City of Cape Town Smart Building Handbook

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If you have any information you believe should be included in the next edition of the City of Cape Town Smart Building Handbook, please send an e-mail to smartliving@capetown.gov.za with ‘SBH suggestion’ in the subject line.
4.2.8 Thermal mass: Heat sinks ................................................................. 13
4.2.9 Natural and traditional building materials and methods .................................................. 13
4.2.10 Design according to standard sizes of construction materials ......................................... 14
4.2.11 Integrated planting and roof gardens ............................................................... 14
4.2.12 Economic impact ........................................................................... 14
4.2.13 Recommendations for the design phase ......................................................... 14
4.2.14 Checklist: Design phase ........................................................................ 15

4.3 Construction phase ............................................................................. 16
4.3.1 Soil conservation ............................................................................... 16
4.3.2 Recycle construction and demolition waste .................................................. 16
4.3.3 Use sustainable materials and products ....................................................... 16
4.3.4 Buy local .......................................................................................... 17
4.3.5 Recommendations for the construction phase .............................................. 17
4.3.6 Checklist: Construction phase ..................................................................... 17

5 SUSTAINABLE RESOURCE MANAGEMENT ............................................. 17

5.1 Energy efficiency ................................................................................. 17
5.1.1 Passive solar design ........................................................................ 18
5.1.2 Insulation ....................................................................................... 18
5.1.3 Ceilings ......................................................................................... 18
5.1.4 Air ventilation ................................................................................ 18
5.1.5 Tight construction .......................................................................... 19
5.1.6 Electricity ...................................................................................... 19
5.1.7 Lighting ......................................................................................... 20
5.1.8 On-site generation: Photovoltaic panels and wind generation ......................... 20
5.1.9 Water heating ............................................................................... 20
5.1.10 Recommendations for energy efficiency ............................................... 21

5.2 Water efficiency .................................................................................. 21
5.2.1 Stormwater management .................................................................. 21
5.2.2 Water-wise landscaping .................................................................... 22
5.2.3 Rainwater harvesting ...................................................................... 22
5.2.4 Plumbing layouts ............................................................................ 22
5.2.5 Water-wise installations ................................................................... 22
5.2.6 Grey wastewater systems ................................................................. 23
5.2.7 Water-wise toilets ......................................................................... 23
5.2.8 Alternative sanitation options ........................................................... 23
5.2.9 Recommendations for water efficiency .................................................. 24
5.2.10 Checklist: Resource efficiency ......................................................... 24

5.3 Waste minimisation and management .................................................. 25
5.3.1 Recommendations for waste reduction .................................................... 26
5.3.2 Checklist: Waste management .............................................................. 26
1 INTRODUCTION

1.1 Who are the target readers of this handbook?

This handbook is intended as a resource for those citizens of Cape Town who make decisions with respect to the built environment. For the purposes of this document, these citizens have broadly been grouped as:

- homeowners;
- professionals, such as:
  - architects;
  - engineers;
  - quantity surveyors; and
  - facilities managers;
- developers;
- contractors; and
- tenants.

This handbook is intended to provide practical information on energy-efficient technologies, design criteria and appropriate materials and solutions that will result in addressing ‘whole green building design’.

It presents broad design guidelines to cover all building types, followed by a series of checklists for various audiences.

‘Green building design’ requires a holistic approach to resource-efficient building design and construction. It relies upon all members of the project team sharing a vision of sustainability, and working collaboratively to implement sustainability goals at appropriate phases during the project. Effective, integrated design leverages synergies among building components, resulting in reduced project life-cycle costs.

The economic life-cycle performance of integrated, sustainable design is a critical element to green buildings across the board.

The built environment contributes towards 40% of the electricity consumed in large cities. The objective of the Smart Building Handbook is to promote green buildings as a viable alternative. Image: Bruce Sutherland

1.2 Why green building?

The City of Cape Town (City) has developed the Smart Building Handbook in order to promote resource-efficient building practices, which will reduce the impact that buildings have on the environment as well as the operating costs of running them. Green building practices benefit not only building professionals but also homeowners, communities and the environment, and afford everyone the opportunity to take the first steps towards a more sustainable future.

1 Words printed in bold in the text are defined in the glossary at the end of the City of Cape Town Smart Building Handbook.
Buildings are responsible for between 40% and 60% of greenhouse gas emissions in the city, and are thus a major contributor towards global climate change. The urgency of reducing greenhouse gas emissions and other environmental impacts is therefore driving the change to a more sustainable built environment. However, green buildings offer a range of other benefits as well, including:

- reduced operational costs;
- reduced resource consumption;
- improved employee health, well-being and productivity;
- reduced exposure to new environmental regulations (e.g. carbon tax);
- reduced exposure to utility price increases;
- attractiveness to staff;
- building environmentally aware businesses and households; and
- improving and future-proofing asset value.

It is a City priority to accelerate resource-efficient development and to drive change through information, green practices and new standards in Cape Town.

This handbook provides broad guidance on green design issues as well as a list of resources for detailed green design.

1.3 How to use this handbook

This handbook provides information to achieve resource-efficient buildings in the following three ways:

1. By stepping through the construction process, from site selection and design to construction and operation, highlighting considerations and opportunities at each stage
2. By providing checklists for stakeholders at each stage of the building process
3. By summarising the guidelines in a series of questionnaires for homeowners, developers and tenants, to work through as they proceed with a project in the built environment, whether it is a new office building or the replacement of a geyser at home. The homeowners’ questionnaire is provided for retrofit and new-build situations.

This handbook also provides specific guidance on green certifications and benchmarking as well as green leasing, which are primarily aimed at developers and commercial tenants.

1.4 Limitations of this handbook

This handbook does not provide or replace statutory requirements or City policies for buildings. Compliance with all relevant regulations, standards and bylaws is still required.

This handbook is of a general nature, and does not apply equally to all conditions and locations. It is not a substitute for proper calculations and modelling by a design team.

The actual performance of design strategies and systems presented in this handbook will depend on the detailed design, implementation and operation of the systems in question.

1.5 Is green building more expensive?

Green buildings are perceived to be significantly more expensive than conventional buildings. This is not necessarily true. Some green building attributes bring capital cost savings to construction (such as natural ventilation), while others bring appreciable operational cost savings to buildings (energy efficiency in all its forms). Further to these direct savings, there are a wide range of other benefits attached to building green, such as improved health, productivity, long-term asset value and reduced exposure to carbon emissions regulation. Integrated design, consideration of sustainability from early on in the development process, and life-cycle costing all provide tools for making the most commercial sense of building green.

The City of Cape Town has a clear action plan for energy and climate change.
2 SUSTAINABLE DEVELOPMENT WITHIN THE CONTEXT OF CAPE TOWN


The Smart Living Handbook provides an excellent resource for understanding the importance of resource efficiency and reduced environmental impact in Cape Town. It has the following to say about energy, water, waste and biodiversity in the city.

2.1 Energy

Cape Town is gaining a reputation as a pioneer in sustainable energy development. The City of Cape Town was the first African city to develop an Energy and Climate Change Strategy in 2005. This outlines a vision for the delivery and consumption of sustainable, environmentally sound energy for Capetonians. The strategy sets quantifiable but challenging targets for the transport, electricity supply, residential, government, industrial and commercial sectors.

The target is to reduce City-wide electricity consumption by 10% by 2012 on unconstrained use, and that growth in demand be met by renewable/clean-energy supply, with a 10% renewable energy supply by 2020. In order to lead by example, the City has set itself the same efficiency target for its own operations.

2.2 Water

Fresh water is a scarce and critical resource. Less than 1% of water on earth is easily accessible and fresh. With the threat of climate change likely to increase water scarcity even further, it is very important for us to understand our role in protecting natural water systems, and to conserve our precious water supplies.

Most of the bulk untreated water supplied to Cape Town comes from dams that store water running off Western Cape mountains during our winter rainfall season. The increasing water demand and threat of climate change mean the future of our water supply in Cape Town is not secure.

The most sustainable option for providing fresh drinking water in the long term is to adopt a water conservation approach. The City aims to reduce water use and water wastage by 20% by 2020. Therefore, the municipality encourages all people to understand water scarcity, protect water resources, and practise responsible water use.

2.3 Waste

Currently, the City’s waste is primarily managed through landfill disposal. However, we are creating waste at a much faster pace than the population growth rate, and our landfill sites are filling up fast.

Currently, Cape Town’s waste is sent to three landfill sites: Vissershok in the north of the city, Bellville South in the central area, and Coastal Park in the south. These sites accept general waste only, although Vissershok also accommodates low levels of hazardous waste. A private site accepts high levels of hazardous waste. It is becoming increasingly difficult to find geologically suitable sites for landfills in Cape Town. Our waste will need to be transported over longer distances, which will push up tariffs.

The City is currently considering the best location for a new regional landfill site.
2.4 Biodiversity

The Cape Floral Kingdom is the smallest of the six floral kingdoms on earth, and the one with the highest density of plant species. It has over 9,000 different plant species and many animal species, and is also one of the global biodiversity hot spots.

Why is biodiversity conservation important?

- Biodiversity provides us with various ‘goods’ (for example food we can harvest, such as fish and maize, and goods for commercial production, such as flowers and herbs) and ‘services’ (for example the absorption of carbon dioxide by plants).
- A healthy biodiversity improves our natural systems’ ability to withstand or recover from the impacts of global climate change.
- Well-managed natural areas assist with damage prevention, such as flood control along river banks.
- Biodiversity provides opportunities for tourism and sustainable livelihoods.
- Biodiversity provides recreational, educational, cultural and spiritual spaces.

2.5 Summary

These excerpts from The Smart Living Handbook paint Cape Town as a city with a vision for sustainable development:

- Energy supply and carbon emissions reduction are strategic focus areas for the City, as we have poor energy security and a large carbon footprint due to our dependence on electricity from coal, inefficient energy use and poor public transport.
- We do not have a secure long-term water supply, and are therefore seeking to lead South Africa in water efficiency.
- We have severe landfill shortages, and are therefore seeking alternative approaches to waste management.
- As a coastal city with severe water constraints, we are vulnerable to the effects of climate change, and the City is therefore committed to building resilience to these impacts.
- We are situated within the smallest and most diverse floral kingdom, which must be conserved.

As an urban environment, Cape Town’s environmental impact is closely linked to the quality of its buildings. This handbook is intended to provide all stakeholders in the built environment with the tools to assist the City of Cape Town in fulfilling its sustainable-development potential and turning the city into a sustainable one.
3 GREEN BUILDING PRINCIPLES

The overarching principle of the City of Cape Town Smart Building Handbook is sustainable development, which the Brundtland report (1987) defines as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

For the purpose of this handbook, sustainable development has been unpacked into a set of guiding principles. To deliver the benefits of green building, these principles must be implemented in the planning, design, operation, management and maintenance of any building project, and should not be seen as add-ons, but rather as an integral part of the design and construction process.

The guiding principles on which this handbook is based are that green buildings should:

1. be locally appropriate;
2. conserve the natural environment;
3. use resources efficiently and effectively;
4. be approached on a life-cycle basis;
5. minimise waste;
6. use renewable resources;
7. implement sustainable procurement;
8. utilise locally sourced materials and skills;
9. maximise the health and well-being of users;
10. allow real-time monitoring and evaluation; and
11. leave a positive legacy.

These principles are explored in more detail below.

3.1 Be locally appropriate

Green buildings should be in sync with the social, economic and cultural context within which they are situated. The community which a development will serve should be involved from the beginning to ensure that the project responds appropriately to the local context, and creates sustained benefits for the community in the long term. The process of engagement with the local community in any project should focus on participation and not just consultation, and should as such be process-focused and not just product-focused.

