SUSTAINABLE HOUSING GUIDELINES
Foreword

The formulation of “Sustainable Housing Guidelines” for Zambia is a major milestone in Zambia’s quest for a responsive and integrated approach in the development of more sustainable housing in Zambia. The guidelines support housing development that responds to global climate trends and they also ensure a response to local sustainable development priorities in an integrated way.

The articulation of these guidelines attests to the seriousness of the situation today, and present a platform to guide the implementation of key interventions towards sustainable housing in an efficient and effective manner.

The guidelines define a comprehensive and coordinated approach to programming implementation, monitoring and evaluation of sustainable housing practices aimed at mitigating and adapting to the impacts of climate change. As such, some existing practices need to be addressed in order to mitigate their negative impacts on the environment.

My sincere appreciation is extended to our partners within and outside Zambia who assisted us in this highly participatory process to draft the sustainable housing guidelines. I am particularly indebted to the Zambia Green Jobs Programme and the United Nations Environment Programme (UNEP), who committed time, technical assistance and financial resources to ensure that the guidelines are formulated.

It is my hope that, with the renewed commitment that ushered in these guidelines, we can allocate time, resources and expertise that are required to fully implement them.

Vincent Mwale, MP
MINISTER OF LOCAL GOVERNMENT
Acknowledgments

Acknowledgment is made of assistance and reviews provided by Patrick Mwesigye and Musoli Kashinga of UNEP Regional Office for Africa and Tapera Muzira and Karl Pfeffer of the Zambia Green Jobs Programme Secretariat, Lusaka ILO office. The facilitation in the review of the first draft of the guidelines by the Ministry of Local Government is greatly appreciated.

This draft document has been developed and facilitated by UNEP, as part of the Zambia Green Jobs Programme, for use by the Government of the Republic of Zambia to promote sustainable housing in the country. The Ministry of Local Government facilitated and coordinated the process of validation and adoption of these guidelines. Dr. Jeremy Gibberd, a UNEP Consultant, provided the technical inputs in developing this document.

Queries with regard to this document should be directed to: The Permanent Secretary, Ministry of Local Government, P.O.Box 50027, Church Road, Lusaka, Zambia

Supervision, Technical Editing and Support:
Mukuka Chibwe (Ministry of Local Government)
Mbumbwe Silumesi (Ministry of Local Government)
Patrick Mwesigye (United Nations Environment Programme, Nairobi)
Julie Kaibe (United Nations Environment Programme, Nairobi)
Musoli Kashinga (United Nations Environment Programme, Lusaka)

Technical Experts:
Mukuka Chibwe (Ministry of Local Government), Cecilia Mwengwe (Ministry of Local Government), Mbumbwe Silumesi (Ministry of Local Government), Fabian Banda (University of Zambia –TDAU), Mr Chisomo Chongo (Zambia Institute of Architects), Patrick Mwesigye (United Nations Environment Programme, Nairobi), Jeremy Gibberd (Consultant - United Nations Environment Programme), Musoli Kashinga (United Nations Environment Programme, Lusaka), Chileshe Musonda (Surveyors Institute of Zambia), Maurice Chitondo (National Housing Authority), Mr. David Thompson Tembo (Ministry of Local Government), Anderson Zulu (National Housing Authority)

Cover Design & Layout:
Job Mubinya (United Nations Environment Programme, Nairobi)
# Contents

Definitions .............................................................................................................................. iv  
Acronyms ................................................................................................................................ vi  

1 Introduction .......................................................................................................................... 1  
1.1 Objectives ....................................................................................................................... 1  
1.2 How to Use the Guidelines ............................................................................................. 1  
1.3 Structure of the Guidelines ............................................................................................ 2  

2 Developing a Responsive and Integrated Approach .......................................................... 3  
2.1 Introduction ..................................................................................................................... 3  
2.2 Zambian Context ............................................................................................................. 3  
2.3 Climate Change .............................................................................................................. 4  
2.4 The Built Environment .................................................................................................. 4  
2.5 Sustainable Housing .................................................................................................... 5  
2.6 Sustainability Integration Processes ............................................................................. 6  
2.7 Sustainability Integration Plans .................................................................................... 9  

3 Energy .................................................................................................................................. 11  
4 Water .................................................................................................................................. 23  
5 Waste .................................................................................................................................. 27  
6 Materials ............................................................................................................................ 29  
7 Biodiversity ...................................................................................................................... 31  
8 Transport ............................................................................................................................ 34  
9 Resource Use .................................................................................................................... 39  
10 Management .................................................................................................................... 42  
11 Local Economy ................................................................................................................ 44  
12 Services and Products ...................................................................................................... 46  
13 Access ................................................................................................................................ 48  
14 Health .............................................................................................................................. 50  
15 Education ......................................................................................................................... 52  
16 Inclusion ........................................................................................................................... 54  
17 Social Cohesion ................................................................................................................. 56  

Appendix 2: Sample Green Home Maintenance Schedule .................................................. 59  
References ................................................................................................................................ 60
Definitions

**Air conditioning**: A mechanical system installed in a building to control the temperature and humidity of the air by heating or cooling.

**Building envelope**: The external elements of the building such as the walls, windows and roofs. Construction worker: Employees of construction firms or the main contractor(s) involved in the construction of a building.

**Embodied energy**: Is the total energy required for the extraction, processing, manufacture and delivery of building materials to the building site.

**Glazing**: Windows, glazed doors or other transparent and translucent elements including their frames (such as glass bricks, glazed doors, etc.) located in the building fabric.

**Global Warming**: Is the gradual increase in the overall temperature of the earth’s atmosphere generally attributed to the greenhouse effect caused by increased levels of carbon dioxide, CFCs, HFCs and other pollutants.

**Gross floor area**: This covers the total floor area of the building protected from the elements but excludes parking.

**Housing**: In this guide, housing refers to dwellings that people live in and associated spaces and services. It includes free standing dwellings and apartments.

**Light Emitting Diode (LED)**: This is a semiconductor device that emits visible light when an electric current passes through it.

**Lighting power density**: The total amount of that which will be consumed by the lighting systems in a space and it includes the lamps, ballast, current regulators and control devices. The total is arrived at by adding the energy used and then dividing it by the floor area of the room.

**Luminous efficacy**: Is a measure of how well a light source produces visible light. It is the ratio of luminous flux to power. Depending on context, the power can be either the radiant flux of the source’s output, or it can be the total power (electric power, chemical energy, or others) consumed by the source.

**Occupants**: People who normally work or live in the building.

**Resistance Value (R -Value)**: The measurement of the thermal resistance of a material which is the effectiveness of the material to resist the flow of heat, i.e. the thermal resistance (Km²/W) of a component calculated by dividing its thickness by its thermal conductivity.
**Social cohesion**: Is defined as the willingness of members of a society to cooperate with each other in order to survive and prosper.

**Thermal mass**: A term to describe the ability of building materials to store heat. Building materials that are heavy weight store a lot of heat so are said to have high thermal mass. Materials that are lightweight do not store much heat and have a low thermal mass.

**Thermal resistance**: The resistance to heat transfer across a material. Thermal resistance is measured as an R-Value. The higher the R-Value, the better the ability of the material to resist heat flow.

**Ventilation opening**: An opening in the external wall, floor or roof of a building designed to allow air movement into or out of the building by natural means including a permanent opening, an openable part of a window, a door or other device which can be held open.

**Watt (W)**: The determined metric or SI (international system of measuring units) value for energy loads (power rating) and is used to rate electrical motors, appliances, lights etc. and in expressing energy loads and energy consumption.
Acronyms

ADSL: Asymmetric Digital Subscriber Line
ATM: Automated Teller Machine
CFL: Compact Fluorescent Lamp
CPD: Continuous Professional Development
EF: Ecological Footprint
EIA: Environmental Impact Assessment
EMA: Eco Mark Africa
FSC: Forest Stewardship Council
GDP: Gross Domestic Product
GWP: Global Warming Potential
HDI: Human Development Index
HVAC: Heating, Ventilation and Air-Conditioning
ILO: International Labour Organisation
LED: Light Emitting Diode
MLG: Ministry of Local Government
Ministry of Local Government was previously the Ministry of Local Government and Housing
ODP: Ozone Depleting Potential
POS: Point of Sale
SABS: South African Bureau of Standards
SUDS: Sustainable Urban Drainage Systems
UN: United Nations
UNDP: United Nations Development Programme
UNEP: United Nations Environment Programme
ZGJP: Zambia Green Jobs Programme
List of Figures

Figure 1: Typical roof overhang and shading devices
Figure 2: Ventilation techniques
Figure 3: Typical rain water harvesting receptacle mounted on a concrete platform
Figure 4: Layout of Kalumbila Township showing location of housing with convenient location of main transport routes, shopping and social facilities
Figure 5: Layout showing good housing density with rear gardens

List of Pictures

Picture 1: House with roof mounted solar geyser
Picture 2: Large indigenous trees preserved to provide shades at Kalumbila town
Picture 3: Safe pedestrian walkway on Chilimbulu road near Libala Secondary School
Picture 4: Clearly marked zebra crossing on Chilimbulu road near Libala Secondary School
Picture 5: Road in Kalumbila with provision for cycling

List of Tables

Table 1: Sustainability Integration Plan
Table 2: Extract of a Sustainability Integration Plan for New Buildings
Table 3: Extract of a Sustainability Integration Plan for existing Buildings
Table 4: Absorbency values for different colours
Table 5: Building envelopes R-values for a hot humid climate
Table 6: Densities for low, medium and high cost housing
INTRODUCTION

The Sustainable Housing Guidelines aim to support the development of housing that addresses global climate change and local sustainable development priorities. The guidelines describe responsive and integrated design strategies, management processes, technologies and techniques that can be used to develop more sustainable housing in Zambia.

1.1 Objectives

The guide has the following objectives:

» To improve the understanding and awareness of sustainable housing by key stakeholders involved in the housing development sector.

» To provide guidance on the design of sustainable housing.

» To support sustainability performance monitoring and evaluation of housing.

» To provide a basis for the development of regulations and standards to promote sustainable housing development.

1.2 How To Use The Guidelines

The guidelines provide an introduction to sustainability and shows how this can be integrated into housing. It provides a comprehensive introduction to approaches and technologies that can be used to improve sustainability performance of the built environment. It can be used suitably by anyone interested in developing more sustainable housing including built environment professionals, government officials and housing developers and owners. The guide provides an introduction; more detailed technical information should also be referred to in detailed planning, design, construction and building operations.
1.3 Structure of the Guidelines

The document has the following structure:

» Introduction: This section describes the objectives and use of the guidelines.

» Developing a responsive and integrated approach: This provides a brief introduction to the Zambian context, sustainability and sustainable buildings. It describes the importance of a responsive and integrated approach and how this can be achieved.

» Sustainable housing objectives and guidance: Sustainable housing objectives are set out and guidance provided on how these objectives can be achieved.

» References and bibliography: References in the text are listed here, as well as other relevant literature.
DEVELOPING A RESPONSIVE AND INTEGRATED APPROACH

2.1 Introduction

Addressing climate change will require cooperation at all levels and a responsive and integrated approach that links adaptation and mitigation strategies to local societal objectives (IPCC, 2014). This means that sustainable housing must address global climate change requirements and respond to local sustainable development priorities (Gibberd, 2014).

Sustainable housing can be achieved through structured plans and processes that ensure that different building systems and components are integrated in a highly effective and efficient way by different stakeholders. This section outlines approaches that can be used to develop structured plans and processes and covers the following areas:

- Zambian context
- Climate change
- Built environment
- Sustainable housing
- Sustainability integration processes
- Sustainability integration plans

2.2 Zambian Context

A review by United Nations for the Green Jobs Programme identified a range of contextual issues that are important to take into account in the development of more sustainable built environments and practices in Zambia. These contextual issues are outlined below (UN, 2013):

- In 2006, 62.8% of the population was below the poverty line, while in 2010 it was 60.5% representing a marginal decline of 2.3%. Rural poverty in 2006 was 80.3% with this declining to 77.9%. In 2010, urban poverty in 2006 was 29.7% and marginally declined to 27.5% in 2010.

- Economic growth was estimated to be 7.3% in 2012, from 6.8% in 2011. Continued growth is predicted in the near future. However, further increases in economic growth are limited by relatively low productivity, low skills, deficient infrastructure, inadequate access to technology, inadequate of access to capital, inadequate market access as well as the risk and costs of HIV and AIDS.

- Formal jobs provide 10% of total employment in Zambia. The remaining 90%, about 4 million jobs in total, are informal jobs within micro, small and medium enterprises.

