These costs can be greatly reduced by waste reduction (for example by insisting suppliers minimise packaging) and replacing conventional waste disposal activities with practices aiming for reuse, disassembly, recycling, and composting.

Waste is a valuable resource and, in principle, all waste should be segregated and sent for recycling. Eventually it will be become our main source of raw materials for consumer products to keep our 'consumer society' going. This is the background to new European legislation on recycling and end-of-use take-back, etc. The EU Landfill Directive,[47] will be an increasing driver to reduce the creation of waste and specifically, the amount sent to landfill or for incineration.

Waste from hotels is created:

- As a result of **site clearance** and **construction**.
- Throughout the **operational life** of the hotel.
- During **refurbishment**.
- At the **end of the building's life** or if there is a **change in use**.

The most significant percentage of this waste will be created by the normal operation of the hotel throughout its life. This will require staff training and good waste management practices, which are outside the remit of these guiding principles. However, developers should anticipate waste management requirements and the need for space and facilities for sorting, compacting and storing waste for reuse or recycling. These considerations need to be designed-in at an early stage of the hotel development.

5.3.1 Facilitating waste management

a In many countries, inexpensive **solid waste management technologies** are now available that allow for a significant percentage of solid waste to be recycled with an economic return to the hotel. For example, it may be possible to install 'total waste treatment technology' whereby kitchen wastes, sewage and waste water can be treated to produce compost, biogas and useable water.

b In order that the hotel, once operational, can deal with its waste in the most efficient manner, thought must be given at the design stage to allocating **specific and well-marked spaces** and facilities for collecting, sorting, compacting, baling and storing materials for recycling and for composting. Separation categories will include glass, metals, office paper, newspaper, cardboard, plastic, cooking oils and organic waste, among others. Some hotels already separate their waste into as many as 15 separate fractions.[48]

- **Locate** the central waste collection and storage area in a basement or on the ground level with easy access for collection vehicles.
- **Allow space** in or near kitchens for separating solid wastes into categories (foodstuffs, paper, plastic, metals etc.) and for separate storage of each.

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[47] EU Landfill Directive 75/442/EEC and subsequent directives and decisions, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31999L0031

[48] See Case Study 21, Hilton Tokyo Bay Hotel, Appendix 1

- Allocate adequate space in the grounds for **composting** facilities. Composting of garden waste (e.g. cut grass, shrub limbs and dead flowers) together with organic kitchen waste such as vegetable and fruit peelings, eggshells, tea leaves and coffee grounds produces compost, a nutrient-rich substance which replenishes soil and replaces the need for fertilisers. It may be necessary to have **several bins** at various stages of decomposition to satisfy supply of composting material and the demand for finished fertiliser.

c Where there is **no existing waste collection** and disposal service, developers will need to design and implement adequate waste disposal systems. The development of a new hotel or resort may provide a **catalyst for new local businesses** to collect the waste and possibly process it as a feedstock for locally-made goods.

d If it is necessary to select an appropriate site for landfill, factors to consider include:

- Obtaining approval from the local **community** as well as the local authority.
- Ensuring that it is sited where the soil is **impermeable** or that liners are used to prevent pollution entering groundwater.
- Ensuring there are **no drainage channels** entering or leaving the site.
- Making sure that the excavated site is above the **highest groundwater levels** (factoring in periods such as the rainy season).
- **Locating the site** at least 30 metres away from wells, boreholes, streams, rivers or other water bodies. Local legislation will need to be checked in this regard.

5.3.2 Hazardous wastes

a Many hotels built during the 1950s and 60s contain **asbestos**, for which there is strict health and safety legislation in many parts of the world. Asbestos should be safely removed by a specialist contractor and properly disposed or encapsulated in order to avoid human exposure.

b **Sludge** from water treatment and sewage treatment must be disposed of in a manner to prevent the contamination of soil, groundwater and surface water.

c **Spent oils, lubricants, and solvents** should be sent to an authorised disposal or recycling company.[49] However, an **increasing range** of waste (including paint, chemicals, light bulbs and electrical equipment) is being classified as hazardous waste. Local legislation will need to be checked in this regard.

d Non compostable **food wastes** (such as raw and cooked fish and meat) should be disposed of separately and kept out of the animal food chain.

More information

Better waste management
Know how number six, green**hotelier** issue 32, July 2004
www.greenhotelier.org

International Solid Waste Association
Includes waste legislation developments around the world.
www.iswa.org

Global Recycling Network
Waste collection, disposal and recycling marketplace with links to glass, battery, paper, textile and plastics recycling, food waste and composting information.
www.grn.com

[49] 'Pollution Prevention and Abatement Handbook: Part III Tourism and Hospitality Development', World Bank Group, 2001, www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/ifc+sustainability/publications/publications_handbook_ppah__wci__1319577543003

5.4 Materials

The choice of materials used for buildings not only plays a substantial role in the comfort of their occupants, but also has important environmental effects. These result from the process of extracting materials from the earth, chemical production processes, transportation energy use and final disposal. Extraction and disposal can negatively affect the environment by using up non-renewable resources and by emitting pollutants to air, soil and water. Communities may experience unhealthy living conditions (from the emissions from paint and varnish manufacturing, for example) and the loss of attractive natural environments. These impacts can be reduced by eliminating certain materials and chemical manufacturing processes, by selecting materials that are not detrimental to health, and by recycling and reusing materials.

According to US government data, buildings account for 60% of raw materials used and around 40% of non-industrial solid waste.[50] The most effective approach to minimising the environmental impacts of material use therefore is to reuse buildings as much as possible, and to minimise the use of materials for new buildings.

Careful and appropriate choice of materials will reduce the overall environmental impact of the building in the following ways:

- **Reducing the use and depletion** of finite non-renewable materials (e.g. marble and slate quarrying).
- Encouraging **sustainable forest management**.
- Promoting **'green' manufacturers** and suppliers.
- **Phase out** of harmful substances.
- **Extending life cycles** through recycling.

5.4.1 Selection criteria

In considering the sustainability of a building material it is important to consider all aspects of its life cycle. Although it may be natural and have 'green' properties, is it sustainable in terms of the ethics of its production or the environmental impacts of its distribution and supply? For example, has its production involved the use of child labour or required transportation across several countries?

Consideration should be given to reducing the total volume of materals used and choosing materials that will reduce the frequency of replacement. When selecting raw materials and products, look for the following characteristics:

a RECYCLED CONTENT, RECYCLABILITY AND WASTE AVOIDANCE

- Apply a **reuse strategy** early in the design phase to include salvaged and refurbished building materials and identify potential local sources.

50 www.greenerbuildings.com

- Give preference to materials made with a high proportion of **recycled content** (preferably post-consumer recycled content) that might otherwise be disposed of as waste in landfill, ensuring that they perform equally or better than virgin materials in terms of strength, maintenance and durability. Materials that can contain recycled content include concrete, masonry, acoustic tile, ceramic tile, metals (steel and aluminium), carpeting and insulation.
- Select materials with highest possible levels of recycled content that can themselves be **recycled or reused** at the end of the building's life.
- Where possible **avoid mixed materials** and give preference to those that have been joined together using mechanical fixings rather than adhesives. This permits dismantling and disassembly, allowing for recycling or reuse of materials.
- Look for products that help eliminate or **reduce packaging** or enable its reuse, and ask suppliers to take back their packaging for recycling.

b SUSTAINABLE SOURCES, BY-PRODUCTS, BIODEGRADABILITY

Adrère Amellal Oasis is built using local natural materials. The architecture also creates a sense of place. See Case Study 5, Appendix 1.

- Research **regionally-sourced** building materials for performance, durability and environmental qualities. Local or regional building materials are often more responsive and **attuned to the local climate** and **aesthetics** compared with materials from other regions.
- Giving preference to locally produced materials will help support the **local economy** and minimise **transportation impacts**. Specify the chosen materials in the construction documents.
- Look for materials that contain **agricultural by-products**, use **abundantly available raw materials** and have advanced levels of **biodegradability**.

c RENEWABLE MATERIALS

- Rapidly **renewable materials** such as wool and bamboo are replenished faster than conventional resources, and often require less input of energy and water, capital and time than conventional building materials. They may require less land to produce the same quantity of material and also have a faster return on investment for producers. Products include: wool carpet, linoleum and bamboo flooring, wheatgrass cabinetry and cotton batt insulation.[51]

[51] See Leadership in Energy and Environmental Design (LEED) , US Green Building Council, www.usgbc.org

d REDUCED GREENHOUSE GAS RELATED IMPACTS

- Choose materials in their **least processed state** which are sustainable and **energy-efficient** during their manufacture (referred to as having low embodied energy), through their transport and lifetime usage to recycling.

e LOW TOXICITY

Qualities to look for include:

- Substantially **reduced emissions** of substances such as VOCs.
- Low or **non-toxic treatments** (e.g. for timber).
- **Non-toxic emissions** from the production process.
- **No listed carcinogens** emitted during production.
- **Low environmental impacts** on disposal.

f OTHER INFORMATION

Other information that should be provided by suppliers/manufacturers in support of more sustainable materials includes:

- **Material safety data sheets** (MSDS).
- The **environmental policy** of the company supplying, manufacturing or extracting them.
- **Independently verified** environmental claims.
- Eco-labels (Type I eco-label schemes), awards and other **relevant accreditation**.
- An accredited EMS such as ISO 140001 or EMAS.
- Information on **maintenance**.

It is worth noting that despite setting sustainability criteria, it is not always possible to choose the most eco-friendly material for construction or interior fittings. Factors such as availability, appropriateness, practicability, cost, maintenance, durability, fire resistance and existing hotel company standards all have to be taken into account and evaluated before a decision is made. For example, although 100% wool carpets may be the most environmentally friendly, some hotel companies find that a mixture of 80% wool and 20% nylon carpet is the best balance between value, durability and causing the least damage to the environment.

5.4.2 The A-to-Z of building materials

See pages 23–24.

5.4.3 Harmful materials

Table 5 shows some materials and substances that might be encountered during hotel construction or refurbishment and which should be avoided wherever possible. Some substances, such as asbestos, should only be handled by specialist contractors. Where alternatives for substances are not available (such as epoxy sealants), ensure that those using them take appropriate health and safety precautions.

5.4.2 The A-to-Z of building materials

Adhesives and sealants — A

The issue with glues and adhesives is that once something has been stuck to the wall or floor it usually means it cannot be reused or recycled. Consider whether there are other ways of fixing the material in place before using synthetic adhesives. Glues can be produced from either animal (bone, hide or casein/soured milk) or vegetable (starches, gum arabic, tragacanth) products.

- Use **water-based** or **low-solvent** synthetic glues and hot-melt adhesives. Most water-based adhesives today perform as well as or better than solvent adhesives but are generally only suitable for internal use. Water based adhesives include glues made from soya, blood albumen, casein and animal products. These have lower toxicity than their synthetic counterparts and are not derived from petrochemicals. Hot-melt adhesives contain little or no solvents, though they may release VOCs when heated.
- **Water soluble** casein or **PVA-based** plain white glue is the lowest in toxicity. These are suitable for woods, paper and leather.
- **Avoid glues** containing nonylphenolethoxylates, isocyanates and formaldehyde.
- **Avoid sealants** with polyurethane, sealant foam and asphalt sealing (tile walls).