3.2 Conserve the natural environment

Green building implies an environmentally sensitive approach to the design and construction of the built environment, and an approach that aims to conserve the natural resources and ecosystems that sustain life in the area. The built environment must contribute to green corridors in the city’s open spaces that will enable conservation areas to be ecologically linked. Ecologically sensitive areas must be conserved and degraded areas restored.

3.3 Use resources efficiently and effectively

Green buildings should be designed to maximise the efficiency of energy, water and materials use and to optimise resource use to achieve the desired function. Building projects should take advantage of emerging technologies, management systems and behavioural change to effect efficient resource use throughout planning, design, construction and operation.

3.4 Apply a full life-cycle approach

When deciding about the design of a building and the specific materials from which it is to be made, the entire life cycle of products must be considered in order to select the best overall option. Particular consideration should be given to the resource intensity (embodied water or carbon) and end-of-life effects (toxicity, recyclability) of materials. Life-cycle costing should also be used to select design solutions that optimise the cost over the life of the building, not just upfront.

3.5 Minimise waste

Green buildings should aim to eliminate waste in their construction and operation by selecting materials and systems that are reusable or recyclable, and eliminating those that are not, through careful procurement and the design of efficient systems in closed cycles where waste streams are utilised in other systems. This requires a systems-thinking approach to the planning and design phases, aiming to emulate nature by reusing, constantly recycling and putting to use discarded resources elsewhere, in adjacent systems.

3.6 Use renewable resources

Resources and materials that can be sustainably renewed through natural processes and sustainable cultivation are preferred to resources from non-renewable sources. Solar or wind energy, harvested rainwater and sustainable timber (certified by the Forest Stewardship Council) are examples of renewable resources. Projects should make use of certification systems to verify that materials are sourced from sustainably managed areas.

Reed ceilings provide insulation by using locally sourced natural material. Image: EcoExhibit
3.7 Implement sustainable procurement

The procurement of goods and services for the planning, operation, management and maintenance of buildings should take environmental considerations into account. Sustainable procurement includes a wide range of factors, including the selection of low-toxicity and renewable materials, local products and services as a mechanism for local job creation, and materials and equipment based on life-cycle assessments. Every project should state procurement criteria that are suited to the project type and location as well as its immediate environmental and social impacts.

3.8 Utilise locally sourced materials and skills

Products and materials sourced and manufactured in the vicinity of a development reduce the energy embodied in transporting materials over long distances to the site. Furthermore, the use of local materials boosts the local economy and promotes job security for people living in the area.

3.9 Maximise the health and well-being of users

Developing healthy environments for people to live, work and play in should be a primary goal when designing and constructing the built environment. Avoiding the impacts of toxic emissions from materials in the indoor environment and during their manufacture requires particular attention.

Indoor environments also have strong effects on occupant well-being and productivity, especially attributes such as the amount and quality of light and colour, the sense of enclosure, the sense of privacy, access to window views, connection to nature, sensory variety, and personal control over environmental conditions.

Consideration should be given to natural light, indoor air quality, visual comfort and thermal comfort in the built environment.

3.10 Allow real-time monitoring and evaluation

Building managers and homeowners play an important part in ensuring the optimal performance of green building systems. The effective operation of buildings requires an environment rich in data on building performance, at least in terms of energy use, water use and internal conditions. Real-time feedback on building performance is the only way for facilities managers to be alerted to poorly performing systems.

3.11 Leave a positive legacy

The lifespan of buildings often far exceeds that of the developers, professionals or owners who initiate the buildings. They also have a significant impact on the resource efficiency, social interactions and environmental connectedness of our cities. The decisions we take now in the design of the built environment will affect the very fabric of our city for decades to come – decades in which the threats of climate change, food security and fresh-water availability will become increasingly real. So, it is critical that our buildings leave a positive legacy, which enables our city to meet these challenges head-on by ensuring that both the short-term and long-term impacts of decisions and actions lead to sustainability.

Sustainable building practices can substantially reduce greenhouse gas emissions by as much as 70 to 80 per cent, according to the World Business Council for Sustainable Development (WBCSD), which has conducted numerous studies on energy efficiency.
4 IMPLEMENTATION GUIDELINES

4.1 Site selection

4.1.1 Greyfield and brownfield redevelopment

A greyfield site is any site previously developed, with at least 50% of the surface area covered with impervious material.

Greyfield redevelopment of disused sites, such as old factories and commercial buildings, rather than clearing new areas in natural environments, helps to avert urban sprawl. Developers benefit by having fewer development restrictions. Redeveloping a degraded area can improve its environmental performance if the area is designed with environmentally sustainable gardens and buildings.

A brownfield site is a property of which the expansion, redevelopment or reuse may be complicated by the presence or potential presence of a hazardous substance, pollutant or contaminant.

Brownfield redevelopment may involve the acquisition of prime land at an affordable price; however, the cost of site rehabilitation needs to be taken into account. Redevelopment of severely degraded land can be a difficult process, as clean-up operations will likely have to be carried out before building can commence, and the full extent of contamination may not be known upfront. There is no regulatory body dealing with brownfield sites, and standard procedures for clean-up operations have not yet been established.

In contrast, greenfield sites are those that have not been previously developed in any way. Development of greenfield sites should be avoided where possible, and no development should occur on greenfield sites beyond the urban edge.

4.1.2 Compact urban development

Compact development involves increasing the density of development in urban areas to limit urban sprawl and the amount of agricultural or undisturbed land that is lost to building. This also saves the cost of extending service infrastructure, such as roads, electricity, telecommunications, water and sewerage, to outlying areas. Urban densification benefits the people who will be using the new development, as they will be required to commute less than if it were built on the urban periphery. High-density development along main transport routes can also increase the viability of public transport systems. However, there are also proven downsides to high-density urban configurations where there are high levels of unemployment.

4.1.3 Access to transport networks

Transport accounts for 58.4% of the energy consumed in Cape Town, and contributes to 28.2% of the city’s carbon emissions.

The apartheid legacy of dormitory suburbs located far from amenities and opportunities has a severe impact on the amount of energy used for transport. A site located far from work opportunities, amenities and access to transport networks, specifically public transport, places an unfair burden on people living there, and increases their environmental footprint. Access to public transport should be considered as a key factor in site selection.
### 4.1.4 Recommendations for site selection

- The redevelopment of a greyfield or brownfield site is generally favoured above the development of a new or greenfield site.
- Appropriate rehabilitation needs to occur on degraded sites to reduce any negative environmental and health impacts.
- Compact urban development should be supported to reduce urban sprawl and make efficient use of infrastructure.
- Consider whether an environmental impact assessment (EIA) or basic assessment (BA) needs to be conducted.
- The influence of topography and soil conditions on a particular site in relation to implementing sustainable interventions should be taken into account when selecting a site.
- Always consider natural drainage paths to avoid flood hazards and to limit disruption of natural hydrological processes.
- Access to amenities and public transport should be taken into account when selecting a site.

### 4.1.5 Checklist: Site selection

<table>
<thead>
<tr>
<th>Issue</th>
<th>Priorities</th>
</tr>
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| Has the site been built on before? | 1. Reuse and refurbish an existing building.  
2. Rehabilitate a contaminated site.  
3. Reuse greyfield or brownfield site.  
4. Develop a greenfield site within the urban edge. |
| Is the site well located? | 1. Avoid building beyond the city boundary.  
2. Appropriate urban density and good location.  
3. Avoid building in floodplains or encroaching on natural watercourses.  
4. Ensure adequate ecological buffers adjacent to watercourses.  
5. Development should enhance the spatial development framework. |
| Is it close to public transport? | 1. Develop within 400 m of a train station or public transport interchange (MyCiTi integrated rapid transit, Golden Arrow bus or established minibus-taxi routes).  
2. Benchmark using the Green Star SA public transport calculator. |
| Environmental impact assessments (EIAs) | 1. Ensure the implementation of all EIA mitigation measures and compliance with the environmental management plan. |

### 4.2 Design phase

#### 4.2.1 Establish a knowledgeable team

Establishing a team who is familiar with the principles of environmental sustainability and green building is perhaps the most important aspect of sustainable building. It is important to provide information, and even training, to ensure that all parties (such as engineers, architects and demolition and construction workers, including subcontractors) understand the reasons for developing a site in a sustainable manner, as they would then be more likely to participate fully in the process.

It is also essential to have good project management to ensure that all the necessary procedures and guidelines are followed correctly. This will not happen without a designated, experienced team leader or implementing agent, who has the authority and the power to control payments if work is not done in accordance with the required standards.

#### 4.2.2 Efficient site planning

Careful site planning can ensure that the proposed buildings placed on the site will have minimal negative effects on the environment, while maximising their efficiency.

The first step of site planning should be to analyse how a site relates to the surrounding neighbourhood and broader context. Establish which development and design guidelines already apply, including recommended building densities for the area.

Good site planning, while achieving the intended function of buildings, also optimises natural features and open spaces to enhance biodiversity. If possible, ensure that the site contributes to the development of green corridors. Positioning the building in a certain way on the site can enhance the natural functioning of a larger ecological network, and contribute to creating a more inhabitable urban environment. Retaining natural drainage paths and watercourses reduces impacts on aquatic ecosystems and provides attractive landscaping features whilst at the same time reducing stormwater management costs. Avoid placing buildings where they will have a negative impact on significant natural features and existing flora and fauna, mature trees, animal habitats and wildlife paths.

Analyse how best to make use of the microclimate, topography, streetscape and views, while also responding to dynamic elements, such as wind, water flows through the site, and potential threats like fire. Buildings should be positioned to make maximum use of natural resources for lighting and ventilation. Avoid placing buildings in a way that will jeopardise the ability of surrounding sites to access views and light.
In urban environments and settlement areas, buildings should contribute to the creation of safer and pedestrian-friendly surroundings. Place pedestrian entrances and lively frontages along the street, and green the streetscape. Windows and entrances should be positioned to provide natural surveillance over the street and other public spaces in order to enhance safety and security.

4.2.3 Efficient building design

The floor plan of any building should be designed to avoid wasted space, which also wastes materials. However, one must be careful not to compromise the ‘liveability’ of the building by creating unpleasant spaces. Generous common areas make for more habitable buildings.

The rooms that are used most, such as living rooms and kitchens, should face north so that they are naturally light and warm. Rooms such as bathrooms and storerooms should be placed so that they screen unwanted western sun, or positioned so as to prevent heat loss from south-facing walls.

Compact houses are attached rather than separate, and double-storey or multi-storey rather than single-storey. A compact plan exposes less wall area to the outside, reducing heat loss from the building.

If possible, those using or living in a building should have a say in the way it is designed.

4.2.4 Passive solar design

Passive solar design uses building orientation, solar energy, natural convection and the inherent properties of materials to heat and cool a building naturally. Passive solar design operates on the principle that as sunlight enters a building, it can be reflected, absorbed or transmitted, depending on the properties of the building materials used.

A passive solar design building can achieve greater energy efficiency and cut heating and cooling operational costs. By using natural light and ventilation instead of air conditioning, the running costs of the building can be reduced, while also creating a more comfortable and healthy indoor environment.

Windows are important for indoor environmental quality, external views and thermal comfort. Image: Jacques du Toit

The following are aspects of passive solar design (also see “Sustainable resource management”, which contributes to passive solar design).

4.2.5 Orientation and shading

In South Africa, overheating due to high summer temperatures is a major challenge faced by developers. Therefore, the idea is to create buildings that are comfortably cool in summertime, while maintaining an environment that is warm in winter, without requiring expensive and environmentally unsustainable air conditioning. All new buildings should be elongated along an east-west axis, with large windows on the northern side of the building. This means that, during winter months, the northern side of the building will receive the greatest amount of sunlight in the morning and early afternoon, thus warming the interior and allowing the building to be naturally ventilated and lit.

However, to prevent overheating in summer months, windows should be shaded. Window awnings or roof overhangs must extend far enough to block incoming radiation from the summer sun, which is high in the sky, while still allowing in the lower winter sun. Deciduous trees and vegetated trellises can also be used to shade windows in summer.