- Eighty percent of existing housing in Zambia can be classified as informal. This housing has limited or no formal services such as electricity, water and sewage.
The proportion of forested areas in Zambia has reduced from 72% in 1990 to 66.5% in 2010. A contributing factor to this loss has been the large proportion of the population (80%) who use solid fuels such as charcoal.

Housing backlogs are estimated to be about one million. It is estimated that Zambia requires 1.3 million new dwellings between 2011 and 2030. This equates to one house every 2 minutes of each working day for the next 19 years.

Construction makes up approximately 21.1% of the economy and is regarded as one of the main enablers of economic growth by the government of Zambia.

Climate change has been identified as a key challenge in Zambia and mitigation and adaptation strategies are required. In particular, construction is regarded as an area where there are significant opportunities to address climate change and as a means of contributing towards greening the economy.

### 2.3 Climate Change

Climate change is likely to impact Africa particularly negatively and significant social, environmental and economic impacts are predicted (DEAT, 2009). Climate change is largely caused by increased carbon emissions from human activities and a reduction in the ability of the natural environment to absorb carbon dioxide, leading to an accumulation of greenhouse gases in the upper atmosphere. These gases trap heat leading to global warming and average temperatures may increase by 5°C by the end of the century (IPCC, 2014). The following impacts are predicted.

- Agricultural production and food security in Zambia and many African countries are likely to be severely compromised by climate change and variability. Projected yields in some countries may be reduced by as much as 50% by 2020 and as much as 100% by 2100. Small scale farmers will be the most severely affected.

- Existing water stresses will be aggravated. About 25% of Africa’s population (about 200 million people) currently experience high water stress. This is projected to increase to between 75-250 million by 2020 and 350-600 million by 2050.

- Changes in ecosystems are already being detected and the proportion of arid and semiarid lands in Africa is likely to increase by 5-8% by 2080. It is projected that between 25 and 40% of mammal species in national parks in sub-Saharan Africa will become endangered.

- Health will be negatively affected by climate change and vulnerability and incidences of malaria, dengue fever, meningitis and cholera may increase.

### 2.4 Built Environment

Construction and the built environment make a substantial contribution to climate change and play a significant role in most economies. Construction is the largest employer of micro-firms (less than 10 people). Buildings are typically located on the most productive land (such as primary agricultural land) and this is estimated to cover 250 million hectares worldwide. Environmental, social and economic impacts attributed to the built environment at a global scale include:

- Consumption of 40% of energy.
- Consumption of 17% of fresh water.
- Consumption of 25% of wood harvested.
- Consumption of 40% of material.
- Employment of 10% of the world’s work force.
- Construction is the largest employer of micro-firms (Firms employing less than 10 people).
2.5 Sustainable Housing

Climate change and the impacts attributed to the built environment mean that it is imperative that built environments address global climate change and respond to local sustainable development requirements. A definition of sustainability that reflects both global climate change and local sustainable development requirements has been developed by the World Wildlife Fund. This defines sustainability as the achievement of an Ecological Footprint (EF) of less than 1.8 global hectares per person and a Human Development Index (HDI) value of above 0.8 (World Wild Life Fund, 2006).

An Ecological Footprint is an estimate of the amount of biologically productive land and sea required to provide the resources a human population consumes and absorb the corresponding waste. These estimates are based on consumption of resources and production of waste and emissions in the following areas:

- Food, measured in type and amount of food consumed
- Shelter, measured in size, utilization and energy consumption
- Mobility, measured in type of transport used and distances travelled
- Goods, measured in type and quantity consumed
- Services, measured in type and quantity consumed

The area of biologically productive land and sea for each of these areas is calculated in global hectares (gha) and then added together to provide an overall ecological footprint. This measure is useful as it enables the impact of buildings and lifestyles to be measured in relation to the earth’s carrying capacity of 1.8 global hectares (gha) per person (Wackernagel and Yount, 2000).

The Human Development Index is a measure of quality of life in relation to personal choice and human capabilities (UNDP, 2007). The measure is based on:

- A long healthy life, measured by life expectancy at birth
- Knowledge, measured by the adult literacy rate and combined primary, secondary, and tertiary gross enrollment ratio
- A decent standard of living, as measure by the GDP per capital in purchasing power parity (PPP) in terms of US dollars

The figures below show that Zambia has an ecological footprint of about 0.8 gha, which is within the maximum target of 1.8 gha, and a human development index measure of 0.448, which below the minimum of 0.8 required for sustainability (Global Footprint Network, 2009; UNDP, 2013).

<table>
<thead>
<tr>
<th>Measure</th>
<th>Zambia</th>
<th>Sustainability target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecological Footprint (gha)</td>
<td>0.8</td>
<td>Under 1.8</td>
</tr>
<tr>
<td>Human Development Index</td>
<td>0.448</td>
<td>Over 0.8</td>
</tr>
</tbody>
</table>

This suggests that development in Zambia should aim to improve its HDI from 0.448 to above 0.8 in an inclusive way, while minimizing ecological footprint increases as this is currently within target. Built environments can directly support this development by providing the capability, or capacity, to enable communities to achieve an HDI of over 0.8 and an EF of less than 1.8 gha. This capability can be described in terms of built environment objectives by analyzing the sub components of the HDI and EF (Gibberd, 2005). This results in the following environment al, economic and social objectives for housing as listed in the subsequent sections below.
Environmental objectives

- Energy: Housing is energy efficient and uses renewable energy.
- Water: Housing minimizes the consumption of mains or borehole portable water.
- Waste: Housing minimizes waste.
- Materials: Housing minimizes the negative impacts of construction materials and products.
- Biodiversity: Housing supports biodiversity.

Economic objectives

- Transport: Housing supports energy-efficient transportation.
- Resource use: Housing makes efficient use of resources.
- Management: Housing is managed to support sustainability.
- Local economy: Housing supports the local economy.
- Products and services: Housing supports sustainable products and services.

Social objectives

- Access: Housing supports access to facilities required for everyday life.
- Health: Housing supports health and productivity.
- Education: Housing supports education.
- Inclusion: Housing is inclusive of diversity in population.
- Social cohesion: Housing supports social cohesion.

These objectives provide a clear way of measuring sustainability performance and linking housing to climate change and sustainable development. They can also be used to define detailed criteria and guidance for housing, as shown in the next sections of the guide. However, objectives, criteria and guidance are not sufficient to ensure that sustainability is integrated in built environments and practices. For this to succeed, structured plans and processes are required. These can be referred to as Sustainability Integration Processes and Sustainability Integration Plans.

2.6 Sustainability Integration Processes

Sustainability Integration Processes are supported by specific activities at different building life cycle stages which ensure sustainability is considered, and integrated, into buildings and construction. These processes can be guided by a series of questions. Sustainability integration processes and questions are set out in Table 1.
<table>
<thead>
<tr>
<th>Lifecycle Stage</th>
<th>Sustainability Integration Processes</th>
<th>Sustainability Integration Questions</th>
</tr>
</thead>
</table>
| **Planning**    | • Strategic review and assessment of client needs and potential sites to ensure that the most sustainable options are selected. | • Is a new building required?  
• Can existing buildings be reused and upgraded for improved performance?  
• Have different sites been evaluated critically in terms of sustainability considerations such as environmental issues, transport, employment, education and health?  
• Has the most suitable site been selected and is this justified by detailed options evaluations and feasibility studies? |
| **Brief Development and Feasibility** | • Set formal sustainability targets.  
• Establish monitoring and evaluation processes for sustainability targets.  
• Carry out studies of site, local opportunities and challenges and future issues such as climate change have been undertaken to inform sustainability targets. | • Have reviews been carried out to establish required climate change and local sustainable development targets?  
• Has a review of similar projects been carried out to inform targets and their achievement?  
• Have monitoring and evaluation processes been set up?  
• Have the client and other non-design team members signed off on required targets and monitoring and evaluation processes? |
| **Concept Design** | • Confirm achievement of sustainability targets and agree any deviation.  
• Develop strategic integrated approaches to achieving sustainability targets including building layout, form, internal design, services design, material selection, construction method and procurement models. | • Has an integrated design process been developed?  
• Is there full support for sustainability targets from the entire design team?  
• Have a range of conceptual designs been developed in order to ensure that optimum solutions in terms of sustainability performance targets are selected?  
• Have sustainability targets been achieved by the proposed concept design? |
| Detailed Design | • Undertake full formal sustainability assessment to check compliance with targets.  
• Undertake sustainable system design (such as grey water systems, renewable energy systems etc) and engage specialists as required.  
• Carry out detailed modelling and calculation to ascertain whether predicted performance matches sustainability targets. | • Have detailed design of sustainable systems such as passive environmental control and rainwater harvesting been carried out and successfully integrated into the design?  
• Has a sustainability assessment been carried out of the detailed design?  
• Have areas of inadequate performance been addressed?  
• Has required performance been achieved and has the client and other non-design team members signed off on indicated performance? |
| --- | --- | --- |
| Tender Documentation | • Check achievement of sustainability targets from formal sustainability assessment; carry out actions to ensure compliance.  
• Ensure design sustainability requirements are effectively integrated into detailed design documentation and specification (including detailed material specifications).  
• Ensure construction process sustainability requirements are effectively integrated into tender documentation including environmental management, procurement requirements and social and economic (i.e. training, employment and SMME) targets.  
• Develop building user guidance and documentation in discussion with facilities management and client.  
• Development detailed commissioning and handover processes and documentation. | • Has detailed sustainability requirements, for instance related to insulation, paint, lighting and solar water heaters, been integrated into the specification?  
• Has the requirement for sustainable construction practices, commissioning and handover and building user support been included in the tender documentation?  
• Has a sustainability assessment been carried out of the detailed design?  
• Have detailed designs and specifications been developed iteratively and in an integrated way to ensure that sustainability targets are achieved? |
| Construction | • Brief Contractor on sustainability requirements and processes.  
• Ensure procurement systems for local sustainable products and services are in place.  
• Ensure sustainability construction targets monitored and corrective action taken, where required. | • Have procurement processes been put in place that supports sustainable and local sourcing of materials and services?  
• Does the appointed Contractor have a full understanding of the sustainability requirements within the tender documentation and how these must be achieved?  
• Is sustainable construction monitoring and evaluation processes in place and is corrective action taken, when this is necessary? |
### Handover
- Ensure that building systems commissioning and fine tuning has been undertaken to ensure optimum performance.
- Ensure that sustainable facilities management systems are set up, including the establishment of sustainability operational targets, training of personnel and handover of documentation.
- Hand over building user awareness systems, including manual, to client and support establishment.
- Has a full commissioning and tuning process of sustainable systems in the building taken place?
- Has this process been witnessed and signed off by the client or their agent?
- Have sustainable facilities management systems for the building been set up?
- Has full hand over documentation and training of building operation staff taken place? Documentation should include as-built drawings and specifications, operational manuals and operational targets.
- Have building user guides and occupant induction processes been developed for occupants?

### Operation
- Operational sustainability targets monitored and corrective action taken where necessary.
- Sustainable facilities management systems in place.
- Building user awareness systems in place.
- Are effective sustainable facilities management systems in place?
- Does regular monitoring and evaluation of sustainability performance take place?
- Are there plans to maintain and improve sustainability performance of the building?

### Reuse / Demolition
- Assessments of existing buildings and options evaluation which aim, where possible, to reuse the building.
- Upgrading of sustainability performance in reused buildings.
- Waste avoidance during demolition of buildings, through reuse and recycling of materials and components.
- Can the demolition of the building be avoided and instead the building be retrofitted and reused?
- Where buildings have to be demolished, are plans in place to maximise reuse and recycling of components and materials from the building?

### 2.7 Sustainability Integration Plans

A Sustainability Integration Plan provides a way of ensuring that sustainability performance targets are set, and integrated, into buildings and building processes. Sustainability Integration Plans can be developed for new buildings as well as existing buildings.