Aluminium

- The production of **primary aluminium** by bauxite mining and refining involves significant energy consumption and CO_2 or greenhouse gas emissions. However, it can be recycled in a way that pays for itself and is sustainable.[52]
- Aluminium panels are **corrosion resistant** and therefore virtually maintenance free. Their lightness means easy construction, while their thermal insulation properties derived from the ability to design thermal breaks in extrusions, and from aluminium foil's reflectivity, can be used to conserve heating energy.

Cement — C

- Cement is a fine grey powder made by burning **clay and limestone**. Its manufacture produces significant CO_2 or greenhouse gas emissions.
- Displacing a portion of cement with **recycled content** reduces the carbon dioxide (CO_2) produced proportionally. The recycled content can contain fly ash (a waste product from coal-fired power generators), slag and crushed concrete, tiles and bricks.

Concrete

- Concrete is a **mixture** of crushed stone or gravel, sand, cement and water, that hardens as it dries. Though these are natural materials, stone and gravel extraction are associated with high CO_2 or greenhouse gas emissions through the use of heavy extractive equipment and transportation lorries.
- Concrete has excellent **thermal mass** properties that help to moderate the temperature of occupied spaces, minimise the need for mechanical cooling and reduce winter heating requirements. To do so it must be 'coupled' to heat sources and some means of distribution such as the air handling system. Although greater mass in a building means that more heat can be stored, practical issues limit the useful amount.[53]
- Autoclaved aerated concrete (AAC) can be used as a **brick substitute** for external walling. It has good thermal insulation properties and a better sound absorption coefficient than ordinary bricks.
- **Blast furnace slag** concrete aggregate is a by-product of iron manufacture. For every tonne of slag substituted for ordinary cement, a reduction of half a tonne of CO_2 emissions is made. Using slag conserves energy already expended in iron production.
- Concrete can be stained with a variety of permanent colours and can also be polished to give an exciting and attractive finish for internal walls and floors.

Flooring — F

See ***Section 8.2****, Floors.*

Glass / glazing — G

- Specify windows and glazing products with high **K-values** (European standard) or low **U-values** (UK and US standards). This reduces heat loss in cold weather, lowering the heating requirement and also resists penetration of heat into cool areas in hot weather, resulting in energy savings.
- When specifying, look for **thermal efficiency**, **acoustic efficiency** (for noise reduction), **longevity** and **ease of maintenance**.
- Choose **window frames** made from sustainably sourced timber in preference to non-traceable hardwood sources, or recycled aluminium in preference to PVC frames.

Insulation — I

- Natural insulation materials help regulate moisture in buildings and also help them to breathe whilst providing good thermal and acoustic insulation. Suitable materials include **wool or wool-blends**, **wood fibre boards**, **straw**, **cellulose** and **newspaper fibre**.
- **Avoid** cellular plastic insulation, which releases toxic smoke in the event of fire.

Masonry — M

- Select bricks that are **fully recyclable** and, if possible, manufactured from other **recycled products**.
- Choose **high-density** bricks for sound-proofing and reduced temperature variation.

Metals

- **Stainless steel** has a long life and helps maintain hygienic conditions.
- Where possible, **avoid chromed metals**. The chroming process involves the use of toxic chemicals. Chrome radiators are 10% less thermally efficient than those finished in a spray painted coating.

[52] At the current primary aluminium production level, known bauxite reserves will last for hundreds of years. More than 55% of the world's aluminium production is powered by renewable hydroelectric power. Products made from aluminium can be recycled repeatedly to produce new products, saving energy and mineral resources. Source: International Aluminium Institute, **www.world-aluminium.org/environment**

[53] Santa Monica Green Building Program **www.smgov.net/departments/ose/categories/buildGreen.aspx**

Plaster and paint
P

*See **Section 8.1**, Walls.*

Plasterboard

- The use of plasterboard eliminates the need for curing and plastering. Choose plasterboard made from waste products that is recyclable and utilises **non-toxic natural materials**, with paper liner manufactured from 100% recycled paper.
- Check with suppliers regarding waste collection and recycling programmes and **encourage recycling** as this can have a large impact in reducing the volume of construction waste.

Steel
S

- There are many environmental impacts associated with steel production, particularly in terms of **energy use** and the associated carbon dioxide (CO_2) emssions. However, steel has proved itself as a strong and versatile buildning material.
- Ask the **supplier** about whether they are addressing environmental impacts through, for example, integral energy management, the use of closed-loop water systems and the avoidance or recycling of production waste.

Varnishes, waxes, oils & other finishes
V

- Choose finishes based on **natural plant oils**, natural **resins**, natural **pigments** and **solvents**. Check that no toxic solvents or heavy metals are used in the production process.
- **Avoid** the use of **solvent-based lacquers**. As an alternative to conventional polyurethane varnishes with a high VOC content, there are acrylic, water-based products which are hard-wearing and should not alter the natural colour of the wood . Often the varnishes are milky on application and dry to a clear, waterproof finish. Pigments can be added to 'tint' the varnish if desired.
- Various components go into the making of **natural protective waxes** including beeswax, larch resin and essential oils. There are different types of wax for different uses and finishes. For example, some waxes are more breatheable and polish to a low sheen, whilst 'antique' wax polishes to a high sheen and is water and dust repellent. Some water-borne light waxes contain ingredients such as carnauba palm oil and are used in diluted form. Over time some waxes mellow and darken the wood. Check with your supplier for the effect you wish to achieve. Wax can also be used as a 'liming' agent by adding vegetable, earth or mineral pigments to highlight the natural grain and surface of the wood.
- Wood panelling such as pine or oak can be fed with **natural oils** made from herbs and resins. These can be brushed on for a matt finish or used as a primer before waxing and varnishing.

Wall coverings
W

*See **Section 8.1**, Walls.*

Wiring[54]

- Polyvinyl chloride (PVC) is the most common insulation and jacketing material for wiring in buildings, owing largely to its flame resistance and low cost. However, some PVC wire insulation and jacketing contains 5–10% lead by weight. Halogen-based compounds, especially fluorinated ethylene propylene (FEP), are common in data wiring insulation.
- If possible, specify halogen-free products such as polyolefin products and avoid wire and cable insulation and jacketing that contain PVC, chlorinated polyethylene, FEP, or products containing brominated flame retardants. Fibre-optics require less insulation and jacketing than copper wiring because they transmit light signals instead of electricity. Consider running fibre-optic trunk lines to smaller copper distribution lines, thus reducing total insulated cable use.

Wood

- Wood is **versatile** and **hard-wearing**, and its appearance often **improves with age**.
- Select **reclaimed**, **recycled** or **salvaged** wood. Salvaged wood is recovered from urban developments and would otherwise be destined for the waste stream. However care should be taken not to use wood that may have been chemically treated for woodworm etc.
- **Veneers** made from reclaimed or recycled wood will not only conserve virgin resources but reduce waste. Reclaimed wood can be used to dramatic effect as the natural grain and distress marks add to its character.
- If using virgin timber, purchase it from **sustainable sources**. There is no global **certification** scheme for forests, but there are various national and regional schemes such the Forest Stewardship Council (FSC), the Sustainable Forestry Initiative (SFI) and the Pan-European Forest Certification framework (PEFC).
- **Avoid** processed wood (such as compressed chipped wood) containing formaldehyde.
- **Avoid exotic woods** such as teak and mahogany and species such as oak, cherry or maple, which take between 30 and 200 years to reach maturity.

[54] 'Getting Down to the Wire', Architectural Record, 2004, **www.archrecord.construction.com**

Table 5: Harmful substances encountered in construction

SUBSTANCE	FOUND IN	AFFECTS / CAUSES
Acrylates	Paint	Skin contact sensitisation (eczema). May also cause respiratory symptoms such as asthma
Asbestos	Used widely in buildings of the mid 20th century in, for example, pipe insulation, ceiling panels, textured paint coatings, roofing felt and wall board. Use is now widely prohibited. Removal must be carried out by specialist contractor	Asbestosis (scarring to lung tissue), lung cancer and malignant mesothelioma. Greatest risk is from long-term exposure or disturbing fibres during refurbishment
Creosote, coal tar	Used as wood preservative to protect against weather breakdown and wood-dwelling pests	Poisonous if it enters the body through the lungs, stomach or intestines
Epoxy resins	Used for adhesives, coatings and sealants	Skin, eye, nose and throat sensitisation have all been reported
Formaldehyde	Widely used in building materials and household products. Pressed wood is bound together with adhesives containing urea-formaldehyde (UF) resins. Products for indoor use include: particleboard, hardwood plywood panelling and medium density fibreboard (MDF). MDF contains a higher resin-to-wood ratio than any other UF pressed wood product and is generally recognised as being the highest formaldehyde-emitting pressed wood product. Pressed wood products for use in exterior construction include softwood plywood and flake or oriented strandboard and contain dark, or red/black-coloured phenol-formaldehyde (PF) resin	Can cause watery eyes, burning sensations in the eyes and throat, nausea, and difficulty in breathing in some humans exposed at elevated levels (above 0.1 parts per million). High concentrations may trigger attacks in people with asthma. There is evidence that some people can develop a sensitivity to formaldehyde. Shown to cause cancer in animals and may cause cancer in humans
Glycol ether	Solvents in paints, cleaners and inks	Toxic if ingested. Care should be taken to minimise inhalation and skin contact
Isocyanates such as toluene diisocyanate (TDI), methylene bisphenyl isocyanate (MDI), hexamethylene diisocyanate (HDI) and isophorone diisocyante (IPDI)	Used in the manufacture of flexible and rigid foams, fibres, coatings such as paints and varnishes, and elastomers	Danger is mainly to production workers. Short-term inhalation may cause sensitisation and asthma. Skin contact can induce dermatitis and eczema. Long-term inhalation exposure has been shown to cause asthma, dyspnea, and other respiratory impairments
Lead	Paint (particularly paint that has been applied around 40 years ago). Less likely to be found in current formulations, but it is important to check	Linked to incidence of blood cancers such as leukaemia
Phthalates	Softeners used in plastics	Linked with hormone disruption and reproductive problems
Radon	Gas arising from decay of radium-226 found in nearly all soils to varying degrees and dissolved in groundwater. New construction projects should include a radon barrier to mitigate effects where radon is present. This is mandatory in building regulations in some countries	Not well defined, though there is evidence of increased likelihood of lung cancer through prolonged exposure, particularly among smokers

Source: International Tourism Partnership working group

More information

International Aluminium Institute
www.world-aluminium.org

ATHENA Sustainable Materials Institute
www.athenasmi.ca

Coatings Technology Centre
Information on environmentally friendly paints from the Paint Research Association.
www.pra-world.com

The Concrete Centre
Promoting and assisting more sustainable concrete design and construction.
www.concretecentre.com

Cornell University Centre for Materials Research
www.ccmr.cornell.edu

Forest Stewardship Council
www.fsc.org

Green Building Handbook: Volume 2
Spon Press, 2000
www.sponpress.com

GreenSpec Directory: Fourth edition
Internet and printed product directory with guideline specifications.
BuildingGreen, 2003
www.buildinggreen.com

Pan-European Forest Certification framework (PEFC, *now the Programme for the Endorsement of Forest Certification***)**
www.pefc.org

Sustainable Forestry Initiative (SFI)
www.sfiprogram.org

World Steel Association
www.worldsteel.org

5.5 Noise

Hotels are subject to many sources of noise, both internally and externally. Noise pollution must be mitigated for legal and safety reasons and to protect the quality of the guest experience. Noise management is largely controlled at the design and construction stages of hotel development. Hotel operators must work closely with architects, engineers and the construction team to ensure appropriate noise-control measures are taken.