A building should also be orientated to work with the wind. It should prevent strong winds from entering, but allow gentle breezes to ventilate the building naturally. It should also be positioned so as not to create wind tunnels.

4.2.6 Energy-efficient building materials

All building materials transmit energy in different ways. Some are good conductors of heat (corrugated iron), some prevent heat from passing through and are therefore good insulators (cardboard, wood and glass fibre) and some can store heat well (clay brick, concrete, stone and water).

These properties of materials are used in different ways in the walls, roof, ceiling and floor of a house to keep a building warm in winter and cool in summer. To make the best possible choices of energy-efficient building materials, you need to understand their properties, both on their own as well as in combination. For example, a roofing material with high reflective properties will contribute to a cooler interior. However, the same roofing material might also be a good conductor of heat, in which case it should be used with a ceiling material that is a good insulator (see “Thermal mass: Heat sinks” overleaf).
Investigate the **embodied energy** of materials during their extraction and manufacture, and how they will contribute to energy use when the building is used and maintained. In general, to reduce the amount of embodied energy in a building and save on costs, specify materials that have undergone little processing, do not require extra finishes, and are made as close to the building site as possible to cut down on transport. Use materials with high embodied energy only when their properties, such as strength or longevity, are critical. For example, use fired bricks for weather-proofing on the outside of a building, and unfired clay bricks for internal walls. Cement blocks are hollow, so fewer resources such as sand, stone and cement are used, and the hollow area can be filled with soil-crete (cement-stabilised soil) to increase its thermal efficiency. Reconstituted bricks are made from crushed rubble with little cement requirement, and their high local content means little associated transport costs or emissions.

Specify second-hand materials that save natural resources, including energy. Include provisions for reusing or recycling demolition waste in tender documentation for the building contractor.

Design the building to minimise the natural weathering and degradation of the building, for example by:

- covering the entrance area;
- specifying drip edging;
- providing adequate roof overhangs; and
- sloping backfill to divert surface water away from the building.

### 4.2.7 Ceilings and insulation

Insulation in the ceiling and walls assists in keeping a home warmer in winter and cooler in summer (also see “Sustainable resource management” for more detail).

Low-income houses with ceilings and insulation burn 26% less coal than un-insulated homes in winter. This translates into less money being spent on energy for heating, less air pollution and a lower incidence of respiratory disease.

![Loose filled insulation is milled from recycled newspapers and is fully biodegradable. Image: EcoExhibit](image)

### 4.2.8 Thermal mass: Heat sinks

Certain building materials, including concrete, masonry and water, have a high **thermal mass**, which means that they can store heat. A basic principle of passive solar design is to make use of these materials to absorb and store heat during the day, thereby keeping the building interior cooler. At night, when the outside temperatures drop, this heat is released, warming up the interior of the building. This helps to offset the dramatic daytime temperature changes that are often experienced in Cape Town.

Walls and floors constructed from concrete for precisely these purposes are termed ‘thermal mass walls and floors’. Certain rules apply to making use of thermal mass:

- Thermal mass materials should not exceed 15 cm in thickness.
- For every square meter of north-facing glass, use 680 kg of masonry or concrete, or 150 litres of water.
- Ideally, thermal mass materials should be evenly spread throughout work and living spaces, and not concentrated in isolated areas.
- Thermal mass floors should be left uncARPeted if possible, or fitted with rugs instead of wall-to-wall carpets, which would insulate the floor from absorbing heat. Modern concrete and stone finishes are attractive and often do not need carpeting to be aesthetically pleasing.
- The colour of thermal mass walls and floors is not important, unless one is trying to increase the heat gained from direct sunlight.
- Thermal mass can also be achieved by building co-joined homes, which work well in South Africa, where large differences between day and night temperatures are experienced.

### 4.2.9 Natural and traditional building materials and methods

Before industrialisation, people used to build with natural materials available in the area. Examples of traditional building materials include:

- **abiotic**: earth material such as stone, rock, gravel, sand and clay; and
- **biotic**: wood, bamboo, reeds, or animal-based organic stabilisers such as cow dung.

Unique building methods and forms developed over time that were suited to the culture and context in which people lived. Many of these natural building methods are being revived and adapted to current use, because they create healthier environments, require less **fossil fuel** to make, as well as less transport.

Examples of natural building methods include:

- straw-bale construction;
- cob, adobe and mud-brick construction;
- rammed-earth construction;
- stone construction; and
- thatched roof.

![Thatching is a traditional biotic building material and very thermally efficient. Image: Kevin Newman](image)
Sundried or cement-stabilised earth bricks are an alternative to conventional clay or cement bricks. They save energy because they are not fired, and also result in houses with excellent thermal mass. (Topsoil, which is rich in decomposing organic material, may not be used for making earth bricks).  

4.2.10 Design according to standard sizes of construction materials  
Many construction materials, such as plywood, tiles, wooden beams and particleboards, are produced in standard sizes. The cutting of such materials to fit designs produces waste in the form of off-cuts. By designing buildings so as to minimise the cutting of standard-sized products, a dramatic reduction in waste volumes and cost can be achieved.  

4.2.11 Integrated planting and roof gardens  
Gardens that are integrated with buildings provide an opportunity for recreation and gardening in urban areas, where space is limited. Urban gardens provide food, avoiding the ‘food miles’ involved in transporting food over long distances, and a habitat for wildlife. Planting that is integrated with buildings can shade and insulate buildings from temperature changes, and reduces the ‘heat island effect’ in cities.  

Gardens can be created on rooftops and in living walls (vertical gardening), which use much less space. When implementing roof gardens, check that the roof is designed to hold the weight of containers with wet soil, which is very heavy. Hydroponics and other lightweight methods can expand the possibilities of rooftop gardening by reducing the need for soil.  

4.2.12 Economic impact  
Although this aspect is mentioned last, it is definitely the most important when considering the design or refurbishment of a building. Unfortunately, the link between the capital costs and the operational costs of a building is seldom considered.  

Capital costs usually constitute about 20% of the operational costs of a building over its lifetime.  

In addition to costing the construction, it is essential for a life-cycle cost-benefit analysis to be done to determine the long-term cost implications of different construction options when design decisions are being made. Design interventions motivated by sustainability will often achieve an operational cost saving, while probably also facilitating integrated design, which can achieve a capital cost saving as well. An example is solar photovoltaic (PV) systems: When considered purely as a capital expenditure to reduce carbon emissions, PV may seem like an expensive add-on. However, when the operational cost savings of reduced electricity consumption from the grid are considered, a payback on the initial capital expense can be included in the decision-making process. Furthermore, if a fully integrated design is proposed, the PV can be integrated with the building fabric (building-integrated photovoltaics, or BIPVs) so as to offset some of the construction material capital cost, resulting in a significantly more favourable cost-benefit analysis. What was previously considered to be a pure expense can now be considered an investment in future savings.  

A strong and diversified local economy is important for sustainability. This can be supported by using local contractors, local building materials and components such as fittings and furniture, and supporting local businesses during construction and maintenance.  

4.2.13 Recommendations for the design phase  
- Do a cost-benefit analysis of the long-term implications of the different design options that are being considered, taking the operating and maintenance costs into account.  
- Support the local economy by using local contractors, building materials, and fittings and furniture.  
- Establish a knowledgeable team, who will support the process of implementing a green building.  
- Do effective site planning to ensure that the development has a positive impact on the existing natural and urban context, taking broader planning and design guidelines into account.  
- Consider natural features, including the microclimate, wind, topography, soil conditions and established features such as trees. Consider densities, block design and streetscape character from an urban design perspective.  
- Position buildings to gain maximum benefit from light and views, while reducing noise and pollution. Create human-scale and vibrant urban spaces, using appropriate setbacks and greening.  
- Design the floor plan of a building to maximise functionality and take into account the microclimate of the site.  
- Include passive solar design and structural interventions that make use of sunlight and natural convection to heat, cool, light and ventilate buildings.
4.2.14 Checklist: Design phase

<table>
<thead>
<tr>
<th>Economic impacts</th>
<th>Priorities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Use life-cycle costing to assess design choices.</td>
<td></td>
</tr>
<tr>
<td>2. Assess the net present value of capital and operational cost impacts over the life of equipment or structures.</td>
<td></td>
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<tr>
<td>3. Procure from local providers of goods and services.</td>
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<table>
<thead>
<tr>
<th>Design team experience</th>
<th>Priorities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Appoint a design team with a track record of environmentally conscious design.</td>
<td></td>
</tr>
<tr>
<td>2. Appoint design team members with relevant accreditation (such as the Green Star-accredited professional rating).</td>
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<tr>
<td>3. Include an environmental consultant and local ecologist on the design team.</td>
<td></td>
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<tr>
<td>4. Appoint a cost controller (QS) who understands life-cycle cost analysis as well as the environmental aspirations of the project.</td>
<td></td>
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<tr>
<td>5. Appoint a design team that is as locally based as possible.</td>
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<table>
<thead>
<tr>
<th>Efficient site planning</th>
<th>Priorities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Assess the site context with respect to the neighbourhood and broader urban design framework.</td>
<td></td>
</tr>
<tr>
<td>2. Assess impacts and opportunities of microclimate, orientation, local topography and local ecology with regard to resource efficiency, the broader ecology and security.</td>
<td></td>
</tr>
<tr>
<td>3. Retain natural drainage flow paths and water courses as much as possible.</td>
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<tr>
<td>5. Develop and maintain green corridors.</td>
<td></td>
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<tr>
<td>6. Maintain ecological buffers adjacent to natural watercourses.</td>
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<tr>
<td>7. Optimise natural features of the site (avoid placing buildings in areas with the highest ecological value).</td>
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<table>
<thead>
<tr>
<th>Efficient building design</th>
<th>Priorities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Avoid wasted or unnecessary space in buildings (without compromising function).</td>
<td></td>
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<tr>
<td>2. Include end users in building design where possible.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Passive solar design</th>
<th>Priorities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Orientation: Orientate rooms to the north for effective summer shading and winter solar access.</td>
<td></td>
</tr>
<tr>
<td>2. Orientation: Use short east-west facades and longer north south facades.</td>
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<tr>
<td>3. Reduce solar gain in summer and allow solar access in winter with shading, orientation, glazing ratio, building-fabric performance and thermal mass.</td>
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<tr>
<td>4. Provide dual-aspect windows in occupied spaces for effective natural ventilation.</td>
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<tr>
<td>5. Shading: Use fixed shading devices on windows and deep eaves or awnings to block high-angle sun in summer and allow low-angle solar access in winter.</td>
<td></td>
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<tr>
<td>6. Use deciduous trees for seasonal shading, or facades and outside spaces.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Energy-efficient building materials</th>
<th>Priorities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Combine materials effectively (i.e. reflectivity and insulation) to mitigate solar gain in summer and retain warmth in winter.</td>
<td></td>
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<tr>
<td>2. Make use of reused or recycled materials.</td>
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<tr>
<td>3. Make use of materials’ resistance to wear and weathering to avoid frequent replacement.</td>
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<tr>
<td>4. Design to reduce weathering by rain and wind.</td>
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<table>
<thead>
<tr>
<th>Ceilings and heat sinks</th>
<th>Priorities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Provide and effectively insulate ceilings in houses.</td>
<td></td>
</tr>
<tr>
<td>2. Make use of thermal mass to balance heat gains and losses between day and night.</td>
<td></td>
</tr>
<tr>
<td>3. Make use of exposed thermal mass to provide radiant heating or cooling for improved occupant comfort.</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Modular design</th>
<th>Priorities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Design using modular and standard dimensions to avoid cutting and wastage of raw materials.</td>
<td></td>
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</tbody>
</table>
4.3 Construction phase

4.3.1 Soil conservation

Conserve topsoil

Topsoil is the most important component of soil, as it is rich in organic materials and seed stock. Good topsoil is a prerequisite for the growth of healthy, strong vegetation.