An example of a Sustainability Integration Plan for new housing is shown in Table 2. This illustrates how a sustainability target, such as a specific maximum water flow rate for wash hand basins, can be set, and then checked at different stages (Concept Design, Detailed Design and Handover) of a building’s development. Formal checking, and ‘acceptance sign-off’ by the building owner, developer, or an independent party ensures that targets, once set, are met.
### Table 2: Extract of a Sustainability Integration Plan for new buildings

<table>
<thead>
<tr>
<th>Sustainability area</th>
<th>Requirements</th>
<th>Feasibility and Brief development</th>
<th>Concept and Detailed Design</th>
<th>Handover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>Target</td>
<td>All hand basin taps to have flow rates that do not exceed 6 ℓ / minute in outline specifications.</td>
<td>All hand basin taps to have flow rates that do not exceed 6 ℓ / minute in tender documents.</td>
<td>Confirmation that hand basin taps to have flow rates that do not exceed 6 ℓ / minute.</td>
</tr>
<tr>
<td></td>
<td>Confirmation</td>
<td>Requirement target setting document</td>
<td>Requirements listed in wet services specifications and in construction tender documents.</td>
<td>Witnessing of commissioning test that confirms flow rates of under 6l/minute at all hand basin taps.</td>
</tr>
<tr>
<td></td>
<td>Acceptance</td>
<td>Party: Signature: Date:</td>
<td>Party: Signature: Date:</td>
<td>Party: Signature: Date:</td>
</tr>
</tbody>
</table>

A Sustainability Integration Plan for existing housing is also illustrated in Table 3. This shows how a water consumption target can be set and monitored over time (Quarter 1, Quarter 2, and Quarter 3). Formal checking and acceptance sign off processes within the plan enhance levels of awareness and accountability and ensure that targets are met.

### Table 3: Extract of a Sustainability Integration Plan for existing buildings

<table>
<thead>
<tr>
<th>Sustainability area</th>
<th>Requirements</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>Target</td>
<td>X litres / month</td>
<td>X litres / month</td>
<td>X litres / month</td>
<td>X litres / month</td>
</tr>
<tr>
<td></td>
<td>Confirmation</td>
<td>Four months of utility metered readings</td>
<td>Four months of utility metered readings</td>
<td>Four months of utility metered readings</td>
<td>Four months of utility metered readings</td>
</tr>
<tr>
<td></td>
<td>Acceptance</td>
<td>Party: Signature: Date:</td>
<td>Party: Signature: Date:</td>
<td>Party: Signature: Date:</td>
<td>Party: Signature: Date:</td>
</tr>
</tbody>
</table>
ENERGY

3.1 Objective

Housing is energy efficient and uses renewable energy.

3.2 Introduction

Energy is used in housing for lighting, ventilation, heating and cooling, to operate equipment, and to heat water. In existing housing, it is estimated that savings of up to 30% of energy consumption can be readily achieved. In new housing, where passive strategies, energy efficient equipment and renewable energy systems are used, energy consumption can be very low, and may even be carbon-neutral. Carbon neutral buildings have effectively no net carbon emissions as they have renewable energy systems that meet all their energy requirements and avoid carbon emissions associated with energy generated using fossil fuels.

The efficient use of energy and inclusion of renewable energy in housing provides the following benefits:

» Reduced carbon emissions and, therefore, global warming impacts.
» Reduced impact of mains power outages.
» Reduced negative health impacts associated with pollution from burning fossil fuels
» Reduced operational costs

3.3 Guiding Principles

3.3.1 Integrated Strategies

Designing and managing housing to achieve energy efficiency and use of renewable energy requires an integrated and responsive set of strategies. These can be summarized in the following way.

» Passive environmental control strategies: Passive environmental control strategies describe responsive and integrated design in which the building envelope, structure and openings draw on ambient conditions such as prevailing breezes, cooler night time temperatures and sunlight to provide comfortable internal conditions without mechanical systems.

» Day lighting strategies: Day lighting strategies describe approaches which enable required levels of lighting within a building to be achieved without artificial lighting during day time.

» Energy efficient systems: Energy efficient systems minimize energy consumption by specifying equipment that is able to carry out required tasks in an efficient way. It also ensures that equipment is used only when required and that this is switched off when not required.

» Renewable energy: Renewable energy systems use energy from natural sources such as the sun, wind, biomass and biogas to create energy which can be used in housing.
3.3.2 Site Layout

Site layouts should be carefully considered to ensure that valuable local resources are used to create productive internal environmental conditions. For instance, prevailing breezes can be used for ventilation and cooling, daylight can be used for internal day lighting, and sunlight can be used to heat buildings in winter and to generate energy through photovoltaic panels.

Housing should ensure that spacing and the location of units enable good access to breezes and ventilation. They should also be spaced to allow good access for sunlight and daylight. Studies of local conditions can be used to ensure optimum layouts are achieved.

3.3.3 External Hard Surfaces and Car Parking

Large areas of hard surfaces such as paving areas and parking can contribute significantly to increased temperatures around buildings. This is referred to as the ‘urban heat island effect’ and the retained heat and warmed air can make it difficult to maintain comfortable conditions in housing. Therefore, large areas of external hard surfaces near housing should be avoided. Parking and other hard surfaces should be shaded, ideally using vegetation such as large shade trees. Lighter coloured materials for paving and external surfaces should also be used to reduce the extent to which these surfaces absorb heat.

3.3.4 Orientation

Housing should be orientated so that the long facades face north – south. This helps reduce unwanted heat gains on west and east facades from low angle sunlight in the early morning and late afternoon. Glazing on west and east facing facades should be minimized and where this exists, appropriate shading should be provided. Trees, or planting, are a low cost, easy, way of creating shading that can reduce unwanted heat gains on east or west facing facades. However, care should be taken in the specification and management of plants to ensure these do not affect foundations or cut off valuable daylight to the interior of the buildings. They should also not overshadow solar collectors.

3.3.5 Building Form

While building form is usually determined by the functions accommodated, buildings can also be shaped to minimize energy consumption. Shaping built form to limit building depth ensures that interior spaces can be naturally ventilated and day lit. Built form can also direct prevailing breezes through houses, supporting natural cooling and ventilation. It can also be used to create comfortable external environments that can be used as outdoor living areas and as play spaces for children.

An analysis of the site and local climate should be carried out as an input to design and the building should respond to local climate and topography. Proposed building shape and form should be analyzed to ensure that this supports optimal performance in terms of reduced energy consumption and comfortable internal and external spaces.

3.3.6 Building Depth

Limiting building depth enables internal space to be day-lit and naturally ventilated, reducing energy consumption associated with lighting, air conditioning and mechanical ventilation. Building depths should not exceed 12m. This ensures, if openings are correctly located, that all areas within the building can be day lit and naturally ventilated.
3.3.7 Building Envelope Colour

The external colour of the building envelope affects the extent to which it absorbs heat from sunlight, with darker colours absorbing more heat than lighter colours. Therefore, building envelopes should be light coloured. In particular, this is important for roofs which are often the source of unwanted heat gains from the sun. Absorbencies of different colours is illustrated in Table 4 (SABS, 2007).

Table 4: Absorbency values for different colours

<table>
<thead>
<tr>
<th>Colour</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slate (dark grey)</td>
<td>0.90</td>
</tr>
<tr>
<td>Red, green</td>
<td>0.75</td>
</tr>
<tr>
<td>Yellow, buff</td>
<td>0.60</td>
</tr>
<tr>
<td>Zinc aluminium—dull</td>
<td>0.55</td>
</tr>
<tr>
<td>Galvanised steel—dull</td>
<td>0.55</td>
</tr>
<tr>
<td>Light grey</td>
<td>0.45</td>
</tr>
<tr>
<td>Off white</td>
<td>0.35</td>
</tr>
<tr>
<td>Light cream</td>
<td>0.30</td>
</tr>
</tbody>
</table>

Source: SABS, 2007

3.3.8 Insulation

Insulation, especially when combined with thermal mass, can be used to maintain comfortable indoor conditions without significant use of mechanical heating or cooling in housing. Insulation reduce unwanted heat gain from external heat sources such as the sun in summer. It can also ensure that valuable heat gains from people, equipment and the sun can be retained in the building to support comfort during winter.

Insulation should be used to reduce the heat flow through the building envelope. Calculations are required to determine appropriate building envelope assemblies, including the type, thickness and location of insulation. These calculations use thermal performance data on building envelope and insulation materials to establish the most effective solution and can be undertaken by hand or using simple software.

These calculations establish R-values of wall and roof assemblies, which can be compared to minimum recommended values for different climates. Examples of minimum R-values for a hot humid climate, such as Zambia’s, are given in Table 5. The reference to the absorbance relates to the colour of the roof and further detail can be found in the section on building envelope colour, and in Table 4, above.

Table 5: Building envelope R-values for a hot humid climate

<table>
<thead>
<tr>
<th>Building envelope component</th>
<th>Minimum total R-values (for full assemblies)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof</td>
<td>Minimum total R-value (for a roof with a solar absorbance of more than 0.55) to be 4.1 K m²/W</td>
</tr>
<tr>
<td>Walls</td>
<td>Minimum total R-value for walls to be 2.8 K m²/W</td>
</tr>
<tr>
<td>Floor</td>
<td>None, expose thermal mass. For instance high thermal mass flooring, such as tiles and concrete floors, should not be covered with carpets or vinyl tiles)</td>
</tr>
</tbody>
</table>
Large heat losses and gains can occur through roofing material and, therefore, it is usually the area where insulation will have the most effect.

In order to maximise the thermal flywheel effect in buildings, insulation should be located on the external face of high thermal mass envelopes and building structures.

The thermal resistance of building envelopes can be increased easily and at low cost through design. For instance, the incorporation of an air gap within a wall build-up, or planting creepers on an external façade, draw on the insulative properties of air to increase thermal resistance of the building envelope at no, or low, cost.

Care should be taken to ensure that insulation is as continuous as possible within a building envelope and gaps in insulation and thermal bridges (bridges of conductive material through insulation) should be avoided.

An analysis of the building envelope should be undertaken to identify areas with particularly high heat flows. For instance, this may occur on an exposed west façade. Where this occurs, additional insulation and/or shading measures may be required to reduce flows in these areas.

### 3.3.9 Glazing

Glazing is usually the most vulnerable area of a building envelope and high heat losses and gains can be experienced through this element. It is, therefore, important to design glazing to control lighting and heat flow.

The area of glazing on a façade should be an optimal balance between daylight quality and heat gains and losses through the envelope. The area of glazing within a façade should therefore not exceed 30%.

Glazing should be limited on east and west facades to avoid unwanted heat gains. Where it is located within these facades, appropriate shading should be applied Glazing should be located where it promotes views, ventilation and day lighting. Locating glazing higher up within external walls supports deeper daylight penetration within buildings.

### 3.3.10 Shading

Shading devices should be used to avoid unwanted heat gains from the sun through glazing. The design of shading devices should be based on calculations related to the geographical location (latitude) of the site and ensure that windows or glazing is shaded from direct sunlight at times when this results in unwanted heat gains.

In general, horizontal elements, such as fins and overhangs are appropriate on northern facades and vertical moveable elements, such as louvers, are suitable on east and west facades. (see Detail 2 and detail 3 in Figure 1, page 15)

Roof overhangs are also useful for shading external walls and windows from direct sunlight and can easily be incorporated into most roof designs. They also shed rain away from walls reducing maintenance requirements and poor thermal performance associated with sodden wall assemblies.
Day Lighting & Shedding Device (Roof Overhang)

- Roof Overhang: $X = Y/0.75$ (Minimum)
- Roof Pitch: $15^\circ - 30^\circ$

Maximum room
Depth from window opening should not exceed $2 \times h$

**Shedding Device Options**

*Figure 1: Typical roof overhang and shading devices (illustration by the Technical Committee)*
### 3.3.11 Daylight

Good day lighting reduces energy consumption by minimising the requirement for artificial lighting. Landscaping and site layouts should ensure spaces within building have good access to daylight and shading is avoided. The depth of the rooms should be limited to avoid internal spaces which cannot be day lit. A general rule of thumb is that daylight quality will be reasonable within the space 2\(h\) from a window, where \(h\) is the height of the head of the window from floor level.

A light colour, for instance, white or cream, should be chosen for internal walls, ceilings and finishes, in order to improve the internal reflectance of spaces. In particular, it is important that the reveals around windows are light coloured. Lighter coloured external surfaces will also promote day lighting within buildings, but care should be taken to ensure this does not lead to glare.

### 3.3.12 Opening Areas

Cross ventilation is an energy efficient way of cooling buildings in areas where there are moderate breezes. Air flow through the building is used to remove heat and bring in fresh air. Cross ventilation is enhanced by exposing facades with opening windows and doors to breezes and avoiding these being in the ‘wind shadow’ of other buildings and obstructions.

Cross ventilation relies on wind or breezes passing through the building to provide ventilation and cooling to occupants and the building. It requires openings on two sides of a space and the sizing and placement of these determines the direction and velocity of cross ventilation through the building. The optimum forms of cross ventilation are where breeze paths (or the flow of air) can be directly across a building or space and pass through the openings on opposite windows (see Figure 2, page 17). The depth of the building should not be more than 12 metres to enable good cross flow of air between openings on different sides of a building.