Table 6 shows recommended ambient noise levels for various types of building during the day and at night. Noise abatement measures should achieve these levels or a maximum increase in background levels of 3dB(A). Measurements should be taken at noise receptors located outside the project boundary.

Table 7 shows the recommended maximum noise levels for various areas in luxury hotels. Typical noise levels for lower-range hotels would differ from the above values; for example, guest room noise curves would be 2–4 dB higher.

5.5.1 Areas where noise transmission can be reduced

a WINDOWS

- Ask suppliers for information regarding window sound reduction factors and specify **sound transmission levels** for windows based on maximum noise levels.
- Allow guests **limited opening** of the windows.

b ROOM TO ROOM

- Specify that **wall penetrations** must not be made from guest room to guest room for sockets, switches, ducts and cables.

c **BATHROOM TO BATHROOM**

- **Isolate baths** and acoustically insulate the drain pipework.
- **Offset exhaust ducts** against each other to prevent direct connections.
- Install **soundproofing insulation** underneath floor tiles in bathrooms.

d **GUEST ROOM DOOR TO CORRIDOR AND ADJACENT ROOMS**

- For luxury hotels, the entrance door should have a **sound transmission class (STC) of 45**. This will reduce noise originating from the corridor by 45 dB. Such doors also satisfy 30-minute fire rating requirements. For lower range and budget hotels specify 35–40 dB.
- Fit **door gaskets** around frames and a drop seal at the bottom.
- Specify **double doors** between rooms. The STC for room to room reduction should be 50 dB.

e **FAN COILS**

- Specify **acoustic lining** within the supply ducts.

f **COMPARTMENTATION**

- Inspect the building regularly throughout construction to ensure that any **openings** between floors and rooms are properly sealed off. This is also a vital requirement for fire prevention.

g **KITCHENS TO RESTAURANT, BANQUETING AND MEETING ROOMS**

- Install **double doors** between the kitchen and the rooms it services.

h **FUNCTION ROOMS SEPARATED BY MOVABLE PARTITIONS**

- Specify the **sound transmission** class (STC) of the separation. A suitable value would be 46 dB.
- **Seal the space** above any false ceilings and run air-conditioning ducts separately from the outside main supply and exhausts.

i **EQUIPMENT**

- Install noisy equipment on **separate foundation bases** and provide acoustic rubber isolation pads made with reinforced rubber.
- Position, enclose, and **isolate** noisy equipment in order to prevent noise disturbance to guests and the neighbourhood or minimise it to acceptable levels. Permit space or buffer zones encompassing two walls between noisy equipment rooms (such as the laundry) and public areas.
- Design-in **physical space** between elevators or rooms such as housekeeping store rooms and guest bedrooms.
- Provide **separate isolated rooms** for ice machines. Use water, not air-cooled compressors.
- **Locate** emergency generators and diesel engine equipment away from public areas.
- When construction is complete, check the sound levels against **specified acoustics**.
- On air-cooled equipment, use **larger cooling fans** to reduce speed.

Table 6: Recommended ambient noise levels

MAXIMUM ALLOWABLE EQUIVALENT SOUND LEVEL (L_{eq} hourly in dB(A))		
RECEPTOR	DAY: 0700–2200	NIGHT: 2200–0700
Residential, institutional & educational	55	45
Industrial and commercial	70	70

Source: World Bank Group Pollution Prevention and Abatement Handbook

Table 7: Recommended maximum noise levels in luxury hotels

AREA	NOISE CURVE (dB)
Guest rooms	27 (night) 30 (day)
Public rooms	35–40
Meeting rooms	30–35
Offices	30–35
Kitchens / Laundry	40–45
Service work areas	45

Source: International Tourism Partnership working group

5.6 Air quality and emissions

5.6.1 Emissions to atmosphere

Emission levels for the design and operation of the building must be established during the pre-design stage during the environmental impact assessment. Boilers and incinerators may require filters or other mechanisms to control particulate matter.

It is suggested that the recommended emission levels shown in Table 8 are followed together with the appropriate national legislation, and the more stringent values adopted. The values are expressed as concentrations to facilitate monitoring.

Table 8: Air emissions requirements

PARAMETER	MAXIMUM VALUE*
Particulate matter	
Fossil fuels	100 mg/Nm^3
Other fuels (such as wood and biomass)	150 mg/Nm^3
Nitrogen oxides from boilers as NO_2	
Coal fired	750 mg/Nm^3
Oil fired	460 mg/Nm^3
Gas fired	320 mg/Nm^3
SO_2	2000 mg/Nm^3

* Maximum levels should be achieved for at least 95% of the time that the plant or unit is operating to be calculated as a proportion of annual operating hours. These are expressed in Nm^3 or Normal cubic metres (gas measured at 1 Atmosphere and 0°C).

Source: World Bank Group Pollution Prevention and Abatement Handbook

5.6.2 Refrigeration and ozone-depleting substances

Hotels and the tourism industry use chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), halons and other ozone-depleting substances (ODS) in various applications: for air-conditioning, in refrigerators, freezers and cold rooms and in fire protection. However, these substances all damage the earth's protective ozone layer, which absorbs the ultraviolet radiation that is harmful to living organisms and human health.

Because of the damage that they do to our atmosphere, there are strict controls over the production and consumption of certain refrigerants and other ODS under the Montreal Protocol—an international treaty to which nearly all the countries in the world are signatories. Many substances have already been banned in developed countries and there are strict deadlines governing the phase-out of production and consumption in the developing world. In the European Union, for example, the supply of CFCs and their use for maintenance of existing equipment is banned, and it is not legally possible to buy them. HCFCs are also subject to restrictions: it will be illegal to both 'place on the market' and to 'use'[55] new HCFCs after January 2010 and illegal to use any HCFCs after 2015.

For virtually all ODS applications there are alternatives available (see **Table 9**). Some are better than others for certain applications and all have performance, safety, cost and environmental trade-offs that must be carefully considered by hotel developers and owners.

Table 9: Key refrigerants used in the hotel industry and their alternatives

Note: Never substitute alternatives without first checking compatibility with your equipment supplier. In some cases, modifications may be necessary before using replacements or it may be necessary to replace the equipment altogether.

CFC	HCFC	HFC *	'NATURAL REFRIGERANT'
R11	R123		
R12	R401A R401B R409A R409B	R134a R413A	R290 R600a R717
R502	R402A R402B R403B R408A R411B	R404A R407A R407B R507	R290 R717
	R22	R404A R407C R410A R417A	R290 R717

* With the exception of R413A and R417A, the HFCs do not use the same compressor oil as CFC and HCFCs.

Sources: ISCEON Distribution Services and Enviros

[55] The definition of 'use' is important, as it is defined as including 'refilling' the refrigerant into a refrigeration system. This appears even to include a ban on replacing refrigerant that has been removed from the equipment for maintenance.

As a guide:

- **CFCs** and **HCFCs** are ozone-depleting.
- **HFCs** are non-ozone-depleting (zero ODP), but have significant global warming potential (GWP).
- **Natural refrigerants**: Ammonia has zero ODP and zero GWP and hydrocarbons (HCs)—i.e. propane and butane—have zero ODP and negligible GWP.

Currently, the most environmentally responsible choice is to select systems using natural refrigerants. In the future, as research into alternative refrigerants progresses, it may be possible to use CO_2 or water as a refrigerant for air-conditioning applications.

More information

UNEP Division of Technology, Industry and Economics (DTIE) OzonAction Programme
www.unep.org/ozonaction/

How the Hotel and Tourism Industry Can Protect the Ozone Layer
UNEP, 1998
www.unep.org/ozonaction/

5.6.3 Indoor air quality

Factors affecting indoor air quality include levels of outdoor pollution, sources of indoor pollution, the rate of exchange between indoor and outdoor air, ventilation rates and distribution, the characteristics and furnishings of the building and the amount of moisture in the indoor environment.

There is a general belief that indoor air quality can be improved only at the expense of energy conservation. However, using proven energy conservation technology for increased ventilation system efficiency could significantly improve indoor air quality without significantly increasing energy consumption.

The following need to be considered during the pre-design and design stages in order to avoid problems:

a. Total **air flow** requirements, required **temperature ranges** and ambient **humidity** levels.

b. Air **cleanliness** (specify high-efficiency filters).

c. The **hotel indoor environment** and **furnishings**.

d. **Fresh outside air** requirements, **minimum ventilation rates** and **indoor air quality levels** need to be set in accordance with ASHRAE standards (American Society of Heating, Refrigerating and Air-Conditioning Engineers).[56]

e. **Variable outside air** provision of up to 100% (providing free cooling and excellent air quality).

f. The installation of **CO_2 monitoring systems** as part of the BMS, which not only provide feedback on ventilation performance, but can also modify air volumes in relation to actual occupancy. These systems will require periodic recalibration to ensure optimal performance.

g. **Energy recovery** (via an energy wheel or other heat recovery devices), which also permits higher fresh air quantities.

h. **Displacement systems** that provide excellent air quality (suitable for moderate climate zones).