It can take 50 to 1,000 years to form one centimeter of topsoil.

In order to limit the loss of topsoil during construction, every construction site should have a soil erosion control plan in place. Topsoil loss occurs when plants are removed in order to build, and the soil is washed away by rain or blown away by wind. This reduces the productive capacity of the land, and may also have a negative impact on rivers or lakes in the area through the build-up of sediments in these water systems. Erosion control measures include temporary and permanent planting, fencing, mulching, and earth dikes.

Reduce soil compaction

Heavy earth-moving machinery and other vehicles are the primary cause of soil compaction on a construction site. If soil becomes too compacted, water is unable to penetrate the surface, causing faster run-off during rain, and eventual erosion and difficulty in establishing plants. In order to prevent soil compaction, wooden planks or mulching can be introduced in areas where vehicles are most often used.

4.3.2 Recycle construction and demolition waste

During the demolition of buildings, large amounts of waste are created in the form of bricks, doors, window frames and other items, which can be reused in a new development. Reuse of these items offers developers an opportunity to cut down on both materials and waste disposal costs. Recycled concrete bricks are available from many major brick suppliers, and are effective substitutes for more conventional types of brick.

A landfill has the potential to turn waste into wealth, and convert a challenge into an opportunity e.g., converting waste into roof tiles. Image: Bruce Sutherland

It is envisaged that, over time, a demolition plan will have to be submitted prior to the demolition of a building to ensure that all the reusable materials and rubble are incorporated into the new building or sold on to demolition companies to avoid waste going to landfills. Include requirements for careful demolition for recycling purposes in the tender documentation.

4.3.3 Use sustainable materials and products

The design team should specify sustainable materials where the life-cycle impacts on human health and the environment have been considered. However, contractors may also contribute by sourcing materials from suppliers who make an effort to be more sustainable.

Investigate the environmental performance of bulk material manufacturers and suppliers, and choose those who follow best practice in terms of pollution control, rehabilitation of mining operations, and the like. For example, the Aggregate and Sand Producers Association has an “About Face” programme, which carries out an environmental audit of its members. This is available to the public at www.aspasa.co.za.

One way to reduce the exploitation of natural timber resources is through the Forest Stewardship Council (FSC), which is a voluntary, market-driven certification and trademark system that allows customers to choose products that promote responsible management of the world’s forests. Suppliers and purchasers can check whether their specified product is FSC-certified in several ways. In all cases, the invoice of the supplier should clearly state that FSC-certified timber was supplied. The chain-of-custody certificate number should be included on all product invoices, although the product may not physically carry the FSC trademark. To verify the FSC certificate number, review the FSC certificates list or the certificates database. If you do not find the certificate number, please contact the international FSC centre via their website, www.fsc.org.

The rubble from the old stadium was used for the foundations of the new Cape Town Stadium. Image: Bruce Sutherland
4.3.4 Buy local
A lot of fossil fuels are consumed when building products are transported over long distances, especially if the product is a heavy material, such as brick or steel. Use local materials from the closest possible supplier to reduce carbon emissions associated with transportation and to reduce the embodied energy of a material.

4.3.5 Recommendations for the construction phase

- Ensure that every construction site has a soil erosion control plan in place in order to limit the loss of topsoil during construction.
- If excavation or grading occurs during construction, ensure that topsoil is removed and stockpiled in order to guarantee that it is protected and replaced.
- Avoid unnecessary soil compaction on a construction site, as it has negative environmental impacts on the soil and vegetation.
- Provide measures to prevent contaminated stormwater runoff from discharging into the stormwater system.
- Reuse and recycle demolition and construction waste to reduce waste sent to landfill and to strive for zero waste.
- All wood products that are used in the construction of buildings should be sourced from sustainable forest plantations or from local alien-vegetation clearing projects with certification from the Forest Stewardship Council (FSC).
- Source bulk and non-renewable materials from suppliers who implement best practice in reducing the impacts of resource extraction, mining and manufacturing.
- Source materials and products locally wherever possible.

4.3.6 Checklist: Construction phase

<table>
<thead>
<tr>
<th>Issue</th>
<th>Priorities</th>
</tr>
</thead>
</table>
| Environmental management     | 1. Implement a site environmental management plan.  
2. Comply with the ISO 14001 requirements for environmental management.                                                                |
| Topsoil conservation         | 1. Implement a soil erosion avoidance plan during construction.  
2. Balance cut-and-fill where possible, and conserve any disturbed topsoil for reuse.  
3. Replant replaced topsoil with endemic vegetation.  
4. Avoid compaction of topsoil by heavy machinery.                                                                                   |
| Waste management             | 1. Recycle construction and demolition waste. Green Star SA, for example, notes a minimum target of 30% waste recycling.  
2. Reuse items such as bricks, timber window frames, doors and rubble.  
3. Prevent stormwater runoff carrying sediment or pollutants from discharging into the municipal stormwater system.               |
2. Avoid toxic substances, such as adhesives, sealants and paints with high volatile organic compound content, PVC and lead, among others, and seek non-toxic alternatives (more details provided in “Human health and comfort”).  
3. Select timber that is FSC-certified.  
4. Select locally produced or extracted products and raw materials.                                                                       |

5 SUSTAINABLE RESOURCE MANAGEMENT

5.1 Energy efficiency
Reducing the energy consumption of a building not only reduces its impact on the environment, but also the running costs of the building. By incorporating energy-efficient and renewable energy options into a building, the demand for electricity during peak consumption times is reduced, delaying the need to build new power stations, and reducing the associated carbon emissions.
Below are some ways to reduce energy consumption.

### 5.1.1 Passive solar design

**Passive solar design** reduces the demand for resources to improve indoor comfort, such as heating or air conditioning. It also provides for effective natural lighting, reducing the need for artificial lighting, as well as natural ventilation.

Key considerations in passive solar design include:

- orientation;
- shading;
- ventilation openings; and
- glass selection.

Passive solar design should allow sun penetration in winter to reduce heating requirements, while shielding the internal space from direct sunlight in summer.

### 5.1.2 Insulation

Perhaps the most important component of energy efficiency in any building is insulation. Properly insulated ceilings and walls mean that indoor spaces are less vulnerable to temperature fluctuations, remaining cooler in summer and warmer in winter than non-insulated spaces, often eliminating the need for air conditioning for much of the day. Furthermore, if air conditioning or heating is needed in peak hours or extreme temperatures, the conditioned air will remain at a comfortable temperature substantially longer in an insulated space, thus saving on a building's energy bill.

Not all insulation has a low environmental impact, though, and there are some important considerations when selecting insulation:

- Insulation that has a high recycled content typically has a lower environmental impact than insulation from virgin materials.
- Some insulation is manufactured with ozone-depleting chemicals, so be careful to enquire about insulation with zero ozone-depleting potential when considering your options.

### 5.1.3 Ceilings

The installation of a ceiling is the most cost-effective energy-efficiency measure, as most heat is gained or lost through the roof, especially if it is constructed from a conducting material, like corrugated iron. This is particularly important to consider in low-cost housing developments. Although eliminating ceilings may be cost-effective at first, it creates an unnecessary energy burden for the occupant in the long term.

### 5.1.4 Air ventilation

The selection of heating, ventilation and air-conditioning (HVAC) systems has a major environmental impact in terms of energy use, occupant health and comfort, and, in some instances, water too. HVAC systems come in a variety of configurations, but all primarily fulfil two functions:

- Provision of fresh air to indoor spaces (ventilation)
- Comfort control (heating and cooling)

In terms of ventilation, the lowest environmental impact can be achieved through natural ventilation using windows that can be opened. Cape Town has an ideal climate for natural ventilation, and there are large portions of the year when comfort can easily be achieved through natural ventilation and good passive solar design.

Where forced ventilation is a necessity (in some commercial buildings, for example), the following should be carefully considered:

- ‘Mixed-mode’ functionality, i.e. providing mechanical HVAC only when natural ventilation is not able to meet the internal conditions.
- Displacement ventilation, i.e. providing fresh air at a low level and using buoyancy to move it through the space.
- Diffuser selection and placement to reduce the likelihood of ‘dead spots’, typically known as air-change effectiveness (can be determined by means of computational fluid dynamics (CFD) modelling during design).
- Provision of greater fresh-air quantities than the minimum provision in the building code (5 L/s/person), with potentially significant health benefits to building occupants.

When relying on natural ventilation, locate and size windows to prevent draughts, while making the best use of prevailing winds and the natural convection of air to ventilate the building. Eliminate or minimise the need for air conditioning by making use of passive solar design techniques.

Where air conditioning cannot be avoided, it is important that a qualified professional accurately determines the size of the air conditioner required, as oversized air conditioners are inefficient and energy-intensive. A smaller air conditioner can often be installed in buildings with adequate thermal insulation, thus saving on electricity costs.
If a large space needs air conditioning, a central unit that services a number of rooms or floors may be more energy-efficient than using many single-room units. However, individual preferences in thermal comfort levels must also be considered. Any centralised systems must be checked regularly to ensure that the ducts do not leak, as this reduces the energy efficiency of the unit. Only air conditioners with a seasonal energy-efficiency ratio (ratio of the seasonal energy output to the seasonal energy input) of 10 or more should be used.

5.1.5 Tight construction

It is important to ensure that a building is constructed so that it is tightly sealed. This means that doors and windows must be properly fitted and sealed, and there should be no cracks in the construction that allow unwanted airflows in and out of the building. In windy locations, consider building an entrance hall with two doorways to prevent draughts.

5.1.6 Electricity

Using energy-efficient electrical installations is one of the cheapest and easiest ways to reduce energy costs, and thus improve the economic and environmental performance of existing developments.

Newer equipment is often more energy-efficient than old equipment. Choose appliances such as energy-efficient geysers and stoves, and refrigerators free from chlorofluorocarbons (CFCs). Although these may initially be more expensive, they reduce electrical costs and environmental impacts in the long term.

Wind turbines and photovoltaic (PV) cells can be used to generate renewable electricity independently, but this is generally quite costly. It is better to store the excess electricity that is generated in the national electricity grid, rather than using batteries, which contain toxic chemicals and heavy metals that are a problem to dispose of safely.

In Cape Town, one can purchase green-energy certificates (GECs) for renewable energy produced at the Darling wind farm.

See http://www.capetown.gov.za/en/electricity/GreenElectricity/Pages/default.aspx for more information. For more on buying GECs, please send your requirements to green.electricity@capetown.gov.za, fax number 021 446 1985 or postal address:

The Head: Green Energy Electricity Services Directorate
PO Box 82
Cape Town
8000

Wind is an abundant source of energy - building new wind energy capacity is crucial in the fight against climate change. The City of Cape Town has signed a 20-year agreement to buy “clean” electricity from Darling Wind Farm, paving the way for an innovative partnership between local and foreign investors, the government and the community of Darling to get South Africa’s first commercial wind farm venture up and running. Image: Sustainable Energy Africa
5.1.7 Lighting

The use of natural daylight instead of artificial lighting is obviously the most sustainable and efficient way of saving energy. Ensure that living and working spaces have an acceptable level of illumination without using artificial lighting during daytime by designing windows and skylights that are orientated to maximise the natural light without glare or overheating. Reflective and angled ceilings will also bring more light deeper into a building.

Energy-efficient light bulbs can substantially reduce energy costs.

Compact fluorescent light bulbs (CFLs) use less than a quarter of the energy required to power a conventional light bulb for the same amount of time, and last ten times longer. Each CFL will save between 500 kg and 1 ton of carbon dioxide (CO₂) emissions in its lifetime.