Where cross ventilation is limited, or cannot be applied, ventilation through the corners of spaces and buildings as well as ‘single sided’ ventilation should be created. Single sided ventilation is created by using external obstructions to air flow, such as opening window panes, to create differential pressures which enhance air flow through multiple openings in a space.

The locations for openings should be designed in relation to the types of passive environmental control and natural ventilation selected for the building.

Where cross ventilation is used for cooling, moving air should be directed around people. Therefore, locations of openings should take into account the normal positions of people (i.e. seated or standing) and the ‘breeze path’ between windows on opposite walls, or sides of a room, should be made as direct as possible to ensure that air movement is effective.

Where night-time cooling is used, moving air should be directed over thermal mass, such as a concrete floor, or ceiling, to cool this at night. In this situation openings should be located in such a way that it supports this type of air flow. In this way, the ‘coolth’ from cooler night temperatures can be retained within thermal mass inside the building and used to cool the building during the day.

Detailed designs of openings should consider aspects of security, insects’ screens and facilities for opening and closing (ensuring that such facilities can be used by people with disabilities) should be considered.
Permanent Ventilation Options

Figure 2: Ventilation techniques (illustration by the technical committee)
3.3.13 Heating and Cooling

Effective passive environmental control strategies based on an integrated and responsive approach to site layout, building envelope design, insulation and thermal mass can be used to avoid the need for mechanical heating and cooling.

Where heating and cooling equipment has to be used, for instance, in retrofitting existing housing, the most energy efficient measures should be specified.

For cooling, increased cross ventilation, thermal mass and ceiling fans should be used rather than air conditioning.

Solar direct or indirect gain systems can be used for heating. These systems use the sun to warm thermal mass such as a concrete floor (direct gain) or a rock bed (indirect gain) and then store this heat enabling it to be released when heating is required.

Biomass heating, such as wood burning stoves, or biogas systems can also be used for heating in preference to mechanical systems. However, biomass systems should be considered very carefully given the rate of deforestation in Zambia. If these are used, it is essential that all fuel comes from sustainably harvested sources. This can be planned for and provided in woodlots.

3.3.14 Ventilation

Ventilation in housing can be achieved through passive methods and electrical air conditioning and fans should be avoided.

Bathroom and kitchen ventilation requirements should be met by locating these spaces on an external wall and providing openings for natural ventilation.

Similarly, all occupied rooms should be ventilated naturally through external openings. The opening area of these external openings should be at least 10% of the floor area of the space.

3.3.15 Internal Layouts

Internal layouts of housing should ensure that spaces are appropriately located in relation to external factors such as noise, sunlight, daylight and ventilation.

Areas that require good daylight and some sunlight in winter such as living rooms and bedrooms should be located on the north side of houses and spaces where this is less important, such as bathrooms and storage areas, may be located on the south side. Spaces facing east will receive morning sunshine and will warm up first, making them suitable breakfast areas. Spaces facing west will heat up in the late afternoon and may be suitable for bathrooms or storage.

Day-lighting and natural ventilation should also be considered in internal spatial layouts. In particular, internal walls, furniture and equipment should be located and designed to avoid creating obstructions and promote good natural ventilation and day lighting. Where there are internal walls, lighting and ventilation can still be supported through high level openings and glazing within walls and above doors.

3.3.16 Artificial Lighting

Effective day lighting strategies mean that artificial lighting should only be needed at night or when it is severely overcast. To support energy efficiency, efficient lighting and controls should be specified. A review of relevant technology should be carried out as this is a rapidly changing field and increasingly efficient lamps and sophisticated controls are being developed.

Efficient lamps such as Compact Fluorescent Lamps (CFLs) and Lighting Emitting Diodes (LEDs) should be specified. An indication of the efficiency of lamps is luminous efficacy and the recommended minimum luminous efficacy of lamps used in housing should not be less than 50 lm/W.

A measure of the efficiency of the lighting system as a whole is lighting power density. This is calculated by dividing the lighting power installed within a space to achieve required lighting levels, by the area of the space. This is measured in Watts per square meter (W/m²). In housing, an overall lighting power density for the housing unit as a whole can be calculated. This can be compared to a lighting power density target of 5 W/m² for housing which should not be exceeded. However, care should be taken that minimum lighting levels for different activities and for safe emergency egress, as required by legislation and good practice, are still achieved.
Additional task lighting could be provided in appropriate areas such as areas for reading, and food preparation. This is an efficient way of avoiding over lighting.

In areas such as storage rooms and staircases, where lights may be left on accidentally, motion sensor lighting controls can be used. These switch on lighting when there is movement and switch off lighting when spaces are not being used.

### 3.3.17 External Lighting

Concerns about security often result in highly-lit external areas. To support energy efficiency, measures should be taken to minimize external lighting and make sure it is only on when required.

External lighting should only be provided where it is required and general ‘background’ lighting should be avoided as this is inefficient and causes light pollution. For instance, low level LED lighting linked to motion sensors are a far more energy efficient means of lighting walkways for pedestrians, compared to high-mast lighting.

External LED lighting is highly efficient and can consume 20 W compared to 200 W of an incandescent flood light. The total power of external lighting in housing should not be more than 40 W per unit. This should also be linked to day/night switchers, timers and motion sensors to ensure that external lighting is only on when required.

The lower power requirements of LED and CFL lamps also mean that they can be powered by simple low cost photovoltaic systems. As well as reduced operating costs, an additional advantage of solar powered lighting, is that cable costs can be avoided.

### 3.3.18 Equipment and Appliances

Equipment and appliances that consume energy should only be used where passive or manual alternatives cannot be used. Where equipment and appliances have to be installed, the most energy efficient type should be selected.

In many cases, appliances and equipment can be avoided by using manual alternatives. For instance, floors can be cleaned manually with brooms and mops, instead of using vacuum cleaners or mechanical floor polishers. Clothes can be hung out to dry instead of using mechanical clothes driers and cars can be washed by hand instead of using mechanical high pressure washers.

Appliances can also be avoided through design. For instance, swimming and ornamental pools that require mechanical pumps can be avoided or alternatively, these can be powered by photovoltaic panels. Similarly, lawns that require mechanical lawnmowers can be avoided or alternatively, groundcover planting and grass that does not require cutting could be specified.

Many appliances have energy efficiency ratings, such as energy star ratings, which can be used to identify the most efficient types. In housing, particular care should be taken in the selection of fridges, freezers and cookers, which consume large amounts of energy. Switching appliances off at the mains switch can also be used to avoid ‘standby’ power consumption.

### 3.3.19 Cooking

Up to a third of the energy consumed in housing may be attributed to cooking food. It is, therefore, important to reduce cooking where possible, avoid over-cooking food and to choose the most energy efficient method of cooking.

Microwaves are an efficient electrical method of cooking food. Induction cookers are also more efficient than conventional electric cookers.

Biogas, biomass and solar cookers use renewable energy to cook food. These are low carbon emitting and low operating cost options. However, the limitations of these types of cookers should be fully understood before they are specified.

Cooking with biogas requires a supply of gas from a bio digester. Biodigestors must be fed with appropriate quantities of organic matter, such as plant and animal waste, in order to provide a reliable supply of gas.

Biomass cookers burn wood or other plant products to cook food. They produce smoke and need very good ventilation. They are, therefore, usually used outside, or in an open covered area, and, therefore, may not be appropriate for highly dense, or apartment, housing. Biomass systems should
be considered very carefully given the rate of deforestation in Zambia. Where biomass cookers are used it is essential that all fuel comes from sustainably harvested sources. This can be planned for and provided in woodlots.

Solar cookers use mirrors and insulation to capture and trap the sun’s energy to cook food. They need to be located in an external space where they can easily be accessed and must have excellent sunshine throughout the day. These cookers, therefore, may not be suitable in highly dense urban, or apartment, housing.

A ‘hot box’ can be used to reduce the amount of energy used in cooking. This is an insulated container in which hot food can be placed where it will continue cooking without additional input energy. This can achieve a substantial reduction in energy associated with cooking, particularly for foods such as stews, pulses and porridge, which take some time to cook.

### 3.3.20 Heating Water

Up to 40% of the energy used in housing may be for heating water. It is, therefore, important to choose the most energy efficient method of heating water and avoid hot water wastage.

An efficient, low energy way of heating water is through the use of solar water heaters. Minimising the consumption of hot water can be used to improve energy efficiency. This can be achieved through plumbing design and the specification of water efficient fittings.

Energy losses from hot water pipes can be reduced by minimizing the length of the piping from the source of the hot water (such as the solar water heater) and where it is used, such as a shower. In free standing houses this length should not exceed 6 running metres (it may be longer in apartment housing with solar water heaters). Insulating hot water pipes can be used to reduce heat losses from standing water and, therefore, the energy requirements associated with heating water. This also reduces water consumption as the amount of cold or cooler water ‘run-off’ while waiting for hot water, is reduced.

Reductions in hot water use can be achieved through specifying water efficient showers instead of baths. Flow controls, aerators and water efficient taps can also be used to reduce hot water flows at taps, thereby reducing hot water consumption.

### 3.3.21 Solar Water Heaters

Solar water heaters use the sun’s energy to heat water and for most of the year can produce ample quantities of hot water for a household. A study in South Africa indicates that 150 L solar water heater can enable households to reduce their energy consumption by 4.5 kWh of electricity per day (Eskom, 2006).

Solar water heaters should comply with relevant technical and quality standards and be installed in accordance with manufacturers guidelines. Examples of standards for solar water heaters are SANS 1307 and SANS 10106 (SABS, 2014).

Solar collectors should face true north but deviations of 45° East and West can usually can be accommodated.

The pitch (angle from horizontal) of the solar collector should normally be latitude of the location plus 10°.

Solar collectors should be positioned where they will not be shaded by surrounding buildings or trees. Small obstacles such as TV aerials will not usually have much effect.

Designing and sizing the system should be carried out in relation to the expected schedule and volumes of hot water demand. For instance, if hot water is required in the morning, designs should cater for this requirement. This may require a system with larger capacity, or a 2-stage storage system, as usage of hot water in the evening can result in lukewarm water the following morning in some systems.

Solar collectors are most effective when they are clean. As these tend to get dusty they should be located where they can be cleaned regularly.

When full of water, solar heating systems will have a considerable weight and sufficient structure should be provided to take this loading.
3.3.22 Solar Cookers
A range of solar cookers have been developed. These are generally inexpensive and could be produced locally. They are particularly effective at cooking food on hot sunny days. They, however, need to be located where they can be easily accessed and where they will be in full sunshine throughout the day.

3.3.23 Biogas
Biogas can be generated from biodigestors fed using household and animal organic waste. This gas can be used for cooking, space heating and heating water. Biogas digesters need to be regularly supplied with waste and be well managed to generate a reliable supply of gas. They have been used very effectively in countries such as Ghana, Nepal, China and India.

3.3.24 Biomass
Biomass describes the process of burning plant material to produce energy. An example is a wood burning stove used to heat a space, such as living room or used to heat water for domestic use. These are very simple and effective devices but can result in deforestation if the biomass consumed is not renewed. It is therefore vital that available sustainable sources of biomass are used and others developed, if this type of system is used. In addition, it is important to understand the pollution and air quality implications associated with proposed biomass systems as these can negatively affect air quality and harm human health, especially if implemented at a large scale.

3.3.25 Wind Power
Wind turbines or wind mills use wind power to generate power or to mechanically pump water. In areas with sufficient and reliable wind this technology can be a low cost, low carbon emission method of providing power to households. Larger wind turbines are likely to require Environmental Impact Assessments (EIAs).
3.3.26 Photovoltaic Systems
Photovoltaic systems convert the sun’s energy into electrical energy which can be used in housing. They need to be located where they have excellent sunshine throughout the day. In addition, they should be positioned where they can be cleaned as this improves their performance. In many buildings photovoltaic panels are located on roofs.

3.3.27 Grid-Tied Wind and Photovoltaic Systems
Grid-tied wind and photovoltaic systems provide energy directly to housing. However, housing also has a mains supply which can be used if there is insufficient energy from renewable systems. Larger grid-tied systems can also supply energy back to the grid and owners of the system can receive income for this. This, however, requires appropriate off-take agreements, legislation and equipment. The advantage of this system is that battery storage systems are not required.