[56] 'Ventilation for Acceptable Indoor Air Quality' (Std 62-2001 and addenda), ASHRAE, **www.ashrae.org**

i ...... **Natural cross-ventilation**. This involves locating windows on both sides of the room, creating airflow across the space. The cross-ventilation principle is, like all natural ventilation principles, based on the requirement of ensuring a fresh and comfortable indoor climate with minimal energy consumption at low cost.

j ...... Location of the **fresh air intakes** relative to exterior pollution sources (such as directly over car parks or loading bays or at street level) to avoid taking in toxic fumes. Also ensure the air intake is not located near the hotel's own emissions from garages, kitchen, laundry and toilet exhausts, sewage tanks and treatment systems, boiler flues or cooling towers (in the latter case because of the danger of *Legionella* contamination).

k ...... Specify adequate **extraction** over cooking appliances and laundry equipment to avoid 'spillage' into the other areas. Kitchens, laundry and toilets must be under negative pressure. Pressurised systems can spread odours inside the building through duct leakages.

l ...... **Duct system layout**. Exhaust fans should be located outside the building and pull the air through the ducts.

m ...... **Ease of maintenance**, particularly ease of access for maintenance to air-conditioning and ventilation equipment.

n ...... It is important to protect all air handling systems during construction and to perform a **building flush-out** prior to occupancy.

o ...... Professional **commissioning** will be necessary to balance all ventilation and air-conditioning systems.

p ...... Choose low-VOC-emitting **building materials**, cleaning chemicals and furnishings. Request emissions test data from product manufacturers. *See **Section 5.4** Materials.*

Table 10: Common sources of indoor air pollution

POLLUTANT	SOURCES	HEALTH EFFECTS
Ammonia	Cleaning products	Eye and mucous membrane irritant
Bacteria	Moulds and mildew	Can cause worsening of respiratory complaints
CO_2	Respiration, combustion	Can cause feelings of stuffiness, drowsiness
Dust and particles	Carpets, surfaces, smoking	Dependent on particle size and nature
Formaldehyde	Foam insulation, fabrics, furniture, fire retardants, adhesives, carpet backing, cigarette smoke	Eye, skin and mucous membrane irritant. Can cause headaches and asthma
Nitrous Oxides (NO_x)	Combustion (boilers, cookers)	Worsening of respiratory complaints
Odours	Cooking, smoking, perfume, etc.	Annoyance and/or stress
VOC	Solvents, aerosol sprays, cosmetics, dry cleaning, paints, pesticides	Wide-ranging, including eye, skin and mucous membrane irritant

Source: Ecospecifier.rmit.edu.au

5.6.4 Non-smoking areas

For health, comfort (and increasingly in many countries, legal reasons) no building occupants who are non-smokers should be exposed to tobacco smoke. According to the WHO, tobacco is responsible for five million deaths annually around the world and the figure is expected to rise to 10 million people each year by 2025 if current smoking patterns continue. The WHO has issued an International Framework Convention on Tobacco Control[57] to which 100 countries are now signatories.

- If national legislation does not already require it, consider making the building totally **smoke-free**.
- Alternatively, provide **separate designated smoking areas** in public spaces and separate non-smoking guest room floors.
- **Air** from smoking areas should be extracted directly to the outside.

More information

Air-Conditioning and Refrigeration Institute
www.ari.org

American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE)
www.ashrae.org

Building Owners and Managers Association International
www.boma.org

Multilateral Fund for the Implementation of the Montreal Protocol
www.multilateralfund.org

5.7 Use of hazardous substances

The storage and handling of all hazardous materials must be in accordance with local regulations and international standards such as COSHH[58] and be appropriate to their hazard characteristics.

- Design to **isolate activities** associated with chemical use, including providing secure storage areas for housekeeping equipment and products, cleaning agents and pesticides. These areas should contain sinks and drains plumbed for adequate disposal of waste and separate exhausts vented to the outside that are operated under negative pressure.
- Potentially harmful products should be stored in **well-ventilated, locked facilities**. These should be included in the design of the building and ancillary areas.

More information

REACH (the registration, evaluation and authorisation of chemicals)
European initiative which will require companies that produce and import chemicals to assess and manage the risks arising from their use, making industry rather than the authorities liable for ensuring the safety of chemicals on the market.

Likely to become law by end 2005 or early 2006 REACH will list around 100,000 different substances with data on their environmental and health effects.
http://ec.europa.eu/enterprise/sectors/chemicals/reach/index_en.htm

57 World Health Organisation International Framework Convention on Tobacco Control, **www.who.int/tobacco**

58 'Control of Substances Hazardous to Health Regulations 2002 (COSHH)' which require employers to control exposure to hazardous substances to prevent ill health, **www.coshh-essentials.org.uk**

Sustainable Hotel
Siting, Design and Construction

The industry guide to good practice

Conservation International

International Tourism Partnership

6 CONSTRUCTION AND REFURBISHMENT

First published 2005 | Digital Release 2014

6.1 Construction and sustainable development

It is well known that construction sites have negative impacts on the local environment and community through noise, air, and water and land pollution. Clients and contractors should make provisions to minimise these impacts and any disruption to the community and ensure the health and absolute safety of local residents as well as that of all staff on site.

The construction phase of a new hotel can have detrimental impacts on its surroundings such as:
Increased **traffic** to and from the site, particularly heavy lorries and construction vehicles, which increases the likelihood of sediments and **contaminated soil** being carried off the site.
Noise, dust and a **poor visual appearance**.
Possible destruction of **flora** and **fauna**.
Increased demand for **utilities**.
Affect on the **social community** by factors such as an influx of workers.
Issues associated with **waste** disposal.

The construction industry can contribute to the achievement of sustainable development by:[59]
Operating to the highest international **safety** standards.
Delivering buildings and structures that provide **greater satisfaction, well-being and value** to customers and users.
Treating its **stakeholders** fairly and respectfully, including the labour force.
Recruiting from the local community, where possible, training and capacity building.
Working with **suppliers** and ensuring sustainable practice is integrated throughout the **supply chain**.
Enhancing and protecting the **natural environment and biodiversity**.
Minimising its impact on the consumption of energy (especially carbon-based energy), **water** and other non-renewable **natural resources**.
Minimising **waste** by reusing materials where possible.
Avoiding **pollution**.
Setting targets and **measuring performance**.

Picture courtesy The Commtech Group

[59] See 'Building a Better Quality of Life—A Strategy for More Sustainable Construction', DTI, 2000, **www.dti.gov.uk**

Some of these measures—for example, reusing existing buildings and waste materials and respecting people and the environment—can be implemented at little or no extra cost. Other measures and techniques may increase the initial capital cost but should be weighed against the resulting long-term savings over the entire life of the building.

If sustainable objectives are followed, the industry can expect to benefit from fewer conflicts, faster planning applications and access to investment, resource efficiency, better health and safety and an improved local employment and skill base. It will also contribute to more sustainable asset management by delivering buildings that are more efficient, have lower maintenance costs and increased value and marketability.[60]

Before construction can commence, the client must be content that the project fully satisfies the original criteria set out in the project and design briefs, including all the sustainability objectives that have been specified. The client should verify that funds are readily available and ensure that payments are paid promptly when they are due in accordance with the contract.

The commissioning and handing over of a project by the construction team is an important and final phase of the construction process. This phase should be given due care and attention with both objectives and activity planned well in advance. As part of the handover it is essential to provide the client with all the necessary training, facility operations and maintenance information and all relevant health and safety files and procedures for reporting defects.

6.2 Pre-construction

A The site should already have been subject to an **EIA** (*see* ***Section 2.3***), which will take into account issues such as contaminated land and specific characteristics of the site that need to be protected. Any recommendations from the assessment must be implemented before work begins on the site. In the case of soil remediation, this work may take several months.

B Establish a **construction policy** that includes health and safety and an EMS for inclusion into the construction documents from the outset. This should cover issues such as health and safety, site preparation, minimising environmental and social impacts and landscape restoration.

C Make sure that everyone is **aware** of the importance of sustainability to the project. This may involve the need for induction training based on sustainable principles such as The Natural Step.

D Identify **minimum infrastructure requirements** during the construction process with regard to waste water treatment, roads, electricity and freshwater supply.

E Provision should be made for **residential and business areas** that will be affected by the project by minimising the severance of local access routes, improving crossings and/or alternative access routes, maintaining temporary traffic diversions during the construction phase and establishing and enforcing safe speed limits.

F Specific **landscape and heritage features** requiring preservation should be clearly identified and appropriate measures and techniques put in place to ensure their protection. This is particularly important for sites that are environmentally or culturally sensitive.

G Aim to ensure **minimum clearance of vegetation**. Re-vegetation should take place as soon as possible and responsibility should be allocated to look after new planting on site.

[60] 'London Sustainable Construction Project: A scoping study', CRIA, Forum for the Future and The BRE Trust, 2004, www.lsx.org.uk

H

Elevated boardwalks should be built for workers to use before construction commences to minimise site disturbance.

I

It will be important to source **materials** for the development that have minimal environmental impact, are produced locally, are appropriate for the area and are sufficiently durable for the task they are to perform. *See* ***Sections 5.4*** *Materials and* ***8*** *Interior design.*

J

Take care to order materials in the **correct amount**. Building materials that are left over at the end of a project usually find their way into landfill. When construction is complete, materials that have not be incorporated into the works can be put in a designated area outside the site compound, and the local community encouraged to come and take them free of charge, benefiting local people and saving unnecessary landfill.

K

Waste disposal facilities will need to be provided to minimise the amount of roadside litter. Assurances should be obtained from the developer that any waste will be collected, segregated and properly disposed of in accordance with government regulations.

6.3 Recruitment, safety and training

A

The **safety** of workers, site visitors and people in the surrounding community should be of paramount importance, yet it is traditionally an industry with a very poor safety record as thousands of lives are lost on construction sites worldwide each year. **Compliance** with the highest international health and safety standards is absolutely essential. For example, no one should be allowed on site unless they are wearing a hard hat.

B

Select the construction team based on their **experience** of working in sensitive locations and ask for attainment of **standards** such as ISO14001 or EEBA Master Builder accreditation. In San Francisco, USA, for example, architects, building professionals, general contractors and specialist tradespeople who complete a course on green building methods and materials can attain NARI Certified Green Building Professional[61] status.

C

Ensure that the site is kept **tidy** at all times and that there are areas designated for waste separation, etc. This is an efficient practice and will improve site safety.

D

In many countries, there is a **skills shortage** for competent builders and construction workers. In the UK alone, the industry requires 80,000 new recruits every year for the next five years.[62] By training apprentices, the construction industry can provide young people with valuable skills for the future, bridge the skills shortage and improve standards. In many countries, grants and other financial incentives are available to encourage apprenticeship.

E

The use of screens and fences around the site will provide **security** against inquisitive children and unwelcome intruders, while also protecting their **safety**.

F

Construction companies should consider signing up to **voluntary schemes** such as Considerate Constructors,[63] which commits contractors to be considerate and good neighbours, as well as clean, respectful, safe, environmentally-conscious, responsible and accountable.

[61] San Francisco Bay Area NARI (National Association of the Remodeling Industry), **www.sfbanari.com**

[62] Construction Industry Training Board (CITB), **www.citb.co.uk**

[63] Considerate Contructors scheme, **www.ccscheme.co.uk**

6.4 Minimising social impacts

A — **Good communication** and feedback mechanisms are essential. Keep the local community fully informed on a regular basis. This should be done through public meetings and face-to-face contact, not just through leaflets.

B — Keep to the **agreed hours of work** and inform neighbours if there is a need to exceed them. This will help to keep complaints to a minimum.

C — Look after the **welfare of the construction staff**. Providing decent accommodation and good canteen facilities will help to maintain their well-being and motivation.

D — Incorporate **appropriate local techniques and skills** and, where necessary, train local people in sustainable building techniques.

E — Train construction crews to recognise **culturally important resources** and to consult project managers on how to mitigate adverse impacts.

F — Reduce ambient **noise** through aesthetically-acceptable noise barriers, such as the placement of earth mounds or vegetation between the road and sensitive receptors.

6.5 Minimising environmental impacts on-site

A — Screen the site from the outside to **minimise its visual impact**.

B — Enter into a **formal contract** with a professional waste contractor that specialises in recycling.

C — **Minimise the load on landfills** when demolishing existing structures. Establish the extent to which materials can be reused or recycled.

D — **Provide incentives** to the workforce to sort and segregate waste and keep the site tidy and safe.

E — Where space permits, erect **waste storage facilities** for separating, recycling and compacting waste, otherwise designate special areas.