Although they currently still cost more than conventional light bulbs (R15 to R50), the amount of money spent on replacing light bulbs is reduced. CFLs last for around 10 000 hours, whereas a conventional incandescent bulb lasts just 1 000 hours on average. Here are some limitations that need to be considered when using CFLs:

- On/off cycling: CFLs are sensitive to being switched on and off frequently, and this reduces their rated lifespan.
- Dimmers: Not all CFLs can be used on dimmer switches. They can however be used with a timer or a three-way fixture. (Note: Some manufacturers, such as Philips, have recently introduced ‘dimmable’ CFL bulbs to the market, so this limitation is being addressed.)
- Outdoors: CFLs can be used outdoors, but should be covered or shaded from the elements. Low temperatures may reduce light levels. (Check the package label to see if the bulb is suited for outdoor use.)
- Retail lighting: CFLs are not spotlights. Retail store display lighting usually requires narrow focus beams for stronger spotlighting. CFLs are better suited for area lighting.
- Hazardous waste: CFLs contain small amounts of mercury. Although the mercury poses no threat while in the bulb, it is a problem for the environment, and the bulbs must therefore be disposed of at a hazardous waste disposal facility.

Although CFLs come with these handling and disposal issues, the large energy savings they achieve compared to incandescent light bulbs are of greater overall environmental benefit. Another new technology that is even more efficient than CFLs is light-emitting diodes (LEDs).

LEDs: • use a fraction of the energy a CFL uses. • have a longer lifespan. • can shine brighter. • have many different applications. • are currently the best green lighting technology available.

5.1.8 On-site generation: Photovoltaic panels and wind generation

Solar photovoltaic (PV) panels generate electricity from sunshine. A panel could produce around 70 watts at 12 volts for roughly six or seven hours per day (about 0.4 kWh/day). A complete off-grid system includes a battery to store PV-generated electricity for night-time use, and a regulator to protect the battery from overcharging or overdischarging. These components should all be matched to one another. PV panels may be connected in series or parallel for larger systems, depending on the electricity requirements.

Connecting PV systems to the national or local grid through two-way metering has not yet been implemented in Cape Town, but is being developed.

Small-scale wind turbines are another on-site renewable option. Turbines come in a wide range of sizes, and connect to PV systems in a similar way. For most installations, the cost benefit of small-scale wind energy is less than that of solar energy based on current technology.

5.1.9 Water heating

Solar water heaters are simply roof-mounted water panels that operate by heating water in black pipes using the power of the sun. Other, more complex systems using vacuum tubes, for example, are also available. Solar water heaters are usually fitted with electricity back-up.

Solar water heaters can save 25–40% of normal electricity use, and typically pay for themselves in three to five years. Financing a solar water heater through a bond translates into immediate monthly cost savings for a household.

Although heat pumps do not use solar energy, they use about one third of the energy of a conventional geyser and, as such, are a much greener option.

Geyser blankets and pipe insulation can be manufactured from any heat-resistant insulating material that is wrapped around the geyser and hot-water pipes. Most modern geyser cylinders do not need...
geyser blankets, but any geyser or piping that feels warm to the touch is losing heat and needs insulation. A vertical geyser is significantly more energy-efficient than a horizontal geyser.

Installing geyser blankets and insulating all hot-water pipes can save about 5–10% of the energy used to heat water.

Geyser timers are devices that are installed on household geysers and that operate by switching the geyser on and off at specified times, thus providing hot water only when it is needed. All solar water heaters with electricity back-up should be fitted with a timer in order to ensure best use of the sun’s power.

5.1.10 Recommendations for energy efficiency

- Install solar hot-water systems or heat pumps.
- Install properly insulated ceilings.
- Place and size windows to make optimal use of natural light, winter heating and ventilation without creating draughts, gaining too much heat in summer or losing heat in winter.
- Avoid the use of air conditioning, or at least ensure that the correct size air conditioner is installed and that use of the unit is minimised.
- Ensure that the building is constructed so as to be tightly sealed to prevent unwanted air flows. Doors and windows must be appropriately sized and fitted with seals.
- Energy-efficient electrical installations should be used.
- Ensure that artificial lighting is designed so that light is focused where necessary, such as on areas where tasks are being performed, with more ambient light elsewhere. Avoid the use of ‘up-lighting’ to reduce light pollution.
- Ensure that energy-efficient light bulbs, such as CFLs or LEDs, are used where possible.
- Consider the installation of independent renewable electricity generators, such as PV panels or wind turbines.
- Further reduce the electrical energy used to heat water by installing geyser blankets, pipe insulation and a geyser timer.
- Install low-flow shower heads.

5.2 Water efficiency

In anticipation of projected growth and the effects of global warming, the City of Cape Town has passed two new bylaws that promote good water demand management practices.

The contents of the Water Bylaw and the Wastewater and Effluent Bylaw, promulgated on 1 September 2006, should be noted and fully incorporated into the design and management of buildings. These bylaws contain most of the restrictive measures introduced during previous dry spells in the region. In short, the new bylaws include the following regulations:

- No watering of residential gardens between 10:00 and 16:00.
- Hosepipes must be fitted with automatic self-closing devices.
- No automatic top-up systems fed from a potable (drinking) water source may be used to supply swimming pools and ponds.
- No person may hose down hard surfacing or paved areas using potable water, without getting prior written approval from Council.
- Potable water may not be used to damp building sand and other building materials to stop them from being blown away.
- The maximum flow rate from a tap installed in a hand basin may not exceed six litres per minute.
- Toilet cisterns may not exceed 9.5 litres in capacity.
- No automatic cistern or tipping tank may be used for flushing a urinal.
- Major water users (using more than 3 650 Kl per annum), excluding multiple-dweller units, must conduct an annual water audit.
- Commercial car wash industries must recycle a minimum of 50% of the water used in their operations.
- No person supplied with water in terms of the Water Bylaw may sell such water without written permission or special agreement.

Report any water wastage or pollution to the Water Services technical operations centre on 0860 10 3054, SMS line 31373 or e-mail WaterTOC@capetown.gov.za.

5.2.1 Stormwater management

Hard surfacing in urban environments increases the volume and speed of stormwater contributing to water contamination, flooding and removal of topsoil. If not managed, urban stormwater can result in significant deterioration of the condition of rivers, wetlands and coastal bathing areas. Design surface drainage to slow down the rate of stormwater runoff and to facilitate infiltration of the groundwater. Where space allows, channel stormwater in open vegetated swales to retention ponds or soak-aways such as “rain gardens”, where contaminants can be treated or removed and the rainwater can slowly seep into the ground. Underground storage tanks installed in conjunction with stormwater infiltration devices allow reuse of stormwater. Replace hard surfacing with permeable paving on pathways and parking areas. This can be attractively planted in the spaces between the pavers, and helps to mitigate the urban ‘heat island’ effect. Mulch garden beds (spread a layer of bark or other organic material over the soil) to prevent evaporation and the development of a hard and impermeable crust on the soil, which makes it harder for plants to grow. Depending on the size of the property/development, the City’s Management of Urban Stormwater Impacts Policy may be applicable.
5.2.2 Water-wise landscaping

Use indigenous plants suited to the Western Cape, as these are hardier and weather-tolerant. Avoid large areas of lawn that require extra water.

Incorporate stormwater management features such as swales, rain gardens and retention areas into the landscaping.

Plant fine couch grass ("kweek") (Cynodon dactylon), Paspallum sp. or indigenous buffalo grass (coastal regions) in areas where lawns are required. Traditional lawns (such as kikuyu grass) should be avoided. Buffalo grass also tends to require a fair amount of water during the summer.

Use water-saving irrigation systems, such as bubblers and drip irrigation, to reduce the water that is lost by evaporation. Drip nozzles should have a low-level, focused spray to reduce evaporation and focus water where it is needed. Water can also be saved by using irrigation timers that limit watering to early evening and morning. Moisture and weather sensors can further reduce consumption by watering only when needed.

Another element of efficient irrigation is not to irrigate when it has been raining sufficiently. One mechanism for providing irrigation only when it is needed is to monitor soil moisture levels and to link the irrigation system to these monitors.

5.2.3 Rainwater harvesting

Harvesting rainwater for household use is an alternative to using potable water on tasks that do not specifically require it, such as gardening, cleaning or flushing toilets. However, an important consideration is that Cape Town's rainfall is highly seasonal, which means that there tends to be an excess of rainfall in winter (when you do not need it) and a shortage in summer (when you do). This can be addressed to some degree through large storage tanks, although these may be costly (both in terms of capital and spatial requirements).

When considering alternative water supplies, the optimum approach is to consider the cost benefit of rainwater or stormwater collection against other options, such as reusing grey water for irrigation. The benefits of rainwater are that it is clean, and the plumbing and installation of rainwater tanks are well understood. The benefits of grey-water reuse are that there is a constant supply year-round and that large storage volumes are not required. A range of cost, performance and 'buildability' considerations should all be taken into account when considering alternative water use strategies.

5.2.4 Plumbing layouts

Design the layout of the plumbing system to avoid creating a 'dead leg' in the hot-water system, where a long pipe runs from the water heater to a supply point. This wastes a lot of cooled water while waiting for the hot water to discharge.

Ensure that the optimum pipe size and water pressure are used. A pressure-reducing valve (PRV) can be installed at a point nearest to where the supply enters the building, to ensure that all water supplies in the building are balanced.

5.2.5 Water-wise installations

All plumbing installations in new or renovated buildings should be chosen with water efficiency in mind, and must have South African Bureau of Standards/Joint Acceptance Scheme for Water Services Installation Components (SABS/JASWIC) approval in accordance with the bylaw requirements.

Simply by using low-flow devices (taps, shower heads) and water-efficient appliances (washing machines, dishwashers), savings of up to 50% can be achieved.

Water-wise showers

All showers should be fitted with low-flow shower heads to reduce the amount of water used during showering. However, these shower heads must still allow water to flow at a comfortable rate for the user, because low-flow shower heads only work efficiently with a balanced pressure geyser.

Water-wise taps

All indoor taps should be fitted with aerators. These simple devices can be fitted onto most standard household taps, and aerate the water, thus increasing its efficiency while reducing the flow as well as the amount of water used.

Metering taps, which have a timer to deliver a predetermined yet adjustable quantity of water when operated, should be used in public buildings and outside taps and showers to prevent taps from being left on or dripping.
5.2.6 Grey wastewater systems

Grey wastewater is used water that comes from basins and baths, as opposed to black water, which comes from toilets. Grey water can be reused to flush toilets, or can be filtered to irrigate gardens. There are many ways to recycle grey water, ranging from having a pipe that feeds water from the basin into the toilet cistern, to simple gravity systems that use plants to filter the water, or sophisticated commercial systems that can clean water for large developments.

One of the major benefits of grey-water systems is that they provide a regular supply of wastewater for reuse, unlike rainwater collection, which is highly seasonal in Cape Town.

5.2.7 Water-wise toilets

Water used for the flushing of toilets is commonly delivered using one of two mechanisms:

Cistern tanks with internal flush mechanisms store nine to 11 litres of fresh water, which is flushed into the toilet bowl when the mechanism is activated.

Flush valves deliver a pre-set amount of water, regardless of the amount required. The flush valve is typically used in commercial buildings and public ablutions, and requires a nominally higher water supply pressure to operate than domestic units. Poor maintenance and incorrect adjustment often lead to water being wasted in these installations.

It is preferable for all flush toilets to have cisterns fitted with dual-flush or multi-flush mechanisms.

A multi-flush mechanism will only flush while the mechanism is held down, allowing the user to control the amount of water needed and to prevent unnecessary flushing. Similarly, all urinals should be operated by a manual flush mechanism, as automatic flush systems often waste water.

5.2.8 Alternative sanitation options

It is important to check the regulations of your local authority with respect to plumbing and sanitation prior to installing alternative sanitation options.