3.3.28 Off-Grid Wind and Photovoltaic System
Off-grid systems supply energy directly to housing or charge batteries enabling energy to be stored for later use. In such cases, housing does not have any mains supply and rely solely on renewable energy systems for their energy needs. Small off-grid systems are highly effective at meeting the lower power needs associated with lighting and small appliances. It is, however, more difficult to meet the power requirements of larger appliances such as electrical cookers. In these cases, it is useful to combine a number of renewable systems such as biomass systems with a photovoltaic arrangement. Larger renewable energy systems can cater for all of the energy requirements of housing.
4.1 Objective

Housing minimises the consumption of mains or borehole portable water.

4.2 Introduction

Water is used in housing for washing, drinking and cleaning, as well as for laundry, irrigation and food preparation. In existing housing it is often possible to reduce potable water consumption at little cost. In new facilities, where water-efficient technologies, grey water and rainwater systems are used, mains or borehole potable water consumption can be reduced significantly and ‘water independent’ housing can be achieved. This means that the building recycles, and harvests, sufficient water to meet its own needs and, therefore, does not need a piped supply from a water utility company or other source.

The efficient use of water in housing has the following benefits:

- Reduced water consumption and associated negative environmental impacts.
- Reduced impact of water shortages or outages.
- Reduced operational costs.

4.3 Guiding Principles

4.3.1 Toilets

Flush toilets (WCs) can consume large amounts of water. It is, therefore, important that if these systems are used, they are made very efficient.

Efficient flush toilets generally have dual flush capability and a flush rate which does not exceed 3 L for a 1/2 flush) and 6L for a full flush.

Flush toilets can also use grey water sourced from hand washing, showers and laundry, reducing mains or borehole potable water consumption. Simple filters can be used to remove any residual soap and clean the grey water, where necessary.

There are also a range of non-waterborne systems that use very little, or no water, to work. These include waterless toilets and urinals. An advantage of some of these systems, such as dry toilets or composting toilets, is that valuable fertilizer can also be produced, which can be used in agriculture.

4.3.2 Wash Hand Basins

Wash hand basin taps are sometimes left running by users, wasting water. Wastage can be minimised by reducing the flow rate of taps and these should not exceed 6 L/minute. In addition, press-button and sensor operation taps can be used to limit the duration of flows.

Warm water is not always necessary at wash hand basins. Where this is the case, a warm water connection should not be installed, as this results in additional and unnecessary loads on the hot water system, and water wastage.
4.3.3  Baths
Baths consume more water than showers and, therefore, water efficient showers should be installed in preference to baths.
If it is necessary to install a bath, a shower attachment should be provided so that showers can be taken as well.

4.3.4  Showers
The flow rates of shower heads should not exceed 10 L/minute. In addition, push-button type controls may be used to limit the duration of flows.

4.3.5  Grey Water
Grey water includes waste water from showers, wash hand basins, washing machines and laundries. Grey water systems reduce mains or borehole potable water consumption by reusing lower quality (grey) water.
Potential uses of grey water in housing include flushing toilets and irrigation.
Significant quantities of grey water can be sourced from showers, hand basins and laundry. However, it may not be worth capturing water from individual fittings, particularly, if these are widely dispersed.
Grey water pipes and usage points should be appropriately labelled to prevent unsafe consumption.
The grey water system specified should be easy and cost effective to maintain. Users and maintenance staff should understand how systems work and be able to maintain them.
Grey water systems are potentially hazardous to human health. In particular, grey water which is left to stand for over 36 hours, or is contaminated by food or similar waste, is considered black water and requires the same treatment as sewage. Therefore, grey water systems should only be designed, constructed and operated by trained competent people.

4.3.6  Black Water
Black water includes water from kitchens and toilets. The water can be treated and used for irrigation and the residual waste used as manure. The cost and space requirements of these system usually make them more applicable to larger housing schemes, neighbourhoods and commercial developments.

4.3.7  Rainwater Harvesting
Rain harvesting water systems capture and store rainwater from roofs, hard and soft landscape surfaces. This water is then available for consumption, washing, irrigation, flushing toilets or for other uses. Benefits of rainwater harvesting are reduced operational costs, reduced reliance on mains supply and reduced energy and carbon emissions associated with pumping water long distances.

> **Roof rainwater harvesting**: Rainwater from roofs is directed to tanks and stored. Usually a proportion of initial runoff is directed to waste as it may have picked up dust and other debris. This system is the most common and generally has the lowest cost as rainwater tanks can be installed above the ground surface.
» **Hard surface rainwater**: This system captures storm water runoff from hard surfaces such as game pitches, paths and car parking. This type of system generally requires some form of filtration to remove debris, and in the case of car parking, oil wastes. Tanks are usually subsurface.

» **Landscape surface runoff capture**: Surface runoff from soft landscaping can be captured and reused. Storage can be in the form of ponds or sub surface tanks. This is sometimes used as part of an onsite storm water retention strategy. The disadvantage of this system is that the resulting water quality can be poor as debris and silt may be picked up. The filtration and maintenance requirements may therefore be more stringent if the water is used for any other use than irrigation.

Rain water harvesting system design depends on factors such as the length of the dry season (period with no rain) and the extent to which housing will operate to be independent of mains water. Where housing is designed to be totally independent of a mains water supply and there is a long dry season (5 – 6 months), the size of rainwater tanks can be substantial as the capacity of this needs to be sufficient for water needs during the dry period. However, even where there is a municipal supply, relatively small rain water tanks which capture, and store, water for irrigation and flushing toilets can achieve substantial reductions in mains or borehole potable water consumption and significantly reduce related operational costs.

### 4.3.8 Irrigation

Irrigation can consume large amounts of mains or borehole potable water. Therefore, ornamental landscaping requiring extensive irrigation should be minimised. Planting locally indigenous species (species found in the local area) or low-water requirement species can be used to avoid, or minimize, irrigation requirements. Where irrigation is required, a high-efficiency system should be used. For example, drip irrigation linked to soil moisture probes can be used to minimize wastage. Mains or borehole potable water consumption can also be minimised through the use of grey water, rain water and treated black water for irrigation.
4.3.9 Ornamental Ponds and Swimming Pools

Ornamental ponds and swimming pools can use large amounts of water as this lost through evaporation or for backwashing filters. Therefore, if ponds and pools are not necessary, they should be avoided.

Where ponds or pools are installed, their surface areas should be as small as possible and a cover should be used to minimize losses through evaporation.

In addition, ornamental and swimming pools should be designed to be ‘topped up’ using rain water rather than mains or borehole potable water.

4.3.10 Storm Water Systems

Conventional storm water systems capture runoff from sites and direct this to municipal or other storm water systems. This results in storm water being lost from a site and a requirement for large-scale municipal storm water systems.

Storm water runoff from sites can be reduced through retention ponds, swales, soft and hard landscaping, permeable surfaces and other relevant technologies. This reduces the requirement for irrigation and municipal storm water infrastructure. These measures are described briefly below:

- **Retention ponds**: Storm water can be directed to retention ponds which store and manage storm water flows from site. Retention ponds can be attractive landscape features and used for rainwater harvesting. However, care should be taken to ensure that sufficient capacity is always available to accommodate peak storm water flows and that access is controlled to prevent ponds from becoming a drowning hazard.

- **Swales and soft landscaping**: Runoff can be directed to, and through, swales and soft landscaping on site to maximise the percolation of water into soil on site. This can be used as part of landscaping strategy and reduces irrigation requirements.

- **Permeable surfaces**: Avoiding hard surfaces and increasing permeable surfaces can be used to increase the extent to which runoff is absorbed on site. Where there are hard surfaces, such as roads, absorbent edges (for instance planted with grass) instead of kerbs can be used to reduce storm water runoff.

Housing development should draw on these techniques, sometimes referred to as sustainable urban drainage systems (SUDS), to retain storm water on site and reduce flows into municipal storm water systems.
WASTE

5.1 Objective

Housing minimises waste.

5.2 Introduction

Solid waste in housing is largely directed to landfill sites. Not only does this use up valuable land, but this can also lead to air, soil and water pollution. In addition, this waste also consists of valuable resources that could be easily reused and recycled. Recycling and reusing materials reduces energy and resource consumption and creates jobs and income.

Minimising, reusing and recycling of waste from housing includes the following benefits:

» Reduced loss of land to landfill.
» Reduced energy and resource consumption.
» Job and small enterprise creation.

5.3 Guiding Principles

5.3.1 Recycling Receptacles

Recycling can be encouraged by developing provisions that make it easy to undertake. These provisions include easy-to-use receptacles for capturing and storing different types of waste at the point at which the waste is generated. Providing space in the right locations so that waste can be easily stockpiled and collected by recyclers also supports recycling.

Appropriate waste receptacles should be located at the source of waste to ensure waste is not ‘spoilt’ and reduced in value by being mixed with other waste. For instance, clean waste paper can be spoilt if mixed with food waste.

In households, the recycling receptacles for the following waste is recommended:

» Organic waste
» Paper and cardboard
» Glass
» Plastic
» Tin
» Aluminium

These receptacles should be easily distinguishable from each other so that waste does not get mixed by accident.

It is usually most convenient to place recycling waste receptacles in, or near, the kitchen, so that recyclable material, such as tins and bottles, can be cleaned and placed directly in the receptacle. Organic waste should be removed every day and can be recycled through onsite or offsite composting, wormeries (where worms convert waste into fertilizer) and piggyries (where pigs convert waste into food).
5.3.2 Recycling Area

In individual smaller houses, recycled waste may be accumulated in a kitchen or storeroom before being taken to a recycling site. In larger houses, or collections of houses, a specific recycling area can be provided. This enables material to be sufficiently stockpiled to make collection and transportation of the waste by a recycler viable.

Recycling storage spaces should be located near roads so that these can be easily accessed by recyclers. Easy access for trolleys or vehicles from roads to the storage spaces should be provided. Local recyclers should be contacted and arrangements discussed during the design phase of the recycling area.

Provision in recycling areas should ensure that material can be stored neatly and is protected from weather and vermin.

Recycling should not include hazardous waste which should be disposed of in accordance with regulations and best practice standards.

5.3.3 Composting

Composting uses the decomposition process to turn organic matter into compost that can be used in gardens and agriculture. It reduces disposal costs of organic waste and avoids the negative impacts associated with artificial fertilizers.

Composting is easy to carry out and does not smell or need to be unsightly. Usually only about 2 to 4 m² area is required for a household and this can be located within a garden. Composting of food waste is best done by combining this with garden waste such as plant cuttings. Waste liquid, such as waste tea can also be used to promote decomposition by keeping organic matter moist.

5.3.4 Suppliers and Manufacturers

Engaging local suppliers and manufacturers, such as grocery shops, supermarkets, fast food outlets and component factories, can be used to reduce waste and transportation impacts. This is achieved by encouraging, or compelling, suppliers and manufacturers to reduce, and/or avoid packaging in non-reusable materials.

5.3.5 Construction Waste

Construction waste is a major contributor to landfill. Waste from construction can be reduced through building design and construction planning and monitoring processes. Construction waste can be minimized through designs based on product and material sizes to avoid cutting and waste off cuts and excess material. Examples include designing walls to align with brick or block sizes and avoiding diagonal tiling layouts which generate wastage.

Construction waste minimisation and recycling should be included as a specific requirement within tender and contract documents. The contractor and/or the developer should be asked to develop a construction waste management plan which minimises waste. This plan should include specific construction waste management targets. For example, this could require that 50% of all waste generated on site must be recycled. The plan should identify parties responsible for implementing the plan and ensure that appropriate monitoring and evaluation systems are in place for targets to be achieved.
MATERIALS

6.1 Objective

Housing minimizes the negative impacts of construction materials and products.

6.2 Introduction

Materials may be extracted, processed, manufactured and transported before being incorporated in housing. Significant negative environmental impacts such as waste, pollution, carbon emissions are linked with these stages. However, these stages also create positive impacts, such as employment. The type and extent of negative and positive impacts varies widely between materials and products. Therefore, selection of materials and products is important.

Careful selection of construction materials used in housing can include the following benefits:

» Reduced land use impacts associated with activities such as mining and deforestation.
» Reduced health impacts from manufacturing.
» Reduced transportation impacts.
» Reduced material use.
» Increased local employment.
» Increased use of local sustainable materials.

6.3 Guiding Principles

6.3.1 Building Reuse

Using existing buildings instead of constructing new ones minimizes the requirement for construction materials and, therefore, reduces the impacts associated with extraction, manufacture and transportation of materials.

In addition, existing buildings are usually part of the urban fabric and in areas already serviced with electricity, water, roads and public transport. Increasing the intensity of use of this fabric improves its efficiency and avoids the requirement to replicate services elsewhere. Therefore, in most circumstances it is preferable to reuse and refurbish existing buildings rather than building new ones. This can be supported by identifying existing buildings that can be used, or continue to be used, and, if necessary, refurbishing them.