F — Maintain a clean site. Enforce **housekeeping** rules (but also reward and celebrate successes).

G — **Limit storm water run-off** by minimising sealed areas and directing the run-off to settling basins prior to discharge to surface waters to prevent contamination. Ensure that ground-level walkways remain pervious.

H — Ensure that the **ground** is not overly compacted or hardened in areas that will later form the gardens. Recover topsoil for reuse later on.

I — Minimise use of **heavy mechanical machinery**.

J Control land drainage to prevent water channelling and sediment transport by diverting flows from areas where soils are exposed, and/or by providing filter barriers or settling basins to remove sediment before the run-off is discharged to surface waters.[64]

K Culverts should be provided as necessary to prevent the road from disrupting or radically changing the existing drainage regime.

L Stabilise slopes after excavation and revegetate cleared areas as quickly as possible. Replanted areas and ground that may be subject to erosion must be monitored and maintained at all times.

M Avoid stagnant water conditions over long periods.

N Include provision in roadways for wildlife bridges or tunnels at migratory route crossings, fencing and vegetation to prevent animal and vehicle collisions, and additional habitats and migration routes for local animals that may be displaced by the project.

O Storage and liquid impoundment areas for fuels, solvents, de-icing materials and waste products should be designed with secondary containment, such as dykes, to prevent the contamination of soils, groundwater and surface waters due to accidental spills or releases. They should also be sited to minimise potential risks from earthquakes, floods, windstorms and fires.

P Pesticides, fertilisers and other maintenance chemicals must be applied strictly according to the directives of the manufacturer, and used in compliance with government regulations. Preference should be given to natural soil improvers and pesticides over chemical compounds.

Q Protect materials that are delivered to the site prior to use.

R Protect installed equipment from accumulation of dust and debris. Enclose any open pipework and flush out the entire system upon completion. Replace and/or clean air filters in ventilation systems prior to handing over to the client.

6.6 Refurbishment

The same rules that apply to new building development also apply to many aspects of refurbishment and remodelling, such as:

- Procurement of materials and services.
- Selection of systems and fittings.
- Management of contractors on site.
- Noise and waste disposal issues.
- Commissioning.

In general these guiding principles should also help to guide the process of refurbishment along more sustainable lines. Since upgrading is a regular process occurring over many years, the hotel should aim to continuously raise environmental construction standards over time.

It is crucial to develop a management plan with an implementation strategy for the refurbishment. This should clearly set out the sustainability objectives for the project and identify chains of responsibility for implementation and monitoring.

[64] 'Pollution Prevention and Abatement Handbook: Part III Tourism and Hospitality Development', World Bank Group, September 2001, www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/ifc+sustainability/publications/publications_handbook_ppah__wci__1319577543003

A .... Select a **refurbishment team** that is experienced in identifying and managing green issues.

B .... Ensure that any potentially **harmful or hazardous materials** such as asbestos have been identified. Removal and disposal must be undertaken by professionals and appropriate time allowed for this.

C .... Plan for the **reuse and recycling** of removed furniture, fixtures and equipment (FF/E) and construction materials.

D .... Implement **rigid housekeeping** rules.

E .... Ensure that the hotel's **life safety systems** are not adversely affected by any work that is carried out.

F .... Comply fully with local **waste regulations** and use licensed waste hauliers.

G .... Use **locally available** materials. *See **Section 5.4** Materials.*

H .... Use **local sub-contractors** where possible.

I .... **Protect existing and new equipment** from dust and debris and flush out duct and pipe systems prior to handover.

More information

A Guide to Managing Health and Safety In Construction
Health and Safety Commission, Construction Industry Advisory Committee, 1995
www.hsebooks.co.uk

Building a Better Quality of Life: A Strategy for More Sustainable Construction
UK Department for Trade and Industry, 2000
www.dti.gov.uk

Construction Industry Training Board (CITB)
www.citb.co.uk

Considerate Constructors Scheme
www.ccscheme.co.uk

Constructing Excellence
www.constructingexcellence.org.uk

International Labour Organisation Standards on Safety and Health
Conventions, Recommendations and Codes of practice for the establishment of international standards on labour and social matters.
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Sustainable Hotel
Siting, Design and Construction

The industry guide to good practice

Conservation International

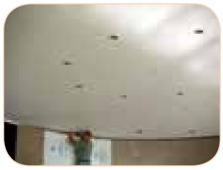
International Tourism Partnership

7 COMMISSIONING AND OPERATION

First published 2005 | Digital Release 2014

COMMISSIONING AND OPERATION

Although the building may appear to be complete, commissioning is the true test of whether it functions as a system. Commissioning is best described as the process of ensuring that a building performs according to its design intent and to suit the needs of its owners and occupants.[65] Proper commissioning of the hotel's mechanical, electrical and plumbing installations is essential to achieve optimum energy efficiency once the building commences full operation. If the water and air systems are not balanced, the equipment will have to run longer and harder to maintain comfort conditions, which increases operating costs and environmentally harmful emissions. Guests may have to wait longer until hot water flows from the tap or for the air-conditioning to respond.



Main image: **Commissioning involves a multitude of inspections, assessments and preparations.**

Right: **Thermal imagery to check the operation of cooling coils and a chilled ceiling.**

Pictures courtesy The Commtech Group.

Commissioning is important for any building project, although its role differs according to the size of the individual building and its location. In some countries there is a 'commissioning leader' or dedicated engineer responsible for commissioning, in others it is the responsibility of the designers and contractors. The earlier in the development process it can be started, the more effective it will be, as it is commissioning that generally reveals any weaknesses in the design and construction. Benefits include fewer defects at handover, timely completion and fewer complaints during the building's operational life.

The performance of each system and item of equipment item must be documented in the commissioning report. As buildings and their systems become more complex, so the requirement for commissioning has developed. The process not only ensures that all systems are in good working order, but also confirms that all specified capacities are being achieved. This data can also be used as part of the company environmental management system such as ISO 14001 and in corporate environmental performance reporting.

65 'Achieving the Desired Indoor Climate: Energy Efficiency Aspects of System Design', The Commtech Group, 2003, www.commtech-group.com

7.1 Planning and design

A — **Appoint** the commissioning engineer at the earliest opportunity. It is preferable to have one person with overall responsibility for commissioning and ensuring that the building objectives and schedules are met.

B — Keep systems as **simple** as possible but ensure that adequate time provision is built in for accurate and efficient testing and regulation.

C — Ensure there is adequate provision of the following:

- **Flushing facilities** to flush and clean water systems thoroughly.
- **Venting and draining facilities**.
- Facilities for **water treatment and analysis**.
- Requirements for **access and maintenance**.

D — Review fabric requirements particularly with regard to **air leakage** and **infiltration**.

E — Ensure personnel and plant **safety** during operation.

F — Review clarity of **'cause and effect'** in fire detection mode and power failure mode.

G — Determine the need for **plant or equipment testing** by manufacturers at their own works. For example, a full load test of a chiller may be difficult to perform on site. A requirements document should be produced in relation to this and included in the design brief.

H — Establish **start-up** and **operating** procedures.

I — The commissioning manager should produce a **logic network**[66] for the testing and commissioning (T&C) showing the logical sequence of events and also how it interfaces with the construction work. The network should include all the various systems and items of equipment and how they interface with each other, culminating in the final **integrated systems test (IST)**.

J — Ensure that **all parties** to be involved in the T&C process have a chance to influence the time scale required for their activities and agree that they can complete on schedule. The Construction Manager can then determine the critical path necessary to achieve the completion date.

7.2 Installation monitoring

A — Ensure that installation teams observe **good housekeeping** principles to prevent unnecessary entry of dirt into ductwork and pipe systems.

B — Review **correct installation** of plant and equipment. Ensure that there is adequate provision for all air to be vented.

C — Review ductwork and pipework **modifications** which result from co-ordination clashes with other services and the building fabric, since such changes may result in high pressure drop sections and reduce plant efficiency.

D — Monitor and witness **system pressure tests** and when proved satisfactory, ensure any sectional caps or membranes are removed.

[66] The logic network is a flow diagram highlighting prerequisites from the various members of the construction teams and indicating testing that needs to be undertaken as construction progresses.

E Ensure that **record drawings** are updated and that they accurately reflect the installation, particularly of services that will be hidden once the building is complete.

F Following installation and pressure testing, ensure that **pipework is flushed out** and, where necessary, chemically cleaned. This work may need to be carried out by a water treatment specialist but should be witnessed at all stages by the Construction Manager. After flushing and cleaning, the system must be quickly treated with appropriate levels of inhibitor to prevent corrosion and contamination, and regular checks of inhibitor levels made to ensure adequate concentrations are maintained.

7.3 Pre-commissioning

A After installation and prior to commissioning, ensure that the system is **complete** and in a satisfactory and **safe** condition prior to start-up.

B Conduct **static** and **electrical checks** of the main plant.

C Prepare documentation in advance in the form of **pro forma check and test sheets**.[67]

7.4 Testing and commissioning

A Ensure that test instrumentation is **not damaged**, carries a current **calibration certificate** and is reasonably easy to use in the environment in question.

B Always select an instrument with an **operating range** greater than expected results.

C Be aware that for the test undertaken there may be a **correction factor** that needs to be applied to compensate for reading error.

D Observe plant **start-up** and **shut-down** to ensure correct operation.

E Monitor conditions within the building to ensure **required conditions are achieved** and the system is stable.

F Witness **cause and effect tests** to ensure the services operate as intended in fire detection and power failure modes.

G **Liaise** with local authorities, fire officers, building control officers, building insurers and the design team to ensure compliance with all legal and statutory requirements.

7.5 Operator training and hand-over

A Co-ordinate the **training** of the building user's operations team, for example, the chief engineer and department member to ensure that first-hand operational knowledge is transferred.

B At the point of hand over to the owner or operator, it is important that **documentation** for all systems and materials is presented to the operations team. These include:

- **Specifications** and **design documents**.
- **As-built drawings**.
- Operation and maintenance (O&M) **manuals**.

[67] Examples of pro forma test sheets can be found in BSRIA application guides 'AG 2/89.3 Commissioning Water Systems' and 'AG3/89.3 Commissioning Air Systems', **www.bsria.co.uk**

- Commissioning reports (testing and commissioning records) showing all the set points and data relating to the building management system and control systems.
- Warranties.
- Material specifications.
- Spare parts and materials.

7.6 Operation, maintenance and continuous commissioning

Continuous commissioning is the last phase of the commissioning process and takes place after handover to the owner or operator. The process enables the function of the equipment to be checked and optimised for energy efficiency and, when changes are made, enables the 'as-built' documents to be updated. In these respects, the continuous commissioning process complements the energy management process of a building.

Since the building will use most energy during its operational lifetime, continuous commissioning ensures that existing systems can:

- Handle changes in activities in the building.
- Adjust equipment to new standards and regulations.
- Monitor equipment deterioration.
- Minimise energy consumption.

Typical problems that are identified at this stage include negative pressurisation of the building, blocked reheat coils, air volume systems (VAV) temperatures set too low, broken thermostats and high exhaust pressures.