Composting toilets

Composting toilets offer a more ecological way of dealing with human waste. They use no water, making use of natural decomposition and air flows to dry and recycle the waste into garden compost. A number of commercial composting toilets are available locally, or you can build your own. There are several different compost toilet designs, including a single composting chamber, twin vault systems (where the use alternates from one to the other) and urine diversion toilets, which separate the urine for use as a fertiliser or disposal in a soak-away. Composting toilets do away with expensive sewage reticulation and treatment, and are therefore highly cost-effective. However, a grey-water recycling system or regular sewage connection will still be necessary for shower, basin, bath, laundry, kitchen sink and other ‘wastewater’.

Reed bed systems

These are ‘constructed wetlands’ that treat wastewater and sewage by creating a mini-ecosystem, where the reeds and micro-organisms in their root systems clean the water flowing through the bed. Reed beds can process both black and grey water, and even some industrial effluents. Building and installing such systems require specialist expertise.

Black water systems

If a black water system is installed, the grey and black effluent from a building is channelled into a biolytic filter, which consists of a peat filter inhabited by earthworms and inoculated with micro-organisms. The solids are digested by these tiny organisms in an aerobic environment, which results in treated water with retained primary nutrients (nitrogen and phosphorus) for reuse as a natural organic fertiliser for irrigation purposes.
Biogas digesters

Biogas is the gas produced when organic matter, including manure, sewage sludge, municipal solid waste, biodegradable waste or any other biodegradable feedstock, is decomposed by microorganisms under anaerobic conditions (without oxygen). Biogas primarily comprises methane and carbon dioxide. Small-scale biogas digesters can be built for a cluster of houses, and are especially practical because they accommodate flush toilets and produce a pathogen-free liquid fertiliser and gas that can be used for cooking and heating. However, better gas yields are obtained when farm animal waste is included in the digester.

5.2.9 Recommendations for water efficiency

- Ensure that only water-efficient devices, such as low-flow taps, low-flow shower heads, washing machines and dishwashers, are used.
- Ensure that all toilets are low-volume (9.5 litres or less), with dual-flush or multi-flush systems.
- Ensure that public buildings and outside taps and showers are fitted with metering-tap buttons, which have set timers to prevent taps from being left on or dripping.
- Design the layout of the plumbing system so as to avoid long pipe runs between the geyser and supply points.
- Reduce hard surfacing to encourage rainwater to seep back into the ground rather than being carried away into the sea by piped drainage systems.
- Design paved areas so that water run-off is slowed down, and use soak-aways or “rain gardens” and permeable paving wherever possible to allow water to filter into the ground.
- Ensure that the optimum pipe size and water pressure are used. A pressure-reducing valve can be installed at a point nearest to where the supply enters the building, to ensure that all water supplies in the building are balanced.
- Install systems for rainwater harvesting and the reuse of grey water where appropriate. However, ensure that the local ecological system is not polluted and that it is managed correctly.
- Make use of indigenous planting and efficient irrigation methods, such as drip irrigation.
- Use a pool blanket to reduce water loss through evaporation.
- In consultation with the local authority, introduce waterless sanitation and alternative grey-water systems that clean black and grey water, while providing useful by-products such as fertiliser and biogas.

5.2.10 Checklist: Resource efficiency

<table>
<thead>
<tr>
<th>Issue</th>
<th>Priorities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulation</td>
<td>1. Insulate roof and ceiling constructions.</td>
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<tr>
<td></td>
<td>2. Insulate hot-water cylinders and pipework.</td>
</tr>
<tr>
<td></td>
<td>3. Insulate walls and windows.</td>
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<td></td>
<td>4. Select insulation with high recycled content.</td>
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<tr>
<td></td>
<td>5. Select insulation with zero ozone depleting potential in manufacturing and composition.</td>
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<tr>
<td></td>
<td>6. Check insulation installation with respect to:</td>
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<tr>
<td></td>
<td>a. avoiding compacting of insulation (e.g. by roofing elements such as rafters);</td>
</tr>
<tr>
<td></td>
<td>b. blown insulation for inaccessible areas; and</td>
</tr>
<tr>
<td></td>
<td>c. overall compliance with SANS 10400 Part XA ‘R value’ for the construction element (wall, roof or ceiling).</td>
</tr>
<tr>
<td>Ceilings</td>
<td>1. Install ceilings in all housing, including low-cost housing, and insulate.</td>
</tr>
<tr>
<td>Ventilation</td>
<td>1. Provide dual-aspect openings in occupied areas for effective natural ventilation.</td>
</tr>
<tr>
<td></td>
<td>2. The extent of natural ventilation openings should be at least 5% of the floor area these openings are ventilating.</td>
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<td></td>
<td>3. Where heating and cooling (air conditioning) are required:</td>
</tr>
<tr>
<td></td>
<td>a. provide passive solutions as a priority;</td>
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<td></td>
<td>b. provide mixed-mode controls for areas with windows that can open;</td>
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<tr>
<td></td>
<td>c. exceed the SANS 10400 Part XA requirements for efficiency;</td>
</tr>
<tr>
<td></td>
<td>d. select units containing refrigerant with zero ozone depleting potential; and</td>
</tr>
<tr>
<td></td>
<td>e. explore advanced HVAC options for commercial buildings on a life-cycle basis (passive chilled beams, chilled ceilings, thermally active building systems, etc.)</td>
</tr>
<tr>
<td>Airtightness</td>
<td>1. Air-conditioned buildings must be designed to be airtight.</td>
</tr>
<tr>
<td></td>
<td>2. Building leakage rates below 15 m³/h/m² are recommended.</td>
</tr>
</tbody>
</table>
5.3 Waste minimisation and management

For every 1 kg of product on shop shelves, 36 kg of waste has already been produced. The City of Cape Town’s Integrated Waste Management Bylaw should be noted and fully incorporated.

Green buildings should aim for zero waste in all aspects of planning, construction, use and maintenance of the built environment. The first step is to avoid creating waste in the first place. If this is not possible, waste should first be reused and then recycled (remanufactured) rather than being sent to landfill. Hazardous waste, such as old asbestos cement products, must be safely handled and disposed of in licensed facilities to prevent environmental and health impacts.

Zero waste can guide waste minimisation strategies, and starts by changing production and distribution systems to emulate the closed-loop systems found in nature. Applying zero waste requires the phasing out of unsustainable and toxic materials that cannot safely feed new production cycles.

| Lighting | 1. Design buildings with effective natural lighting, such as a daylight factor of greater than 2% for at least 30% of floor areas is the minimum rewarded in Green Star.  
2. Provide daylight, occupancy and dimmer controls for artificial lighting systems.  
3. Select CFL lamps instead of incandescent bulbs.  
4. Select LED lamps for task lighting and some architectural lighting initiatives. |
| --- | --- |
| Renewable energy | 1. Consider solar hot-water systems.  
2. Consider solar photovoltaic (PV) systems.  
3. Consider small-scale wind generation systems. |
| Water heating | 1. Check the temperature of hot-water cylinders, e.g. settings higher than 60 °C result in significant energy wastage.  
2. Install solar hot-water heaters, e.g. flat-plate and evacuated-tube collectors both have strengths and weaknesses, and the appropriate selection will depend on the specific location, orientation and intended operation.  
3. Install gas instantaneous heaters, whereby losses through storage and piping are eliminated. Gas is also less carbon-intensive than the grid electricity.  
4. Reduce hot-water consumption through efficient shower heads, taps and appliances.  
5. Install insulation in the form of geyser blankets and pipe insulation on hot-water cylinders and pipes.  
6. Install geyser timers to provide hot water only when required. |
| Water efficiency | 1. Understand and comply with City of Cape Town bylaws for water and wastewater. |
| Stormwater | 1. Mitigate stormwater run-off volumes and quality through permeable paving, swales, soakaways, rain gardens and detention ponds.  
2. Collect rainwater and stormwater for reuse. |
| Irrigation | 1. Plant water-wise gardens.  
2. Use drip or bubbler irrigation to reduce evaporative losses.  
3. Use soil moisture monitors to avoid watering when rainfall has met the irrigation needs. |
| Fittings, fixtures and appliances (showers, taps, toilets, plumbing networks, dishwashers, washing machines) | 1. Avoid long ‘dead leg’ runs on hot-water systems, which waste both energy and water.  
2. All new fittings and fixtures must comply with SABS/JASWIC requirements as well as with bylaws.  
3. Select fittings, fixtures and appliances with Water Efficiency Labelling and Standards (WELS) Scheme certification as well.  
4. Select dual-flush or multi-flush toilets.  
5. Consider composting or other dry toilets. |
| Water treatment | 1. Include grey-water reuse systems for irrigation.  
2. Consider grey-water treatment systems for reuse in toilets and heat rejection systems.  
3. Include reed bed systems for passive water treatment and added ecological value.  
4. Consider alternative sanitation options, such as Biolytix systems, biogas digesters and commercial wastewater treatment plants (for larger buildings), to mitigate both water demand and sewer flows. |
The design phase is a critical time for making decisions concerning waste. This includes specifying materials that have resulted in minimal waste during their production, and that will result in minimal waste during the construction, maintenance and demolition of the building. Tender documentation should ensure that demolition and construction processes are managed to reduce waste. Building rubble can be used, for example as subgrade for driveways, rather than being dumped. Old doors and windows can also be reused, which saves on costs and the environmental impact of using virgin materials. Waste management systems that facilitate waste separation at source for composting, reuse and recycling must be incorporated into the design of a building.

Household waste should be separated into recyclables (glass, metal, plastic and paper) and general waste (which goes to landfill). Many local waste collection services provide a separate service for the collection of recyclables, while there are drop-off points for most that do not have these services. Within a home, food waste can be collected and composted, potentially through a worm farm. Some garden waste can also be composted for reuse. Any e-waste (such as appliances and electronics) contains many dangerous and valuable metals, and should be disposed of separately.

### 5.3.1 Recommendations for waste reduction

- **Aim for and promote zero waste** in the planning, operation, management, maintenance and demolition of a building. Zero waste emulates the closed-loop processes found in nature, taking a ‘cradle-to-cradle’ approach to designing products and buildings.
- Incorporate waste avoidance into the process at the design phase already, by specifying products and materials that have less wasteful production processes and do not create wasteful emissions during construction, maintenance and demolition of a building.
- Ensure that all buildings that are to be demolished compile a demolition plan, outlining how the building material and rubble will be used to avoid waste sent to landfill.
- If waste is created, consider how this can firstly be reused and then recycled to recover the value invested in these materials, rather than losing this value when the resource is simply dumped in a landfill or incinerated.
- Provide waste compactors in buildings where large amounts of waste are created, to save landfill air space and the transport costs associated with waste removal.
- Facilitate the separation of waste at source for composting, reuse and recycling when designing waste management systems. The building management plan should encourage people to recycle their waste.

### 5.3.2 Checklist: Waste management

<table>
<thead>
<tr>
<th>Issue</th>
<th>Priorities</th>
</tr>
</thead>
</table>
| Separation     | 1. Separate household waste into food waste (composting), green waste (composting or collection), glass, metal, paper and plastic (all for recycling), e-waste (for hazardous disposal) and general waste (to landfill).  
                2. Construction waste should be separated for recycling, to reduce waste sent to landfill. |
| Waste reuse    | 1. Prioritise opportunities for reuse, e.g. doors, window frames, bricks, floor coverings and furniture.  
                2. Identify opportunities to recycle, e.g. construction waste and operational waste.  
                3. Consider wastewater reuse opportunities (irrigation, toilet flushing, nutrient reclaim for fertiliser, and waste-to-energy opportunities). |
| Zero waste     | 1. Assess all waste streams and prioritise opportunities for reuse and recycling through separation.  
                2. Avoid toxic materials in procurement.  
                3. Minimise general waste sent to landfill.  
                4. Analyse general waste and amend procurement procedures to eliminate input streams that end up in landfill. |
5.4 Human health and comfort

5.4.1 Heating, ventilation and air conditioning (HVAC)

HVAC systems influence the following two key factors relating to occupant health and comfort:

- Air quality
- Thermal comfort

With respect to air quality, proper ventilation is vital for the health and comfort of a building’s occupants. Fresh air prevents bacteria and pollutants from building up in the air. Windows should preferably be able to open so that users can control the level of outside air coming into the building. Windows should also be positioned to aid the airflow through a room or building, without causing draughts. In areas where windows are inappropriate, extractor fans should be installed.