6.3.2 Contribution to Global Warming

Construction materials can contribute to global warming through carbon emissions associated with energy used in their extraction, processing and transportation. In addition, materials such as refrigerants can contribute directly to global warming if they are released, or leaked, into the atmosphere.

To minimize carbon emission associated with materials, construction materials with low embodied energy, such as timber from local sustainable sources or locally made compressed earth blocks, should be specified. Where high-embodied energy materials, such as cement and aluminium are used, the quantities of these materials should be minimised. Specifying locally manufactured products or locally sourced materials rather than imported materials and products also reduces impacts related to transportation.
The use of refrigerants should be avoided. Where these must be used, for instance in HVAC systems, cold rooms or in fire-suppression systems, refrigerants which have no, or low, global warming potential (GWP) and ozone depleting potential (ODP) impacts, should be selected.

There are a number of guides on sustainable materials and construction that can be consulted to develop low embodied energy, local solutions such as ‘Going Green: A Handbook of Sustainable Housing Practices’ (UN-Habitat, 2012).

6.3.3 Reused Materials or Materials with Recycled Content

Construction materials that are reused, or have recycled content, have less energy associated with their manufacture than equivalent new materials. It is, therefore, preferable to reuse materials or to select materials with recycled content.

A range of materials and components from buildings that are being demolished can usually be reused. This includes structural steel elements, facades, demountable structures such as carports, as well as building components such as windows and doors. Crushed concrete from demolished structures can also be used as aggregate in new construction.

Materials with recycled content should be selected in preference to materials without any recycled content. Recycled content should be confirmed in writing by suppliers and manufacturers. Steel, for example, can be specified to include recycled content.

6.3.4 Reduced Material Use

The quantity of construction materials used in facilities can be reduced by avoiding their unnecessary use or using them prudently and reusing them for different purpose.

There are a range of opportunities that can be used to reduce material use in buildings. For instance, ceilings and plaster finishes can be avoided through better concrete finishes. Improved floor finishes can be used to avoid the requirement for carpets and tiling. The use of passive systems can be used to reduce the requirement for ducting and plant associated with mechanical ventilation, heating and cooling.

Dual use of materials and products can also enable reduced material use. For instance, photovoltaic panels may be used both as a roofing material for carports and to generate energy.

6.3.5 Renewable Sources

Materials can be defined in terms of whether they are from renewable or non-renewable sources. Materials from renewable sources include timber, thatch, cork, and wool that are farmed on a sustainable basis and, therefore, can be harvested in an ongoing manner. Other materials such as plastics and metals are manufactured from materials that are mined and, therefore, once these sources are depleted, will not be available.

Where possible, materials from renewable sources should be specified. For example, timber, and plant-based products can be used in many applications in preference to materials that have to be mined and processed. Examples include roof trusses, staircases, doors, windows and furniture that can be easily made of timber.

Materials from renewable sources mean that these are grown and harvested in a sustainable manner. This can be established through written confirmation from suppliers and independent certification. For instance, a Forest Stewardship Council (FSC) or an Eco Mark Africa (EMA) certificate can be used to establish whether timber is from a sustainable source.
BIODIVERSITY

7.1 Objective

Housing supports biodiversity

7.2 Introduction

Biodiversity is a measure of the variety of organisms present in an ecosystem. Biodiversity plays a very important role for man through provision of ecosystem services. Ecosystem services include the production of food and water, the control of climate and disease, support for nutrient cycles, crop pollination, spiritual and recreational benefits.

New housing can minimize negative impacts on biodiversity by avoiding green field sites and building outside urban boundaries. Housing can enhance biodiversity through careful site location, planning and landscaping strategies.

Sustainable housing that takes into account biodiversity has a wide range of benefits including:

- Maintaining local ecosystem services.
- Providing natural amenities such as gardens and parks which support health and well being.
- Providing land for the growth of organic fresh healthy fruit and vegetables.

7.3 Guiding Principles

7.3.1 Site Location

Biodiversity is being lost at a rapid rate through urban sprawl. Preserving existing biodiversity can be achieved by building on brown field (already built-on) sites in preference to green field sites.

Housing should also be located within urban boundaries in order to avoid using land that is, or could be, used for agriculture or left in a natural state, supporting biodiversity and ecosystem services.

Sites can be classified in terms of ecological value. Ecological value refers to the extent to which biodiversity exists on site and whether this has been disturbed by human activity. Sites with low ecological value should be built on in preference to sites with high ecological value. Where sites with high ecological value are used, designs should ensure that this is preserved, and enhanced.

7.3.2 Site Layouts

Site layouts should preserve existing valuable trees, planting and ecosystems as far as possible. These may have taken many years to establish and can greatly enhance housing by providing attractive natural environments as well as providing valuable ecosystem services such as storm water management. Where natural areas and trees are being maintained specific measures should be put in place during construction to ensure that these are protected.
7.3.3 Ecological Value

Vegetation can be classified in terms of ecological value. Ecological value refers to the extent to which biodiversity exists on site and whether this has been disturbed by human activity. Sites with low ecological value should be built on in preference to sites with high ecological value. Where sites with high ecological value are used, designs should ensure that this is preserved, and enhanced.

7.3.4 Vegetation

New housing should aim to increase the amount of vegetation on a site from an existing situation. Green roofs, planted terraces and balcony gardens as well as vertical vegetation such as creepers can be used to replace vegetation lost during construction.

Planting should be of locally indigenous, or low water requirement, species. Where irrigation is required this should be sourced from rainwater harvesting or grey water systems. Similarly, fertility should be provided as far as possible from local natural sources such as onsite composting, rather than using artificial fertilizer.

7.3.5 Functional Planting

The concept of functional planting can be used to support biodiversity and provide a clear demonstration of its value. Examples of functional planting are provided below:

» Woodlots can provide renewable biomass that can be used as fuel in housing for cooking, space heating and for heating water in housing.

» Orchards can provide fruit which can be harvested and sold or consumed by households. Bees can also be kept in orchards and the honey harvested.

» Food gardens can provide fresh vegetables throughout the year which can be consumed or sold.

» Large trees and pergolas with creepers can provide shading and reduce capital costs associated with external shelters such as car ports. (see Picture 2, page 32)

» Vegetation can also be planted to manage storm water runoff and reduce erosion. The resulting retained moisture can also play a valuable environmental control role through evaporative cooling.
7.3.6 Design for biodiversity

Biodiversity can be enhanced by understanding how ecosystems can be created and supported. Studies of existing local natural ecosystems can be used to provide an insight into appropriate planting and animal life combinations in order to develop flourishing and resilient biodiversity. In addition, an understanding of natural farming systems is useful. This refers to systems of agriculture which mimic natural systems to increase biodiversity and avoid the requirement for artificial inputs.

Biodiversity can also be supported through site layouts and landscaping that retains and enhances existing biodiversity. On sites of high ecological value, surveys should be carried out to ensure that development is based on an understanding of existing biodiversity and enhances this.

Where possible, designs should link new planting with areas of existing vegetation within and around the site in order to provide larger continuous vegetated areas which support the creation of habitats and genetic diversity. Where boundaries are required, suitable fencing material and openings should be incorporated to provide ‘wildlife corridors’ between these areas.

During construction, this can be achieved through protection measures incorporated in construction documentation. For example, a contractor can be required through the approved architectural designs to fence off and protect particular trees and vegetation.
TRANSPORT

8.1 Objective

Housing minimises the negative transport impacts through environmentally friendly technologies and practices.

8.2 Introduction

Housing should be located and designed in such way that its supports cycling, walking and energy efficient public transportation to avoid negative impacts. These negative impacts include health problems, such as obesity associated with a lack of exercise, carbon emissions and traffic congestion from vehicular traffic. In addition, transportation costs can consume a large proportion of household incomes that would be better allocated to education, health and nutrition.

Ensuring that housing supports walking, cycling and energy efficient transportation has a wide range of benefits including:

» Reduced air pollution and noise from vehicles.
» Health benefits from increased opportunities for exercise.
» More affordable mobility.
» Reduced space requirements as a result of reduced parking and road requirements.

8.3 Guiding Principles

Transportation is important in housing as large numbers of people need access to work, education and shops on a daily basis. The right location and provision of transport-related facilities helps to ensure that negative transport impacts are minimised and potential health benefits associated with exercise are supported.

8.3.1 Location

The selection of a site is an important aspect of sustainability performance. Housing located within walking distance of key facilities and public transport will reduce the requirement for cars. Reducing the use of cars in preference to walking or cycling enables very significant reduction in energy use and carbon emissions as indicated in Table 6.
Table 6: Energy equivalents of different modes of transport

<table>
<thead>
<tr>
<th>Type of transport</th>
<th>Litres of fuel, or energy equivalent, consumed per person to travel 100 km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car (single occupant)</td>
<td>9.00</td>
</tr>
<tr>
<td>Car (2 occupants)</td>
<td>4.50</td>
</tr>
<tr>
<td>Taxi (12 passengers)</td>
<td>1.00</td>
</tr>
<tr>
<td>Bus</td>
<td>0.70</td>
</tr>
<tr>
<td>Train</td>
<td>0.50</td>
</tr>
<tr>
<td>Walking</td>
<td>1.00</td>
</tr>
<tr>
<td>Cycling</td>
<td>0.36</td>
</tr>
</tbody>
</table>

Source: Gibberd, 2008

8.3.2 Access

Locating housing near employment, education, health and recreation facilities, shops, banking, post offices, telecommunications, business and government services enables households to access these by walking, or cycling, reducing the need for cars.

This type of access has many benefits. Households can avoid the expense of a car and public transport. Walking and cycling improves health and fitness in adults and children. Less time is spent commuting, enabling more time to be spent on family life, sport and education. Traffic congestion and accidents can be avoided or reduced. This type of access is, therefore, very valuable in contributing to more sustainable built environments. It has therefore been integrated in other areas of this document such as Education and Health.

8.3.3 Access to Public Transport

Locating housing near public transport facilities encourages people to use these in preference to personal vehicles. (see Figure 1, page 15)

Housing should be located near good public transport nodes, including bus, train and bus rapid transport systems (BRT). Walking distances between public transport nodes and housing should not be over 2 km and ideally should be less than 400 m but will be dependent on the form of public transport. Safe, direct and easy-to-use walking routes between public transport nodes and housing should be developed. Route design and management should be in line with best practice standards, particularly in relation to disabled access and environmental safety (see Inclusion, page 54).

8.3.4 Provision for Walking

Walking can be encouraged through safe, direct and easy-to-use routes. Permeable urban fabric and housing layouts which include shaded paths away from moving traffic between well used areas and important points can be used to create pleasant walking routes (picture 3, page 36). Safe pedestrian provision includes safe road crossings such as clearly demarcated zebra crossings (see picture 4, page 36). It also includes appropriate finishes, visual supervision by surrounding facilities, lighting and provision in line with best practice for people with disabilities and environmental safety.
Picture 3: Safe pedestrian walkway on Chilimbulu Road near Libala Secondary School, Lusaka

Picture 4: Clearly marked zebra crossing on Chilimbulu Road near Libala Secondary School, Lusaka
8.3.5 Provision for Non-Motorised Transport

Provision for cycling, such as safe parking areas and designated, safe routes encourage cycling as an alternative to the use of motorised vehicles. Apart from environmental benefits, cycling has environmental, health and productivity benefits.

Secure cycle storage should be provided undercover within housing and at local social facilities. In particular, provision should be made at schools, hospitals and shopping areas.

The use of cargo bikes or hand-pushed trolleys should be considered for moving goods in preference to using motorised vehicles. This can be supported by providing routes that are appropriately designed and managed. This includes ensuring that the width of routes, changes in levels, surfaces, lighting levels and signage support cargo bikes and trolleys.

Safe provision for cycling routes around the site should be provided. This includes ensuring that crossing points, lighting, signage and surface finishes are in line with best practice.

*Picture 5. Road in Kalumbila with provision for cycling (Picture courtesy of Kalumbila Town Development Corporation - KTDC)*
Figure 4: Layout of Kalumbila Township showing location of housing with convenient location of main transport routes, shopping and social facilities
RESOURCE USE

9.1 Objective

Housing makes efficient use of resources.

9.2 Introduction

There are limited resources in the form of land, finance and raw materials to construct and maintain buildings. It is, therefore, important to use resources carefully. Benefits associated with careful resource use include:

» Avoiding wastage by ensuring effective and efficient use of resources.
» Ensuring that resources are available for other uses where these are required.