All systems must be regularly inspected and serviced. Regular testing should be carried out on large energy consumers such as chillers, boilers and air-conditioning systems, to verify actual performance versus the original conditions. In this way, the building will be able to operate to optimum efficiency and ensure the highest level of comfort for guests and staff.

7.7 Post occupancy evaluation

Post occupancy evaluation (POE) involves the systematic evaluation of opinion about buildings in use, from the perspective of the people who use them. It assesses how well buildings match their users' needs, and identifies ways to improve building design, performance and fitness for purpose. POE can be used for many purposes, including fine-tuning new buildings, developing new facilities and managing 'problem' buildings. It is also valuable when establishing maintenance, replacement, purchasing or supply policies; preparing for refurbishment; or selecting accommodation for purchase or rent.

More information

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Sustainable Hotel
Siting, Design and Construction

Conservation International

International Tourism Partnership

The industry guide to good practice

8 INTERIOR DESIGN

First published 2005 | Digital Release 2014

INTERIOR DESIGN

It is now generally agreed that providing good indoor air quality is critical to asthma and allergy prevention and the minimisation of other health effects such as headaches and nausea. Some of the synthetic products used in the 1960s and 70s have proved to have adverse environmental and health effects. Examples include paints and varnishes containing high levels of VOCs, which can cause headaches and, when released to atmosphere, contribute to the formation of photochemical smog associated with respiratory diseases.

The Orchid Hotel in Mumbai, India was the first hotel in Asia to win Ecotel certification shortly after it opened in 1997.

See Case Study 28, Appendix 1.

Since the early 1990s, there has been a move back to the use of more traditional building and decorating methods, not only in historic conservation buildings but also for the most modern 'design' hotels.[68] Not only are they often safer and more pleasant to work with, but sustainable, natural building materials have proved over time that they are more able to respond to the surrounding environment and, in helping to regulate the temperature and humidity of buildings, can make life more comfortable for those inside. With so much emphasis being placed on contemporary and dramatic interiors, natural products can also help play a distinctive part in the hotel's interior design and be a positive talking point among guests.

Natural and sustainable materials are not automatically better for the environment than synthetic materials. It depends on whether there is a sustainable supply of the natural resource (for example, it may be over-harvested due to a popular trend); how the raw materials are gathered, processed and transported; and what emissions may be involved. Ask for information about the environmental impacts of the product during manufacture and use and the implications for its disposal when it has reached the end of its life—i.e. its whole life cycle. Consider too how the material will be fixed to the wall or floor. The effort taken to source a sustainable product can be quickly wasted by using an environmentally-damaging adhesive.

With a little effort, it is possible to find products that are durable, practical and good value that will not damage the environment.

[68] According to the 2004 Design & Hospitality Giants survey, 96% of the top 100 interior design firms in the USA are specifying sustainable products, and 20% specified US$10 million or more worth of green products in 2003. Together the 100 firms specified over US$869 million in green products in 2003, with an average per firm of US$12.8 million. More than half of the time (58%) the initiator of sustainability is the interior designer although clients initiate the concept 34% of the time and it is a joint effort in 8% of projects. The most common green products recommended include carpet, flooring, and wall covering. More than 80% of these firms expect to specify more green products in the future. Interior Design, October 2004.

8.1 Walls

8.1.1 Plasters

A **Clay plasters** are a blend of clay, fine aggregate and plant fibres. Supplied in powder form, they are suitable for internal surfaces and bond well to masonry, clay board, lime plaster and plaster board. They enable buildings to breathe, helping regulate internal humidity. Clay plasters now come in a variety of earth colours such as pink, red and yellow and require no further decoration. Alternatively they can be colour-washed or painted with emulsion.

B For a finer finish, a **sand and clay** plaster can be used. Clay slips are also very smooth and can even be polished to a high sheen.

C **Lime mortar and plaster** was used for centuries until the development of cement in the early 20th century, but its use is now being revived particularly for restoring older buildings. Lime is made by firing limestone to make quicklime. Water is then added and causes a chemical reaction and the mixture forms a putty. Lime plaster is porous and flexible to work with. If left too long it will revert naturally to limestone so it has to be kept damp and covered in hessian in a controlled atmosphere while being worked on.

8.1.2 Paint

A If possible, use paints that contain only **naturally-occurring ingredients**, are solvent free, have zero-VOCs and comply with eco-labels in the countries where these exist. Water-based natural paints, mineral paint and distemper emit no or low VOCs.

B Where possible, **avoid** alkalyd/oil based paints and those containing titanium dioxide, vinyl, acrylates, formaldehyde, VOCs (organic solvents), chromium, cadmium, nonylphenolethoxylates and lead.

C **Synthetic paints** (alkalyd, vinyl and acrylic) are manufactured from highly-processed petrochemicals, produce large amounts of waste in their manufacture and contain a small percentage of solvent. If a synthetic paint is necessary, acrylic-based water-borne paints have excellent durability, although they still involve an energy-intensive production process and the use of neutralising agents, auxiliary diluents and preservatives. Although only traces of the chemicals remain in the finished product, at least one Swedish nature conservation authority advises that a 40 million-to-one dilution is necessary to render water-soluble gloss paint harmless before entering the sewage system.[69]

D Give preference to paints using **plant and mineral-based** ingredients for the binder, resins, pigments and solvents. Examples include linseed oil-based, wood and vegetable resin-based paints containing plant-based pigments.

E **Casein paint** (or distemper) is a traditional paint that has returned to popularity. Casein is a derivative of milk and the paint is usually made up of a mixture of casein, minerals and white pigments (without the addition of titanium dioxide, a whitener). Being microporous (breathable), it can assist in regulating indoor humidity. Some manufacturers supply it as a base white paint for tinting, others supply it in powder form for mixing with water. Suitable only for interiors, it is usually odour-free, or at least should smell fresh and pleasant, and is suitable for people who suffer from allergic symptoms or headaches. Many manufacturers do not test their products on animals. Pigment (usually in powder form) must be added to obtain the desired colour and the paint dries to a soft, chalky finish. It can be used over wallpaper, wood, stone, clay, plasterboard and plaster. Some formulations are not suitable for ceilings because of their watery consistency, making them difficult to apply.

[69] Environmentalism and paint, Auro, www.auro.co.uk/natural-paint-faqs/68-principles

f Water-based, transparent **glazes** can be used on painted surfaces and for fixing powdery or sandy surfaces, protecting them from dust and making cleaning easier. Colour washes are glazes combined with casein paint and stained with pigment. The pigments are finely-ground organic earth and mineral pigments.

g **Lime washes** can be used as an alternative to paint. They consist of lime and water and around 10% tallow, casein or pulverised fuel ash. They are applied by brush and several coats are required, making application more labour intensive than modern paints, but they provide a high-quality, decorative finish.

8.1.3 Non-woven coverings

a Non-woven **wallpapers and coverings** come in many forms including recycled newspapers, wood chips and textiles. Textured covering can be made from cellulose, glass fibre, glue and other binding materials. It is important to find out exactly what they contain as some are more environmentally appropriate than others.

b **Avoid** products that contain or use formaldehyde, vinyl chloride or heavy metals in the manufacturing process as these persist in the environment. Vinyl (mainly PVC) wall covering and vinyl coated paper not only have adverse environmental impacts associated with the manufacturing and disposal processes but, if used in humid climates, can lead to mould growth.

c Non-woven, printed wall coverings can be used as an alternative to vinyl and can be made of either **natural** and **renewable** or **recyclable** materials. Some have designs overprinted in water-based inks (that contain no heavy metals or solvents) and are often washable, stain repellent, light resistant, tear and abrasion resistant, as well as being easy to install.

d Consider Forest Stewardship Council (FSC) **certified paper** that contains a mixture of recycled paper and sustainably-harvested wood.

e **Rice paper and parchment** wall coverings are made from natural ingredients and coloured with water-based dyes for a natural look. They may require specialist expertise in hanging.

8.1.4 Woven wall coverings

a The advantages of **fibre wall coverings** are in their permeability. They are suitable for humid areas because they minimise the risk of mould formation, which has serious implications for indoor air quality. Silk and velvet are the most luxurious and expensive natural fabrics, while wool or cotton are more affordable. Most will come bound to a natural backing to facilitate hanging. Look for fabrics coloured with natural dyes. For a completely natural and more organic look, consider fabrics made from hemp, corn, soy or hessian, which can be used undyed.

b **Glass textiles** are made of woven glass yarns that are woven into various textures and patterns and treated with a natural starch binder so they do not stretch during the hanging process. These fabrics are strong and breathable and can be overpainted many times. Although glass is a natural material made from sand, lime and clay, the firing process is fairly energy intensive.

c More unusual **fibre wall coverings** incorporate coloured flakes (made of calcium carbonate, polyvinyl biodegradable acetate binders and pigments) on a glass fibre backing. The flakes should be non-toxic and free of heavy metals.

8.1.5 Recycled materials

a Particularly suitable for bathrooms, tiles made from **recycled glass** are even stronger than ceramic tiles and are an attractive way of helping to keep glass out of landfill. They can have a matt surface (commonly associated with recycled glass) or a polished finish and are available in clear or opaque forms and a wide variety of colours and sizes. The percentage of recycled glass varies according to the manufacturer and quality of the glass—anything from 55–100%. Their manufacture does not require the use of toxic substances or production of toxic waste and they can be fired at lower temperatures than ceramic tiles.

b Tiles made from **bonded recycled leather** can give a luxurious feel to an interior. The tiles must be treated as leather and allowed to acclimatise for 48 hours at normal temperatures in the location where they are to be used. They can be fixed with special eco-adhesives or dry tape systems. They are low maintenance, and require only dusting occasionally with alcohol-free agents.

c The potential for using recycled materials for wall coverings is almost infinite—as demonstrated in the American Honda office training and warehouse building in Gresham, Oregon. Its conference room walls are covered in wall coverings made from **recycled telephone directories**, the restroom walls are composed of **recycled wood** and **fibre chips in a resin base** and the tiles are made from **recycled glass bottles**.

8.2 Floors

A range of environmental impacts are associated with floor coverings. The most serious are probably associated with the manufacture of synthetic carpets and vinyl. These rely on energy-intensive manufacturing processes (adding to global warming, acid rain and the production of toxic by-products and photochemical smog). They also use non-renewable resources (largely petro-chemicals) as a basic raw material (especially in the case of nylon carpets).

The initial investment in environmentally responsible flooring products will often be higher than that required for conventional products (with the possible exception of linoleum and some locally-quarried stone). However, there are cost benefits associated with these products. Many environmentally responsible flooring materials can function effectively for tens of years as opposed to the five to seven years associated with some synthetic materials. Cost savings can also be gained through the relatively lower maintenance costs associated with natural materials.

- **Avoid** products containing halogenated plastics, (the manufacture and disposal of PVC can result in the production of highly toxic dioxins, and the phthalate plasticisers used to improve flexibility are suspected of disrupting hormones in human beings).
- Alternative and more **environmentally responsible** products such as natural wool carpets, cork or wood flooring can all have significantly reduced environmental impacts and contribute to biodiversity if they are from sustainable sources. Natural flooring products such as wool, sisal and coir can benefit the internal environment of a building as they absorb and give out moisture, regulating the internal climate. They are also anti-static.