Ventilation systems should seek to improve the amount of fresh air provided to occupants compared to the minimum building code requirements. Further to this, air distribution systems should seek to avoid recycling air, effectively filtering air and avoiding indoor contaminants (such as mould).

Occupant thermal comfort is a critical issue in HVAC system design, as it affects health and productivity. Thermal comfort is a term used to describe how individuals perceive their environment. It is very common for two individuals in the same environment to experience two different levels of thermal comfort. For this reason, it is a challenge precisely to predict the thermal comfort of a space. Predicted mean vote (PMV) is a tool that can be used to help understand how a building’s occupants will likely perceive indoor thermal comfort.

Thermal comfort is affected by six variables:

- Air temperature: The air temperature upon skin contact
- Radiant temperature: Radiant temperature refers to the temperatures of surrounding surfaces and objects. For instance, if a person is standing next to a very cold piece of glass in winter, even if the air temperature is quite high, the occupant’s perceived comfort will be less.
- Relative humidity: Very high humidity levels in summer cause greater discomfort. The opposite applies in winter.
- Metabolic rate: Waiters, who are constantly moving (i.e. generating heat), are more likely to experience heat than customers seated at a table.
- Clothing: An environment will seem warmer to someone wearing a jumper and jacket, than to someone in shorts and a T-shirt.
- Air velocity: Higher air velocities make people feel cooler for a given air temperature. A fan does not lower air temperature, but simply allows a body to get rid of heat faster than still air would allow.

HVAC systems should be designed to take into account the ideal air temperature and radiant temperature to create comfortable conditions. This could include radiant heaters or radiant cooling panels, chilled beams or chilled ceilings.

Old air conditioners that are to be reused should be thoroughly checked to ensure that they do not use chlorofluorocarbon- (CFC-) based refrigerants, which are largely responsible for depleting atmospheric ozone. Also avoid materials that use CFCs or hydrochlorofluorocarbons (HCFCs) in their production, such as plastic-foamed materials.

5.4.2 Sick building syndrome (SBS)

This is a combination of ailments (such as headaches, irritation of the eyes, nose and throat, a cough, itchy skin, dizziness, nausea, fatigue and concentration difficulties) typically associated with modern office and commercial buildings, although SBS has also been seen in residential buildings. A 1984 World Health Organisation report found that symptoms of SBS may be linked to up to 30% of new and remodelled buildings worldwide.

Symptoms occur while one is in an SBS-affected building and clear up once one has left the building.

Factors contributing to SBS include combinations of some or all of the following:

- Indoor air pollution caused by chemicals emitted by processed materials and finishes
- Artificial fragrances, such as dryer sheets
- Poor or inappropriate lighting (including absence of, or limited access to, natural sunlight)
- Poor heating or ventilation
- Microbial contamination of HVAC systems
- Bad acoustics
- Poor ergonomics
- Electromagnetic radiation from equipment (e.g. computer monitors and photocopiers)
- Chemical and biological contamination

A ‘sick building’ results in high levels of employee illness or absenteeism, lower productivity, poor job satisfaction and high employee turnover. Green buildings aim to eliminate SBS.
5.4.3 Indoor air quality

Although most people are aware of the negative impacts of outside air pollution, few consider the serious health impacts of unclean or contaminated air indoors. Maintaining good indoor air quality is an essential part of creating comfortable and productive living and working environments.

5.4.4 Allergens

Special attention should be given to creating a home and garden that are low in allergens that can cause asthma and other allergies. Most people with asthma are affected by the allergen produced by dust mites, particularly in humid climates. Design buildings to avoid materials and fittings that gather dust. For example, avoid fitted carpets and pelmets, and use angled skirting.

5.4.5 Volatile organic compounds (VOCs)

Office machinery and many modern materials contain and emit high levels of volatile organic compounds. These products include, but are not limited to, paint and other wall treatments, particleboards (especially those with formaldehyde glues), chemically treated and varnished wood, carpets, photocopiars and fax machines, and chemicals used in cleaning materials. Emissions from these products can cause headaches, irritation of the eyes, throat, nose and skin, nausea and dizziness.

Although there are no official guidelines for indoor air quality, developers should make every effort to reduce the use of materials with VOC emissions. This may involve using natural wood finishes or paints (which are commercially available) and limiting the use of particleboards. Organic cleaning products, which do not contain harmful chemicals, are also available.

5.4.6 Microbial and bacterial growth

Microbial growth inside buildings is largely due to damp indoor conditions and badly maintained air-conditioning systems. These damp conditions allow fungi (such as mildew) and bacteria to breed, creating an unhealthy environment for those working or living in the building. Illnesses and symptoms associated with such conditions include allergies, upper respiratory tract infections and irritations, asthma, bronchitis and pneumonia, as well as Legionnaire’s disease, which can be fatal.

Microbial growth can be prevented by regularly cleaning and servicing air-conditioning equipment and ducts. Rising damp and associated fungal and bacterial growth can also be prevented by using breathable paints, so that water cannot accumulate under the paint surface.

5.4.7 Fire

Fire blankets and extinguishers must be provided. Avoid halon-based fire extinguishers due to their negative impact on the ozone layer. Solvent-free and flame-retardant building materials should be used wherever possible. Electric cables made from ‘low-burn’ materials should be fitted. Low-burn materials do not emit toxic fumes when they ignite. (Fire-fighters have found that in the case of a house fire, occupants are often harmed by toxic fumes from furnishings rather than the fire itself.)

5.4.8 Visual comfort

Another element of occupant comfort relates to visual comfort. The three key elements in addressing visual comfort are:

- reducing eye strain by providing external views to building occupants, allowing multiple points of focus at different distances;
- reducing eye strain by limiting indoor lighting to below 400 lux; and
- reducing visual discomfort by providing glare mitigation through external shading elements or blinds.

5.4.9 Recommendations for human health and comfort

- Reduce the risk of SBS through natural ventilation, natural light, good acoustics and ergonomics.
- Ensure that microbial growth is prevented by regularly cleaning and servicing air-conditioning equipment and ducts.
- Prevent damp conditions that lead to microbial and bacterial growth, by ensuring exteriors are properly sealed and drained. Rising damp and associated fungal and bacterial growth should also be prevented by using breathable paints, so that water cannot accumulate under the paint surface.
- Avoid building and decorating materials (such as paint, varnished wood and carpets) which may emit high levels of VOCs. Rather use natural wood finishes or paints (which are commercially available) and limit the use of particleboards.
- Ensure that no CFC-based air conditioners are used.
- Encourage the use of organic cleaning products, which do not contain harmful chemicals.
- Provide fire blankets and extinguishers.
- Use solvent-free and flame-retardant building materials.
- Ensure that electric cables made from ‘low-burn’ materials are fitted to avoid any toxic fumes during a fire.
5.4.10 Checklist: Human health and comfort

<table>
<thead>
<tr>
<th>Issue</th>
<th>Priorities</th>
</tr>
</thead>
<tbody>
<tr>
<td>HVAC systems</td>
<td>1. Use natural ventilation with dual-aspect openings.</td>
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<tr>
<td></td>
<td>2. Prioritise fresh-air provision at higher than minimum rates (nominally 5 L/s/person) for mechanical air-conditioning systems.</td>
</tr>
<tr>
<td></td>
<td>3. Focus on radiant cooling to achieve comfortable conditions.</td>
</tr>
<tr>
<td>Reduce indoor pollutants</td>
<td>1. Avoid volatile organic compounds in carpets, adhesives, sealants and paints.</td>
</tr>
<tr>
<td></td>
<td>2. Avoid formaldehyde in wood products.</td>
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<tr>
<td></td>
<td>3. Avoid mould in air-conditioning ductwork through humidity control.</td>
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<tr>
<td></td>
<td>4. Avoid coatings or coverings that emit toxic fumes in the case of fire.</td>
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<tr>
<td></td>
<td>5. Remove pollutants from printing and copying equipment through direct exhaust.</td>
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<tr>
<td></td>
<td>2. Do not provide artificial light above the recommended or regulatory minimums.</td>
</tr>
<tr>
<td></td>
<td>3. Mitigate glare through shading or blinds.</td>
</tr>
</tbody>
</table>

6 CERTIFICATION AND BENCHMARKING – HOW GREEN IS GREEN?

6.1 Avoiding greenwashing: Certification

Greenwash is not a new concept. The term emerged from the Rio Earth Summit in 1992, and it entered the Concise Oxford Dictionary in 1999.

Green-wash (green’wash’, -wôsh’) – verb: the act of misleading consumers regarding the environmental practices of a company or the environmental benefits of a product or service.

Therefore, greenwashing is the public claiming of performance without it being backed up in reality. This is one of the largest risks in the move towards sustainability. It hampers actual environmental performance when sub-standard products are selected or untrue claims are made, and acts as a disincentive for those who are providing truly environmentally effective goods and services.

Greenwashing has been especially prevalent in the buildings sector, where products and services are often promoted on their ‘green’ merits. The advent of green building certification systems has largely been aimed at providing an industry standard for claims relating to green buildings.

The Green Building Council of South Africa administers the local green building certifications tool, namely Green Star SA. Other certification that should be considered when embarking on a building project, whether retrofitting or new construction work, are:

- appliance certification (such as Energy Star);
- material certification (such as the Forest Stewardship Council for timber);
- ISO (International Standards Organisation) certification (ISO 9000 for quality, ISO 14000 for environmental management);
- SABS certification; and
- Eskom rebate certification for solar water heaters.

Other considerations when faced with unsubstantiated claims are to:

- request confirmed performance records under a range of conditions, especially with regard to different climates and seasons;
- be wary of fluffy, vague language where words have no clear meaning (such as ‘environmentally friendly’);
- be wary of ‘green’ branding and pictures that do not relate directly to the product; and
- consider the overall impact of a product if just a small element of it is claimed to be ‘green’.

The value attached to appearing ‘green’ means that there are many suppliers of goods or services that will attempt to make their product appear greener than it really is. The key tools to outsmart greenwashers are independent product certifications and astute interrogation of product claims.
6.2 Green Star SA

The South African market has adopted the Green Star SA rating tools (administered by the Green Building Council of South Africa, or GBCSA) as the primary benchmarking strategy for buildings. An office tool, retail tool and multi-unit residential tool (MURT) are currently available, while a public and education buildings tool is at a pilot stage of development.

The Green Star SA rating tools are a holistic environmental rating scheme for South African buildings developed by the Green Building Council of South Africa and based on the tools developed by the Green Building Council of Australia (GBCA). The tools measure environmental performance over a wide range of issues, including water, energy, materials, indoor environmental quality, site considerations and emissions.

The Green Star SA rating tools benchmark buildings against a six-star rating scale, although the GBCSA only recognises developments that achieve four, five or six stars. A four-star Green Star Rating represents ‘best practice’, placing a development within the top 25% of the industry. A five-star rating generally describes South African excellence, whilst six stars describe a world leader in environmental building design.

Due to the diverse range of topics covered by the Green Star SA rating tools, it is possible to achieve a Green Star SA rating in a variety of ways. There are many different combinations of sustainability initiatives that could be adopted to achieve a particular star rating.


7 GREEN LEASE GUIDELINES

Environmental performance in commercial buildings is encouraged to be formalised in a ‘green lease’. The aim of a green lease contract is, at the very least, to encourage tenants to assume responsibility for their consumption patterns. Tenants are required regularly to report on energy and water consumption. The agreement requires tenants to formally disclose measures that they have undertaken to reduce their environmental footprint within their operations, in keeping with the environmentally sustainable vision of the building.