Housing uses financial, material, energy and land resources for construction and maintenance. Careful use of these resources reduces wastage and increases the availability of resources for other purposes.

9.3 Guiding Principles

9.3.1 Strategic Planning

Strategic plans for housing should be developed that take into account future development. This helps ensure that change can be accommodated and that housing can be designed to become more effective and efficient over time, instead of being developed in an ad-hoc way that can lead to inefficiency and wastage.

The potential for sharing services and facilities with neighbouring land owners and sites should be explored. For instance, parking requirements can be reduced where this is shared between two or more facilities, particularly where operational schedules differ. Similarly, sustainable urban drainage systems, ecological sanitation, social facilities, recycling schemes and renewable energy systems can become more viable when costs are shared between larger numbers of users.

9.3.2 Housing Density

There are a range of benefits associated with increased housing density. These include:

» Support for walking and cycling
» Increased efficiency in the provision of services such as energy, water and sanitation
» Increased efficiency in the provision of public transport
» Increased support for small business development and employment as these have a local ready market for goods and services.

Densities can be measured in dwelling units per hectare or persons per hectare. Low cost, medium and high cost housing has been analysed in terms of plot sizes to calculate minimum and maximum resulting densities. This is indicated in Table 7.
Table 7: Densities for low, medium and high cost housing (Ministry of Local Government (MGL) Standards)

<table>
<thead>
<tr>
<th></th>
<th>Average number of people per unit</th>
<th>Plot size m² (min)</th>
<th>Plot size m² (max)</th>
<th>Plots per hectare (min)</th>
<th>Plots per hectare (max)</th>
<th>Persons per hectare</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Density (Low Cost)</td>
<td>12 x 27m</td>
<td>5.00</td>
<td>324</td>
<td>539</td>
<td>31</td>
<td>19</td>
</tr>
<tr>
<td>Medium Density (Medium Cost)</td>
<td>18 x 30m</td>
<td>5.00</td>
<td>540</td>
<td>1349</td>
<td>19</td>
<td>7.5</td>
</tr>
<tr>
<td>Low Density (High Cost)</td>
<td>30 x 45m</td>
<td>5.00</td>
<td>1350</td>
<td>1350</td>
<td>7.5</td>
<td>7.5</td>
</tr>
</tbody>
</table>

UN Habitat indicate that minimum densities of 150 people/ha are required for sustainable neighbourhoods. Table 7, indicates that where individual plots are large, developed for single units only or where there is an inappropriate distribution between high density and low density housing it is difficult to achieve the recommended density standard.

If towns and urban areas fail to achieve the minimum standard of 150 people/ha it is difficult to create sustainable built environments as accessible local facilities and public transport are less feasible. National and local planning policies should actively promote higher density development subject to the protection of public amenity and health, and, particularly, the provision of effective sanitation.

9.3.3 Food Production

Food production in the form of orchards or vegetable gardens are a productive use of land that leads to both environmental and health benefits. Available land in housing plots should, therefore, be used for food production. Resulting fresh produce can be used to supplement diets of housing occupants and the local community, supporting improved health.

Appropriate provision in the form of irrigation, fencing, organisational and capacity requirements should be established to ensure that food production is effective and sustained. The cost of irrigation systems and water can be reduced by linking gardens to rainwater harvesting, storm water management and grey water systems.
9.3.4 Renewable Energy Generation

Renewable energy generation is a productive use of available space within housing developments. Advantages of locating renewable energy within housing is that occupants can manage and maintain their energy source, have some control over costs, and can reduce their reliance on fossil fuels.

Examples of how renewable energy generation can be integrated in housing are outlined below. Solar water heaters can be located on roofs of housing. Photovoltaic panels can be located on roofs of housing as well as community buildings and outbuildings such as equipment stores and carports. Wind turbines (where there is sufficient wind) can be located in elevated open locations within housing developments. Biogas plants can be located where there is a reliable, appropriate and sufficient supply of organic material and a productive use for gas within housing. Woodlots can also be located within housing developments to provide biomass for cooking, space heating and heating water (also see Energy, page 11).
MANAGEMENT

10.1 Objective

Housing is managed to support sustainability.

10.2 Introduction

Systems and capacity in housing can be developed to support the effective and efficient management. For instance, technology and training can be used to ensure that energy and water consumption in housing are managed and reduced. Some of the benefits of effective and efficient management of housing are as follows:

» Ensuring that operating costs are controlled and reduced.
» Minimising disruption as result of maintenance and repairs.
» Ensuring that maintenance is planned for and carried out.

10.3 Guiding Principles

10.3.1 Energy and Water Metering

Energy and water metering enables home owners and estate managers to manage the consumption of energy and water in housing and reduce costs associated with these services.

Energy meters should be installed in each unit. Meters selected may allow remote monitoring or be manually read. Where meters are manually read, they should be located where they can be easily accessed and read by the homeowner. Where remote monitoring is carried out homeowners should be given access to the data and be trained in how to use this to manage energy.

In housing estates, energy consumption related to functions such as street lighting and pumps should also be sub-metered and monitored by estate managers in order to reduce energy consumption.

Water meters should be installed in each unit. Meters may allow remote monitoring or be manually read. Where meters are manually read, they should be located where they can be easily accessed and read by the homeowner. Where remote monitoring is carried out homeowners should be given access to the data and be trained in how to use this to manage energy.

In housing estates, water consumption related to functions such as irrigation should also be sub-metered and monitored by estate managers in order to reduce water consumption. Water leak detection systems should also be specified for large water installations.

Water and energy consumption should be monitored and reviewed on a monthly basis by households. Simple graphs of consumption can be developed by hand or by computer and posted on a pin board to ensure that occupants are aware of consumption and manage this.

Water and energy consumption should be monitored and reported monthly by estate managers. Reports should be circulated to key role-players, including home owner associations and nominated senior managers. Quarterly reviews should be held to ensure performance is improved over time.
10.3.2 House Manual

A house manual provides technical detail on a building’s systems and how maintenance and management should be carried out.

House manuals should include a detailed schedule and procedures for carrying out building maintenance. It should also include protocols for checking and tuning equipment, lighting and plumbing systems to ensure this is functioning optimally. Checks should include aspects such as ensuring lamps, light fittings and solar water heater collectors are kept clean. Tuning checks should ensure that settings on dual flush Water Closets (WCs) and motion sensor lighting are set for optimum performance.

As-built drawings and equipment manuals should be included in house manuals. Both hard copies and electronic copies of as-built drawings and manuals should be provided so that these can be stored, updated and transmitted electronically.

House management manuals should include a recommended list of spares and replacement parts. This helps ensure that appropriate parts, such energy efficient lamps, are kept in the house and are used, instead of inappropriate inefficient lamps which may be the only type available in a local shop.

The layout of house manuals should be simple and very easy to use. Complex documents with technical language should be avoided. Photographs of actual equipment installed and diagrams should be used. Manuals should include:

- A glossary
- Descriptions of energy, water, sanitation, and waste systems, irrigation and landscaping (if included) systems in housing and appropriate management and maintenance procedures to ensure optimal performance.
- Local resources which support more sustainable living such as public transport nodes, recycling depots, retailers that provide local products and local sources of fresh produce.
- References to further resources and guidance.

10.3.3 Occupation Induction

Occupant induction programmes are used to introduce new occupants to buildings and building systems in order to ensure that they understand how these work and are able to support their efficient functioning. This enables occupants to understand, for instance, how renewable energy, energy management, water and recycling systems work and can be operated optimally. These programmes should be run for new occupants of housing to ensure that systems are managed, and used, to support sustainability.
11

LOCAL ECONOMY

11.1 Objective

Housing supports the local economy.

11.2 Introduction

The construction of housing is a significant investment in an area. This investment, if considered carefully, can be used to support the local economy and create employment. This is done by specifying products and services from the local area and providing ongoing employment in relation to maintenance and other services required within housing.

Ensuring that housing supports the local economy has a wide range of benefits, including:

» Increased local employment.

» A diversified local economic base.

» Increased local capacity for new construction and maintenance of housing.

11.3 Guiding Principles

11.3.1 Small Enterprise Support

Supporting and developing local small enterprises enhances sustainability by creating jobs and a diversified local economy. It can also enable services, products and maintenance required in housing to be delivered more efficiently and rapidly.

Small local enterprises should, therefore, be provided with opportunities to tender for relevant construction and maintenance contracts.

Where local small enterprises have limited capacity and experience, support should be provided through skills training. This may include encouraging small enterprises to work with each other, or to collaborate with more established, larger enterprises.

11.3.2 Material and Component Procurement

The specification of local materials and components in housing developments can provide a strong incentive to local suppliers and manufacturer to develop and supply appropriate products and capacity. This in turn provides local employment and can ensure products and parts installed in buildings are locally available for maintenance and repairs.

A review of local materials and components should be carried out to establish the nature, capacity and suitability of local products. Where production capacity is adequate and the quality and performance of materials and products is suitable, preference for local products should be made.

11.3.3 Construction Employment

The construction industry employs significant numbers of people. This can be enhanced through designs, specifications and construction techniques which support labour-intensive processes. If considered carefully, this does not need to lead to additional costs or longer construction timeframes. Local construction employment improves the local economic impact of projects and ensures that there is local capacity to undertake repairs and maintenance of facilities, at their completion.
Construction employment should be a consideration in the design, specification and construction of a facility. Targets for construction employment (i.e. x person years of employment per K 1 million construction budgets) should be set and included in tendering requirements. Monitoring processes should be in place to ensure targets are achieved.

Local maintenance and management capacity should be developed during construction in order for this to be available for the housing on completion. Local people and small enterprises who have experience and skills as a result of working, or training, on housing should be engaged to undertake ongoing maintenance work. Additional training should be provided, if this is required.
12.1 Objective

Housing supports sustainable products and services.

12.2 Introduction

In everyday life a wide range of products and services are used. Specifying more sustainable products and services can be used to address climate change and support local sustainable development. Within households, products such as food and drink are consumed on a daily basis, and it is therefore important to understand how the consumption of these items can be influenced to support sustainability. The use of sustainable products and services in housing has the following benefits:

» Increased local employment.

» A diversified local economic base.

12.3 Guiding Principles

12.3.1 Local Produce

Impacts associated with transport, storage and refrigeration mean that produce supplied from distant places has a significantly higher ecological footprint than local produce. Households can therefore reduce ecological footprints associated with food by buying local produce where this is available.

Local produce can be supported by ensuring that local retailers and markets stock locally produced food such as vegetables and fruits.

12.3.2 Vegetarian Options

Meat-based meals have significantly higher ecological footprint impacts compared to vegetarian meals. Providing vegetarian options can therefore support food-related impacts within housing. Indigenous knowledge is often a very useful resource for identifying local vegetarian dishes that are particularly suitable for a local area.

Local retailers and markets should stock ingredients required for vegetarian meals. This includes fruit, vegetables, pulses and relevant flavouring.

Local restaurants, fast food outlets and food stalls should include vegetarian options within their menus.

12.3.3 Drinking Water

Water is very important for health and body temperature regulation. With the possibility of increasing temperatures as a result of global warming, it will be increasingly important to have safe and free drinking water available. Water fountains or taps provide a low cost, low waste, healthy alternative to bottled drinking water or carbonated drinks.

Housing should have external taps to enable people and children working and playing outside to have easy access to drinking water.

Within a house, access to drinking water should be easy, by providing taps in bathrooms and kitchens or by providing water containers.
Community facilities such as clinics and schools located within housing should provide ready access to safe drinking water. Care should be taken to ensure that sufficient water points are provided and that water can be easily and safely accessed by everyone including children, the elderly, and people with disabilities.

12.3.4 Reusable Vessels

Significant waste streams can be avoided through the use of reusable vessels. In particular, disposable food and drink vessels can be eliminated by providing reusable vessels.

Local retailers should be encouraged to provide goods in reusable vessels in preference to disposable containers. This can be easily achieved in a number of ways. For instance, milk and other drinks can be supplied in reusable glass, metal or plastic containers that are washed and reused. Dried pulses and other staples can be provided in reusable locally made baskets and other containers. Similarly, fresh vegetables and fruit can be transported and stored in locally made reusable containers or other materials.

Provision for reusable vessels, such as storage space and washing facilities, should be in place to ensure that these can be used easily and safely in housing.
ACCESS

13.1 Objective

Housing that supports access to facilities required for everyday life.

13.2 Introduction

Current work patterns and lifestyles mean that people have to access banking, retail, childcare and communications on a regular or daily basis. Ensuring that these services are available within housing or easy walking distance helps to avoid wasting time, cost and transport impacts.