- **Smooth flooring products** require the least cleaning and maintenance. Stone, wood, cork and linoleum are therefore often the lowest-maintenance options. They also require the least energy-intensive and/or synthetic cleaning solutions. In heavy-use situations, some types of wood may need sanding and revarnishing (or oil and waxing) after two to five years.
- When choosing flooring materials, consider how they will be **fixed** to the floor as the use of a toxic or environmentally damaging adhesive can undermine the thought that has gone into selecting a sustainable floor covering. *See **Section 5.4.2** The A–Z of building materials.*

Below are suggested natural materials suitable for various flooring applications:

8.2.1 Bamboo

a An **alternative** to rainforest hardwoods, bamboo grows up to 20 metres each year and will achieve substantial thickness in a short time. The mother plant produces new shoots annually with stems maturing sufficiently for harvesting within 3–5 years (as opposed to species such as oak, cherry or maple, which take between 30 and 200 years to reach maturity).

b Bamboo is mainly produced in **controlled forests** in China. The timber bamboo is cut and milled into long, thin strips that are treated with a non-toxic formula to resist pests. After drying, the strips are laminated together into a single-ply veneer. Several layers are then compressed together using high temperatures and pressure to create a multi-layer flooring product that can be milled into tongue and groove planks.

c Bamboo **will not shrink, swell, bow, cup** or **twist** with moisture changes. However, some products are more scratch-resistant than others.

8.2.2 Carpet

a Carpet is **long lasting**, has excellent **thermal insulation** and **acoustic value** and is also very comfortable to walk upon. It can be made of wool or other natural fibres such as hemp, or from synthetic yarns such as nylon.

b The **best environmental option** (apart from use in damp or humid climates) is pure organic or natural wool (available unbleached or undyed) with hessian backing and underlay made from recycled felt (of sisal or coir). This should be fixed to the floor with tacks and grippers rather than adhesives.

c If it is not possible to specify 100% natural wool, choose 80% wool/20% nylon, which combines **durability** with natural content.

d Wool is naturally moderately stain resistant but may require **protection** to resist dirt, stains or insects. If a chemical treatment must be used, ask the supplier which treatment is the most environmentally preferable.

e Make it a **purchasing requirement that suppliers** take back old carpet for recycling or to be manufactured into new products rather than sending it to landfill.

8.2.3 Ceramic tiles

a. Apart from the clay firing process, which is **energy intensive**, the environmental impact of producing ceramic tiles is low, so the tiles have considerable 'embodied' energy.

b. Unglazed tiles are able to **breathe** and therefore help to regulate the internal climate.

c. Ceramic tiles can usually be treated with **natural linseed oil** as they are laid and then coated with **natural wax** once in place. They are available with 50% recycled ceramic content.

d. Tiled floors can be **slippery** when wet. Location and cleaning procedures must be taken into account when specifying tiles. Tiled areas should be cordoned-off during cleaning and should remain so until the tiles are dry.

8.2.4 Cork

a. A very **resilient and hard wearing** flooring material, cork tile is derived from the bark of cork oak trees found mainly in Portugal, Spain and Northern Africa. The material is taken from the outer casing of the trunk of trees once it is 25 years old. The stripping of the outer casing is essential for the recovery of the tree, which then regenerates and is further harvested every nine years. Cork floors can provide 30 years of service or more.

b. Cork requires little energy in production though the **transportation impacts** of using European cork outside Europe should be taken into account. However, these may be offset by the fact that it is much lighter than many other materials, so more can be transported at once.

c. Cork is soft, quiet and warm to the touch and is an effective, naturally-occurring **insulator**. It is easy to lay even over slightly uneven surfaces—cork planks are made from two layers of cork which sandwich a tongue and groove material. It wipes clean and is easy to maintain.

d. Cork is **biodegradable** and can be disposed of at the end of its life, so long as it has been fixed with biodegradable adhesives or pins. It is also largely recyclable and recycling programmes already exist in Germany and Japan.

8.2.5 Linoleum

a. Often confused with vinyl, linoleum is a **natural, renewable** and **biodegradable** product although the energy required for its manufacture is considered by some to be greater than that of vinyl flooring.

b. Linoleum should be considered as an **alternative** to vinyl, ceramic tiles and other products where a durable, hard, waterproof surface is sought.

c. It is produced in sheet and tile form which is usually pressed onto a **natural jute backing**.

d. During manufacture, almost all rejected material from processing and inspection can be **recycled** back into the product.

e. **Low VOC-emitting adhesives** should be specified.

The desired look, whether contemporary or classic, can be achieved using sustainable materials.

Pictures courtesy Novotel and Scandic

8.2.6 Natural vegetable fibres

a Natural fibres are able to **store humidity** and emit it when the air is dry. This 'breathing action' promotes a healthy indoor atmosphere.

b Vegetable fibres for floor coverings include **sisal, coir (coconut husk), sea grass** and **jute**. The plant sources for each of these do not need artificial fertilisers, pesticides or herbicides to flourish. Some of these products may be attached to a natural latex backing.

c These floor coverings have **good acoustic** and **thermal qualities**, are **anti-static** (so vacuuming easily removes dirt and dust particles), and are **durable** and **biodegradable**.

d Vegetable fibres may **not be suitable** for areas subject to excessive moisture, spillage and/or excessive wear so it is worth checking with the supplier.

8.2.7 Rubber

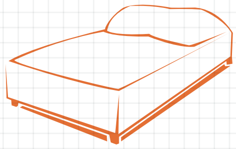
a Rubber flooring is available in **roll and tile formats**, is highly durable, resilient, shock and sound-absorbent. However, rubber is flammable and can have a distinctive odour.

b Rubber is generally considered to be a **low environmental impact** material. Virgin rubber is derived from trees, and the manufacture of synthetic rubber has a comparatively low impact on the environment.

c Flooring that contains **recycled rubber** is cheaper and more durable than synthetic or virgin rubber, and is an even better choice for the environment. Tyre dumps pose a serious environmental hazard and so all recycled rubber tyre products help to alleviate this problem. Some rubber floorings contain between 75 and 100% post-consumer and post-industrial content.

8.2.8 Vitreous tiles

a Vitreous tiles are durable, easily cleaned and **do not support mould and mildew growth** if kept clean. For high-traffic areas where acoustics can be handled properly, tile is comparable to carpet in terms of life cycle costs.



b **Cement installation** is preferable to adhesives for reasons of indoor air quality. Where this is not possible, specify **water-based adhesives** or those with a low VOC content.

c Tiles with **recycled content** are available.

d Tiled floors can be **slippery** when wet so the location and cleaning procedures must be taken into account when specifying tiles.

8.2.9 Wood

See ***Section 5.4*** *Materials.*

More information

Paints and wall coverings
green**hotelier** issue 27, April 2003
www.greenhotelier.org

Environmental Design and Construction
www.edcmag.com

8.3 The green guest room

In creating a green guest room, the aim is to evaluate every component of the room and its relationship with the entire building from a sustainable viewpoint. Many of the concepts articulated here, such as those relating to walls, floors, furniture, fixtures and fittings, are equally applicable to other rooms in the hotel.

Scandic pioneered the concept with their 'eco-guest room' in Norway in 1995. Although a truly sustainable room is probably yet to be achieved, Scandic used the principles of The Natural Step and the Nordic Swan eco-label[70] in defining a standard to follow. Today there are over 10,000 eco-rooms in the Hilton & Scandic portfolio and the Scandic Environmental Construction Standard[71] covers not only the guest room, but all aspects of hotel design and construction.

The materials used in each Scandic eco-room are 97% recyclable. The floors are wood, as is the furniture, and textiles are pure wool or cotton, with as few fittings as possible made of chrome, metal or plastic. The company works closely with its suppliers to obtain the best possible materials for the health of its guests and the environment, selecting materials that are non-toxic, hypo-allergenic and renewable.

70 A product carrying the Swan label meets extremely high environmental standards. See **www.nordic-ecolabel.org**

71 See **www.scandichotels.com**

8.3.1 Components of a green guestroom

Guestroom corridors 1

- Install **motion detectors** to demand control lighting except for emergency illumination.

Electrical 2

- Provide a keycard-activated **master switch** at the room entrance that automatically activates room systems and shuts off lights, TV, etc. when the guest enters or leaves the room. Exceptions include the electricity supply to the minibar, in-room safe and socket designated for charging laptop computers.

Lighting 3

- *See **Section 5.1.6**, Lighting.*

Heating, air-conditioning & ventilation 4

- Depending on the class of hotel, provide a **fancoil** or a separate independent unit such as a through-the-window unit or heat pump. They should all be of high efficiency and low noise level.
- **Interface** the unit with the **front desk system** to activate or shut off upon check-in/checkout.
- Integrate a **motion detector** with adjustable time delay to shut off or operate on a higher or lower temperature level (winter/summer). Combine with lighting.
- Ensure that **fresh air provision** to the guest rooms conforms with internationally-recognised standards such as those set by ASHRAE. A suitable rate would be to introduce fresh air at a rate if 90 m^3/hr (cubic metres per hour) exhausted from the bathroom at 85 m^3/hr.
- **Heat transfer** (k-factor) in moderate to cold climates should be at least 1.5 in order to minimise energy losses.
- *See also **Section 5.1.5** Heating, ventilation and air-conditioning (HVAC).*

Walls 5

- *See **Section 8.1** Walls.*

Floors 6

- *See **Section 8.2** Floors.*

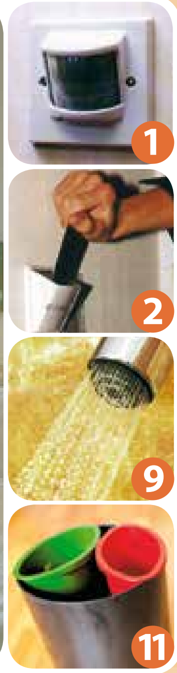
Furniture, fixtures & fittings 7

- Choose furnishings made from **sustainably-harvested** sources of wood, which contain **solvent-free** glues and **CFC-free** foam.
- Use **natural fabrics** of wool, eco-certified or organic cotton, linen, silk or hemp (alone or in blends), and window coverings made from natural fabrics, wood slats, woven reeds and grasses.
- Consideration should be given to using **inherently flame-retardant materials** for upholstery and curtains, which require less fire-proofing treatment than synthetics.
- **Avoid** nickel and chrome; leather treated with chrome; paints; varnish and glue containing nonylphenolethoxylates; PVC; brominated flame retardants and synthetics including plastics where possible.