A green lease is a contractual mechanism to oblige tenants to comply with the environmentally sustainable initiative designed for the building. This contract may formally include guidelines noted under the “Existing buildings” section, and require disclosure:

• of measuring and reporting on energy performance, water consumption, and waste reduction targets;
• of certain non-toxic products that are being used (e.g. low-VOC paint); and
• of adherence to specified indoor environmental quality standards.

The Green Building Council of South Africa has produced a Green Lease Toolkit which provides guidance for landlords and tenants. (See www.gbcsa.org.za)
8 QUESTIONNAIRE FOR HOMEOWNERS

8.1 Make your home green

1. Is your geyser set higher than 60 °C? If so, consider turning it down.
2. Is your geyser and hot-water piping insulated? If not, check if pipes and geyser are warm/hot to the touch. If so, consider adding a geyser blanket and pipe insulation.
3. Is your geyser only electric? If so, consider switching to a solar thermal, heat pump or instantaneous gas system.
4. Is your ceiling insulated? If not, consider insulation options (targeting insulation that has a high proportion of recycled content and is non-toxic).
5. Do you still use incandescent light bulbs? If so, switch to CFL bulbs.
6. Do you have air conditioning? If so, consider how your walls can be shaded and insulated to reduce solar gain.
7. Is your roof light or dark-coloured? If it is dark, consider painting it in a lighter colour.
8. Do your appliances have certified energy and water ratings? If not, consider cooking, refrigeration, clothes washing/drying and entertainment equipment with an energy and water certification, such as Energy Star, when your current appliances are due for replacement.
9. Do you water your garden? If so, consider collecting rainwater or grey water for irrigation.
10. Do you have a pool? If so, consider covering it with a pool blanket when it is not in use.
11. Does your garden contain exotic or invasive species? If so, consider replanting only endemic species, which require little irrigation and link positively to local ecological systems.
12. Do you separate your waste? If not, consider installing separate waste bins for paper, bottles/cans (plastic, glass and metals), food waste and non-recyclables.
13. Do you allow rainwater and stormwater to soak into the ground rather than discharge into the municipal stormwater system?

8.2 New homes: Design questionnaire

1. Has the house been designed with dual aspect to allow natural ventilation?
2. Has the house been designed to allow solar shading in summer and solar access in winter?
3. If air conditioning is provided, has it been linked to heat recovery systems (such as water heating)?
4. If air conditioning is provided, have passive solar design strategies been implemented to reduce solar gain?
5. Does the hot-water system use any of the following?
   a. Solar hot water
   b. Heat pump
   c. Instantaneous gas (i.e. no hot-water storage)
6. Are all lights either CFL or LED?
7. Does the house meet the SANS 204 requirements for building fabric that has non-toxic insulation with a high recycled content?
8. Do all appliances have energy and water performance certifications?
9. Do the materials or finishes contain toxic materials (such as VOCs, lead, formaldehyde and asbestos)?
10. Does the house have a rainwater tank, and is it linked to irrigation, toilets or washing machines?
11. Does the house have a swimming pool, and, if so, does it have a cover?
12. Does the kitchen have separate waste storage areas for paper, bottles/cans (plastic, glass and metals), food waste and non-recyclables?
13. Does the landscaping design include exotic or invasive species?
14. Has provision been made for rainwater harvesting?
15. Will stormwater be infiltrated into the ground rather than discharged into the municipal stormwater system? Are the requirements of the City’s Management of Urban Stormwater Impacts Policy applicable?
9 QUESTIONNAIRE FOR DEVELOPERS

1. Have you researched the value impacts of green building design, e.g. rental premiums, improved occupancy and an increased asset sales value?
2. Is it appropriate to develop this site, e.g. has it been built on before, is it close to public transport systems, does it affect sensitive ecological systems?
3. Do you have a sustainability consultant on your professional team?
4. Is your professional team familiar with green building practices?
5. Are you planning to obtain a green certification for the building (such as through Green Star)?
6. Is your cost consultant able to provide life-cycle costing of design options?
7. Has your professional team identified a benchmark of environmental performance that they are aiming to achieve?
8. Has your professional team considered passive design options for solar control, ventilation and natural lighting?
9. Has your professional team recommended materials with lower environmental impacts (embodied energy, toxicity, resource depletion) than current industry standards?
10. Has your professional team recommended more efficient systems than industry standards for HVAC, lighting, hot water, irrigation, cooking and refrigeration?
11. Has your professional team considered alternative resource supplies (such as rainwater, recycled water or renewable energy)?
12. Does your building have a waste management strategy?
13. Have you considered the local ecology, and engaged the community in terms of their relationship to the site?
14. Is your professional team familiar with the City’s policies on Management of Urban Stormwater Impacts, and Floodplain and River Corridor Management?

10 QUESTIONNAIRE FOR TENANTS

1. Have you researched the productivity benefits of tenanting a green building?
2. Is your lease a ‘green lease’?
3. Does the building have a green building certification (such as Green Star SA)? If not, can it be assessed against another sustainability benchmark?
4. Does the building have systems designed to improve the indoor air quality above the regulatory minimum?
5. Does the building have toxic materials or finishes?
6. Does the building have an air-conditioning system that is designed for comfort and not just condition (i.e. does it address radiant as well as conductive cooling)?
7. Does the building facade have systems to address glare?
8. Does the building have efficient fittings, fixtures and appliances?
9. Does the building have facilities to allow non-vehicular transport (such as cyclist facilities)?
10. Is the building connected to local public transport systems?
11. Does the building have alternative water sources (such as rainwater capture or grey water systems)?
12. Does the building have alternative energy sources (such as on-site PV or wind generation)?
11 RESOURCES

Regulations
1. City bylaws and policies: www.capetown.gov.za
2. SANS 10400 Part XA Draft National Standard; National Building Regulations
3. SANS 204 Energy Efficiency in Buildings

Voluntary standards and tools

Useful websites
5. Clinton Climate Initiative: www.clintonfoundation.org/what-we-do/clinton-climate-initiative
6. City Energy Support Unit [CESU]: www.cityenergy.org.za
10. Department of Environmental Affairs and Tourism-Climate Change Awareness Campaign: www.climateaction.org.za
11. Eco-specifier South Africa: www.ecospecifier.co.za
14. ICLEI Local Governments for Sustainability: www.iclei.org
15. Master Builders South Africa: www.mbsa.org.za
19. Sustainable Home Design: www.sustainablehomedesign.co.za
21. Thermal Insulation Association of South Africa: www.tiasa.org.za
22. The Sustainability Institute: www.sustainabilityinstitute.net

World Green Building Council: www.worldgbc.org
GLOSSARY OF COMMONLY USED TERMS AND ABBREVIATIONS

Abiotic: Processes that do not involve biological functions

Biotic: Processes that do involve biological functions

Black water: The wastewater from toilets that contains urine and/or faeces or ‘industrial effluent’ which is wastewater from industrial operations or manufacturing processes often containing problematic chemicals

Black water system: A household wastewater treatment system that converts waste into a reusable resource in the garden

Brownfield: Land previously used for industrial purposes or certain commercial uses. The land may be contaminated by low concentrations of hazardous waste or pollution, and has the potential to be redeveloped once it is cleaned up.

CFC: Chlorofluorocarbon

CFL: Compact fluorescent light

Climate change: The process of rapidly shifting global climate patterns caused by greenhouse gas emissions associated with human activity (anthropogenic emissions)

Embodied energy: The energy used in the extraction, manufacture, distribution and disposal of a product (as opposed to the operational energy use)

End-of-life effects: Refers to the toxicity or recyclability of a product once it has reached the end of its useful lifespan. In order to reduce negative end-of-life effects all parties involved in the lifespan of a product are called upon to take up responsibility to reduce its environmental, health, and safety impacts. For manufacturers, this includes planning for, and if necessary, paying for the recycling or disposal of the product at the end of its useful life. This may be achieved, in part, by redesigning products to use fewer harmful substances, to be more durable, reusable and recyclable, and to make products from recycled materials. For retailers and consumers, this means taking an active role in ensuring the proper disposal or recycling of an end-of-life product.

Ergonomics: The design approach for effectively matching the built environment to its human inhabitants and users

Food security: A nation or group’s ability to source and procure basic food at an affordable rate

Fossil fuel: Ancient plant and animal matter in the form of coal, oil or natural gas

Gas instantaneous heaters: Water heaters that use gas to heat water on demand rather than storing it in a geyser

Greenfield: Land which has not been built on before in a city or rural area either currently used for agriculture or landscape design or left to naturally evolve

Greenwash: The act of misleading consumers regarding the environmental practices of a company or the environmental benefits of a product or service

Greyfield: Land previously developed, with at least 50% of the surface area covered with impervious material

Grey water: The wastewater from bath tubs, showers, washbasins and washing machines. Whilst grey water may also include the more polluted wastewater from kitchen sinks, it does not include ‘black water’

Hard surfacing: Site area that is impermeable to water, i.e. that creates run-off instead of allowing water to soak into the earth

HCFC: Hydrochlorofluorocarbon

Heat island effect: Refers to an atmospheric condition occurring in urban areas with tall buildings, in which heat and pollutants create a haze dome that prevents warm air from rising and being cooled at a normal rate, especially in the absence of strong winds
HVAC: Heating, ventilation and air conditioning

LED: Light-emitting diode

Life cycle: Consideration of impacts of a product, building or system from extraction of the raw materials through to retirement (or reuse)

Life-cycle assessment (LCA): Life-cycle assessments consider all the environmental impacts of a product from extraction to retirement. These can be quantified in terms of carbon footprint, water footprint or other environmental indicators.

Life-cycle costing: Life-cycle costing is a process of considering both the capital and operational costs of an advanced system compared to the business-as-usual approach. A simple payback calculation divides the capital cost premium by the annual operational saving to establish a payback in years. A more complex net present value calculation can be undertaken by taking into account the cost of capital.

Mulch: A protective cover (of leaves or bark chips) that is placed over the soil to retain moisture, reduce erosion, provide nutrients and suppress weed growth and seed germination

Net present value: The value in present-day terms of a series of cash flows; a measure of life-cycle costing taking the cost of capital into account

Passive chilled beam: A commercial HVAC system that provides cooling through chilled water that cools coils in the ceiling void of the occupied space, and relies on natural convection to move cool air. These are among the most energy-efficient HVAC systems available.

Passive solar design: The incorporation of design features which lessen the building’s reliance on mechanical systems of heating and cooling, leading to energy savings and lower operational costs

PV: Photovoltaic

Recyclable: A product that can be broken down into its constituents, each of which can then be reprocessed (recycled) and reused as a raw material

Resource intensity: The resource intensity of a product relates to the amount of water, energy, raw materials or waste associated with its manufacture, use or disposal

Reusable: A product that can be reused (for the same or different purpose) at the end of its first ‘life’, without the need for recycling

SBS: Sick building syndrome

Swales: Urban stormwater management systems that make use of gravel pits and plantings to attenuate and filter stormwater

Thermally active building systems (TABS): An HVAC system that provides cooling by running chilled (or hot) water through the building structure, making use of thermal mass to provide cooling to the building. TABS are also a very energy-efficient HVAC system.

Thermal mass: a material that absorbs heat from a heat source, and then releases it slowly. Common materials used as a thermal mass include adobe, mud, stones, or even tanks of water.

VOC: Volatile organic compound

Zero waste: Refers to the designing and managing of products and processes to reduce the volume and toxicity of waste and materials, conserve and recover all resources, and not burn or bury them. Zero waste also predetermines that the whole production process is cyclical, and emulates nature, so that the cycle of production, consumption, decomposition and regeneration all happens in an integrated organic manner and where unused by-products are utilised optimally by adding value in different ways.
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