Equipment 8

- The TV should use less than 5 Watts when in **standby** mode.
- **Minibars** should be energy efficient and use the least environmentally damaging refrigerant. *See **Section 5.6.2** Refrigeration and ozone depleting substances.*

Components of a green guestroom/continued



Bathroom 9

- Rather than using granite or marble for surfaces, consider using **recycled granite**, which can have over 90% recycled content.
- Install **refillable** soap, shampoo and shower gel **dispensers**. These need not look 'low budget' as there are now attractive dispensers for wall mounting and a variety of luxury branded amenities that can be purchased in bulk.
- Where standards demand individually-packaged **guest amenities**, ensure these are made from natural, sustainable, biodegradable ingredients and preferably eco-labelled and that the packaging is minimal, recycled and biodegradable.
- Choose **radiators** and taps with a painted rather than a chromed finish. Not only is the chroming process very environmentally damaging, but the radiator will be 10% more energy efficient.
- The larger the **bath or basin**, the more water it will take to fill it. Just using one litre per bath per guest per year less will have a dramatic effect on water consumption.
- Consider installing **programmable controls** to dictate the temperature and maximum fill level of the bath. This enables the guest to press a button to fill the bath, and reduces the risk of it overflowing.
- *See also **Section 5.2.2** Water efficiency.*

Noise 10

- *See **Section 5.5** Noise.*

Waste 11

- Provide **waste baskets** with **separate compartments** for paper, glass/cans and other waste to facilitate separation at source by the housekeeping department.
- The compartmentalised waste basket is the first link in a chain involving separate waste areas within **housekeeping trolleys** and **back-of-house** recycling facilities, backed up by **staff awareness and training**.
- *See **Section 5.3** Waste.*

Main Picture: The eco-guestroom—a model for the future of hotels, with long-term benefits, both economically, and environmentally. Picture courtesy Scandic, photographer: Åke e:son Lindman.

Inset, from top: Corridor motion detector, keycard-activated motion switch, flow-limited shower head, and compartmentalised waste baskets.

Sustainable Hotel
Siting, Design and Construction

The industry guide to good practice

Conservation International

International Tourism Partnership

9 MONITORING PERFORMANCE

First published 2005 | Digital Release 2014

9.1 Measurement

There is a well-known phrase that says '*You cannot manage what you cannot measure*' and it is particularly true for managing resource efficiency in hotels. The hotel operator should use the appropriate measuring devices that will permit monitoring, assessment and adjustment of all major energy and water-consuming equipment and systems, and of the waste output of the establishment.

Once the hotel is operational and its environmental performance is being tracked and benchmarked on an ongoing basis, internal competition between departments and incentive programmes will help the operator to improve environmental performance on a continuous basis.

A Energy and water consumption should be **sub-metered by major department** and by energy type. Suitable areas for sub-meters are:

- **Guest rooms**.
- **Restaurants**.
- **Function rooms**.
- **Public areas**.
- **Kitchens**.
- **Laundry**.
- **Gardens**.
- Staff **changing rooms**.
- **Air-conditioning, ventilation and heating** systems.
- **Pools** (indoor and outdoor) and **spa facilities**.
- **Gym** and **sports facilities**.
- **Garages** and parking areas.
- **Leased areas**.
- Any other areas of major resource consumption.

This will allow each department to take responsibility for its usage and enable feedback on deviations and implemented improvements, depending on size and complexity of the hotel. It will also be useful for benchmarking performance. Much of the monitoring work can be carried out by the BMS.

B **Benchmarks** should be set for water and energy consumption and the architect's, designer's and contractor's **final payments** should be tied to the building's overall energy and water performance.

C The architect and engineers and any specialist consultants for lighting, kitchens and gardens, etc. will all have a **major influence** on resource demand and consumption. This needs to be factored into the commissioning process to ensure that design capacities and functionality are being achieved.

D For **large, energy-consuming equipment** such as boilers and chillers, efficiency should be monitored continuously. This will enable corrective action to be taken as soon as any deviation from optimum performance is detected.

9.2 Setting benchmarks

Benchmarking is a standard by which something can be **measured or judged**. It is an ongoing process in order to determine what needs to be improved. Benchmarks provide a quantitative assessment of the current situation against which **targets** can be set for future improvement and progress measured. Benchmarks for hotels can include indicators such as the number of covers served by waiters or profit per square metre (m^2), etc.

Environmental benchmarks specifically measure environmental performance such as:

- **Energy** use (typically expressed as kWh per m^2, kWh per guest night or CO_2 in tonnes per year).
- **Water** use (litres per m^2, litres or m^3 per guest night).
- **Waste production** (kg per guest night or tonnes per year).
- Amount of **waste recycled**.
- Use of **cleaning chemicals**.
- Use of **hazardous products**.

Most hotels can benchmark their own performance. Some hotel groups not only measure the performance of individual buildings but also compare this across the group, referencing their results against industry performance benchmarks.

The following tables provide a guide to help establish performance targets for electricity, energy, water and waste production. The benchmarks have been established on the basis of data available from approximately 1,000 hotels of differing standards from around the world.

It should be borne in mind that there are many variables when it comes to benchmarking and that hotels vary greatly in type, facilities, types of equipment, weather conditions, occupancy and age, and not every hotel will fit the simple examples given here. The following benchmarks should therefore only be used as a guide. Individual hotels or chains may wish to develop their own specific benchmarks.

9.2.1 Electricity and energy use

Table 11: Benchmark values for electricity and other energy (fuel, gas, district heating) consumption in typical hotels

Energy consumption (kWh/m² of serviced space)	EXCELLENT	SATISFACTORY	HIGH	EXCESSIVE
luxury* serviced hotels — temperate				
Electricity	<135	135 – 145	145 – 170	>170
Other energy	<150	150 – 200	200 – 240	>240
TOTAL	<285	285 – 345	345 – 410	>410
mediterranean				
Electricity	<140	140 – 150	150 – 175	>175
Other energy	<120	120 – 140	140 – 170	>170
TOTAL	<260	260 – 290	290 – 345	>345
tropical				
Electricity	<190	190 – 220	220 – 250	>250
Other energy	<80	80 – 100	100 – 120	>120
TOTAL	<270	270 – 320	320 – 370	>370
mid-range serviced hotels — all climate zones				
Electricity	Insufficient data	70 – 80	80 – 90	>90
Other energy	Insufficient data	190 – 200	200 – 230	>230
TOTAL	Insufficient data	260 – 280	280 – 320	>320
small and budget serviced hotels — all climate zones				
Electricity	Insufficient data	60 - 70	70 – 80	>80
Other energy	Insufficient data	180 – 200	200 – 210	>210
TOTAL	Insufficient data	240 – 270	270 – 290	>290

Source: benchmarkhotel.com

NOTE: Benchmark values may adjust over time.

* Luxury in this context is a large luxury hotel (approx 400 rooms) with ventilation and air-conditioning (electrical chillers), and a laundry.

For the different CO_2 emission values of various fuels see **Section 5.1.2** *Energy Sourcing*.

Worked example: calculating maximum demands

In this example, the above benchmarks can be used as follows to determine the maximum energy and electricity demand that a planned hotel should not exceed.

1 Specification

- A large luxury **400–room** hotel with full air-conditioning is planned in a temperate climate zone.
- The total enclosed area is **30,000 m²** (75 m²/room).

2 Typical full **operating hours** for hotels in temperate climate zones are:

- ELECTRICITY: **5,000 hours**
- ENERGY: **2,000 hours**

3 From the above tables the **benchmarks** for large hotels in temperate climate zones are:

- ELECTRICITY: **145 KWh/m²**
- ENERGY: **200 KWh/m²**

4 Equations:

$$\underset{\text{KWh}}{\text{ANNUAL CONSUMPTION}} = \underset{\text{KWh / m}^2}{\text{CONSUMPTION BENCHMARK}} \times \underset{\text{m}^2}{\text{AREA}}$$

$$\underset{\text{KW}}{\text{ANTICIPATED MAXIMUM DEMAND}} = \underset{\text{KWh}}{\text{ANNUAL CONSUMPTION}} \div \underset{\text{h}}{\text{\# HOURS}}$$

5 Annual consumption results:

- ELECTRICITY: 145 KWh/m² × 30,000 m² = **4,350,000 KWh**
- ENERGY: 200 KWh/m² × 30,000 m² = **6,000,000 KWh**

6 Anticipated maximum demand results:

- ELECTRICITY: 4,350,000 KWh ÷ 5,000 hrs = 870 KW = **0.87 MW**
- ENERGY: 6,000,000 KWh ÷ 2,000 hrs = 3,000 KW = **3.00 MW**

The results can be used to compare the planning engineers' calculated total demand at the end of the design stage. Transformers and boilers are sized accordingly. The anticipated peak demands are the basis for concluding utility contracts.

Should the planning engineers' figures turn out to exceed the above figures, the hotel would then be less efficient and exceed annual consumption figures. The design should therefore be re-evaluated in order to maximise the building's energy efficiency.

9.2.2 Water use

Most water utility companies express their bills in cubic metres so water consumption is expressed here in m^3. 1 m^3 = 1000 litres.

Table 12: Benchmarks for total daily consumption (excluding any water use in gardens)

TYPE OF HOTEL	DAILY CONSUMPTION
Large hotel with HVAC, laundry, kitchens, pool	< 0.60 m^3/guest night
Mid-range class hotel	< 0.40 m^3/guest night
Small hotel	< 0.33 m^3/guest night

Source: International Tourism Partnership working group

Table 13: Benchmarks for water consumption (m^3/guest night)

Water consumption (m^3 per guest night)	EXCELLENT	SATISFACTORY	HIGH	EXCESSIVE
luxury fully serviced hotels				
temperate	<0.50	0.50 – 0.56	0.56 – 0.90	> 0.90
mediterranean	< 0.60	0.60 – 0.75	0.75 – 1.10	> 1.10
tropical	< 0.90	0.90 – 1.00	1.00 – 1.40	> 1.40
mid-range fully serviced hotels				
temperate	< 0.35	0.35 – 0.41	0.41 – 0.75	> 0.75
mediterranean	< 0.45	0.45 – 0.60	0.60 – 0.95	> 0.95
tropical	< 0.70	0.70 – 0.80	0.80 – 1.20	> 1.20
small and budget fully serviced hotels				
temperate	< 0.20	0.20 – 0.21	0.21 – 0.31	> 0.31
mediterranean	< 0.22	0.22 – 0.25	0.25 – 0.38	> 0.38
tropical	< 0.29	0.29 – 0.30	0.30 – 0.46	> 0.46

Source: benchmarkhotel.com

Table 14: Benchmarks for daily individual consumption

DEPARTMENT	DAILY CONSUMPTION
Guest rooms	< 0.22 m^3/guest
Kitchens	< 35 litres/cover
Laundry	< 20 litres/kg

Source: International Tourism Partnership working group

9.2.3 Waste production

Total annual waste is usually measured in terms of kg per week/month or tonnes per year sent to landfill, total waste recovered for recycling or percentage of total waste recycled. A benchmark that is often used by the hotel industry is kg of waste produced per guest night.

Table 15: Benchmark values for waste production in typical hotels

Waste production (kg/guest night)	EXCELLENT	SATISFACTORY	HIGH	EXCESSIVE
luxury fully serviced hotels				
all climate zones	< 0.60	0.60 – 1.20	1.20 – 2.00	> 2.00
mid-range fully serviced hotels				
all climate zones	< 0.40	0.40 – 1.00	1.00 – 1.50	> 1.50
small and budget fully serviced hotels				
all climate zones	<0.60	0.60 – 0.80	0.80 – 1.50	> 1.50

Source: benchmarkhotel.com

More information

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