The provision of essential services within housing has the following benefits:

- Reduced transport impacts.
- Reduced time and costs spent travelling to and from facilities.
- Reduced time waiting at facilities

13.3 Guiding Principles

13.3.1 Banking

Banking services should be readily accessible to users and occupants of housing. Housing developments should consider how this will be achieved and engage with banking service providers to develop local and appropriate services.

Access to banking services may be provided through formal banking facilities such as bank tellers, Points of Sale (POS) and ATMs as well as through internet banking or through bank ATMs. Alternative banking solutions, such as cell phone banking, mobile banks, ATMs within retail outlets and ‘cash-back’ options within grocery stores should also be explored, as these may enable banking services to be provided more efficiently and at lower cost compared to conventional solutions.

13.3.2 Grocery Retail

Grocery retail can be provided through local shops, supermarkets and markets. As grocery retail is required on a regular basis, easy access to this service should be integrated into housing.

There should be a hierarchy of outlets to ensure that retail businesses are both viable and their products are readily accessible. Goods purchased on a regular occurrence by households such as fruits, vegetables and milk should be within 500 m walking distance of housing. Goods such as washing powder, which is bought on a weekly or monthly occurrence, can be at more distant, larger retail units within 2 km of housing. Routes to these outlets should be along safe smooth paths suitable for walking and for wheeled traffic, such as trolleys, which may be used to transport goods.

13.3.3 Communication

Access to communication has become a requirement for modern life and should be considered in housing. In particular, access to telephone, postal services and the internet should be addressed. Where these services are not accessible within housing, access to these services should be within 2 km.
Increasingly mobile telephones are replacing landlines. Mobile telephone services require regular monthly or ‘pay-as-you-go’ payments. Housing can ensure that that local affordable access to mobile communications is provided by creating opportunities for service providers of the technology and mobile telephone services. This can be provided through local retail units.

Direct access to the internet can be provided in housing through, for instance, ADSL lines. Alternatively, access can be provided through local Wi-Fi networks and services within local community facilities such as schools and community services. In addition, internet café can be encouraged to provide facilities within, or close to, housing.

13.3.4 Restaurants, Cafés and Food Stalls

Access to restaurants, cafés and food stalls should be considered in housing designs and access to these facilities should be within 2 km.

These facilities also provide opportunities for local entrepreneurs to prepare and sell food. They are also potential buyers of local products such as vegetables, fruit, bread and pastries.

13.3.5 Childcare

Childcare and after school care for children should be considered in housing design and be located within 500 metres of housing.

As small children cannot walk far and some may be carried or pushed in push-chairs it is particularly important that routes between housing and child care facilities are safe and easy to use.

13.3.6 Employment

The location of employment opportunities for housing occupants should be considered in housing location. Work opportunities should be located within 2 km of housing so they can be accessed easily by walking or cycling. Care must however be taken not to locate hazardous and conflicting land uses within housing.

13.3.7 Rural Areas

In rural areas many facilities and services, such as schools, clinics, post offices, government services and shops may be over 2 km from housing. Safe, easy to use walking and cycling routes are particularly important in such areas. Efficient bicycles and safe smooth cycling paths can greatly reduce the time and effort taken to access distant facilities. Measures that can be used to support sustainable access in rural areas include subsidies for bicycles, oversized hard shoulders on roads which can be used for safe cycling and local construction and maintenance contracts to develop and maintain cycling routes.
HEALTH

14.1 Objective

Housing supports health and productivity.

14.2 Introduction

The World Health Organization indicates that environmental risk factors play a role in 80% of regularly reported diseases (Prüss-Ustün and Corvalán, 2013). Housing can promote health through beneficial environmental conditions including a plentiful supply of fresh air, water, views and optimum thermal conditions. Ensuring that housing supports health in users and construction workers has a wide range of benefits, including:

» Improved productivity.
» Reduced absenteeism associated with environmental conditions.
» Reduce ill health and injury and therefore a reduced requirement for medical care and associated costs and impacts.

14.3 Guiding Principles

14.3.1 External Views

Adequately oriented views and a connection to the external environment improve internal environmental conditions and health.

Living spaces in housing should have views. Layouts should avoid overlooking and associated privacy issues to ensure curtains or blinds are not used on a continuous basis thereby reducing day lighting in housing.

Windows should be located where they will provide a view from regularly used locations within housing. For instance, windows can be located to provide a view from seating locations within a living, dining, study and home office and from standing working locations in a kitchen or workshop.

14.3.2 Daylight

Day lighting has health and energy consumption advantages. Day lighting improves indoor environmental quality and reduces energy required for artificial lighting.

Good day lighting into housing should therefore be achieved through housing layout, window design and interior and exterior material specifications (see Energy, page 11).

14.3.3 Ventilation and Indoor Air Quality

High levels of fresh air are important for human health and productivity. In housing this should be provided through natural ventilation.

Natural ventilation is achieved by ensuring that there openings in the right locations and of sufficient size between occupied spaces and external environments. An opening area of at least 10% of the occupied floor area is recommended.

Openings should be located to ensure that fresh external air is directed to the breathing zones of occupants. Therefore, this should be between 1 to 2 m zone above finished floor level in spaces where people are standing and to a zone of 0.5 to 2 m in spaces where people are sitting.
It is particularly important to provide good ventilation to kitchen, bathrooms and laundry spaces. In kitchens, good ventilation is required to vent out heat and smells and required in bathrooms and laundry spaces to reduce humidity and the possibility of mould.

Controls for openings should be easy to operate by all occupants including older people and differently abled people.

14.3.4 Building Materials

Building materials can have negative impacts for human health associated with their extraction and manufacture. They can also affect the health of occupants within buildings.

Construction materials should therefore be screened to avoid products being used in housing that have negative impacts on human health.

Building materials that emit gas substances such as formaldehyde and volatile organic compounds within buildings that are harmful to human health, should be avoided. In particular, paints, varnishes and wood based particle boards should be screened for these types of chemicals.

14.3.5 Construction Worker Health and Safety

There are significant health and safety risks in the construction industry. Considering health and safety in the design of housing reduces health and safety risks associated with construction and maintenance.

Contractor health and safety should be considered as a key issue in the design of the building. Appropriate design risk assessments and mitigation measures should be undertaken to ensure construction risks are minimized. For instance, avoiding high level glass or lighting, reduces risks involved in installation, cleaning and maintenance.

Construction planning, procedures and processes should consider health and safety as a key issue and ensure that risks are minimized during construction. By addressing health and safety in contracts and construction planning, procedures and processes can be used to eliminate many construction health and safety risks.

14.3.6 Health Facilities

Local clinics can play a useful role in improving health by promoting health awareness and education. In addition, by addressing minor ailments and injuries, clinics avoid these becoming aggravated and reduce the negative impacts associated with serious illnesses, such as hospital treatment and absenteeism.

Healthcare facilities such as clinics should therefore be located within 2 km of housing.

14.3.7 Local Parks, Sports and Recreation Facilities

A network of local parks, sports and recreation facilities can be used to encourage walking and cycling and provide for sports, exercise, games, playing and social interaction. A hierarchy in the size and type of park and facilities can be used to ensure a range of amenities are available which cater for all age groups and differently abled people.

Local parks with play areas and some provision for exercise such as volley ball court should be located within 500 m of housing.

Larger and more specialist facilities such as tennis courts, football fields, netball courts should be located within 2 km of housing.

Safe pedestrian and cycle paths to local parks from housing should be provided to enable children, mothers with prams, differently abled people and older people to access these easily (see Transport, page 34).
EDUCATION

15.1 Objective

Housing supports education.

15.2 Introduction

Education and on-going learning is an essential component of sustainable development and a competitive economy. Estimates indicate that a 1% increase in training days leads to a 3% increase in productivity in a working population (ILO, 2010). Education and ongoing learning can be supported through the provision of local education establishments and technology in housing.

The provision of education and awareness services in housing includes the following benefits:

» Improved education levels and therefore likelihood of employment and ability to succeed in entrepreneurial activities.

» Increased health awareness and knowledge and therefore reduced disease and ill-health.

» More competitive and responsive economies based on an educated work force.

15.3 Guiding Principles

15.3.1 Contractor Education

There is considerable scope to improve education and skills levels within the construction industry. This can be supported through careful planning and skills development programmes during the construction of housing.

Skills targets can be determined, and set, as part of a construction tender programme. These should relate to skills needs and opportunities within the local area and within the industry.

Contractors can be requested to develop a skills development plan and engage local training providers. Valuable practical training can then be carried out as part of the construction of housing and recognition through certification provided. This ensures that construction workers can progress their careers and it also increases capacity within the industry.

Contractors can also be requested to develop mentoring programmes, in which more experienced workers mentor inexperienced workers. This type of provision can be invaluable as it ensures the learning and practice of skills which are not always provided in theoretical training.

15.3.2 Notice Boards

Awareness can be used to guide decision making and behaviour by occupants within housing to promote sustainability. This can be supported through media such as the internet, print media and the radio. Notice boards also provide a very simple and inexpensive means of improving awareness.

Notice boards can be located on main thoroughfares within housing or at entrance and exit points. They should be designed so that they can be easily read by the main form of passing traffic whether this is walking, cycling or vehicular.
Notice boards can be used to promote sustainability by providing information such as energy, water consumption and waste production within the local area. They can also increase awareness of environmental issues such as recycling initiatives and promote health through promoting exercise events such as walks and runs in the local area. In addition, local education and work opportunities can also be publicised through notice boards. The common language within the housing area must be used in addition to the official language.

15.3.3 Schools

Education facilities such as primary and secondary schools should be considered in housing design. Primary schools should be located within 500m from housing and secondary schools within 2km. All routes between housing and education facilities should be safe and easy-to-use.

15.3.4 Adult and On-going Learning Facilities

There is an increasing requirement for ongoing learning within the workforce. In addition, many adults may want to improve skills and qualifications. This can be supported through formal adult education institutions and programmes in local community or private facilities.

Housing should ensure there is support for adult and ongoing learning. This can be provided through programmes that run after-hours at local schools or can be accommodated in specifically designed facilities.

15.3.5 Spaces for Learning

Learning will increasingly become a part of everyday life for everyone. This may include school children doing homework, youths doing correspondence courses and adults working on vocational courses and Continuous Professional Development (CPD).

The design of housing should acknowledge the requirement to support learning by making provision for this. This should include sufficient space for a work surface, storage and good lighting. Access to electrical sockets and internet connections should also be provided as information and communication technology is likely to be a key resource for learning in the future.
INCLUSION

16.1 Objective
Housing that is inclusive in diversity in population.

16.2 Introduction
Design for inclusion helps to ensure that housing can be used by all users including older people, sick people, and people with children and differently abled people. Inclusive design also often means that buildings are safer and easier to use. Ensuring that housing is inclusive has a wide range of benefits including:

» Housing that is easier and safer to use.
» More flexible and adaptable accommodation options.
» Increased support for extended families.

16.3 Guiding Principles

16.3.1 Environmental Access
Housing location, design and management should support environmental access and ensure that housing is inclusive. This requires a comprehensive approach that ensures that access considerations are effectively integrated into all aspects of the housing including physical access, signage and housing estate management training.

16.3.2 Routes
Pedestrian and cycling routes should be designed and constructed to be easy and safe to use by older people, children, people with trolleys and differently abled people. This includes ensuring that routes have at least a clear width of 1200 mm, have smooth, even, non-slippery surfaces, suitable gradients and have appropriate markings and signage.

16.3.3 Entrances and Exits
Entrances into housing should have relatively level thresholds. Where we have entrances without level thresholds, rumps should be included. The entrance door should have a minimum clear opening width of at least 900mm. This enables wheelchair users to access housing and ensures that it is also easier to use trolleys and pushchairs.

16.3.4 Accessibility Standards
All housing should be made as accessible as possible and there are standards and guidelines of good practice which should be consulted. More accessible options not only improve the usability and safety of housing, they can also increase the lifespan of housing as it is more likely to be compliant with regulations and standards as these become more stringent over time.

In addition, some housing may require further modification to make them easier to use for differently abled people. To support inclusion, planning for further modifications in at least 2 to 5% of the units should be allowed for. However this proportion may be higher where there are older users or more users with disabilities.
16.3.5 Affordability

Housing affordability can be defined as housing that has a monthly rental or mortgage value that is less than 30% of the gross monthly salary of average gross salary of occupants. Housing developments should consider a mix of housing types to ensure that provision is made for people on lower incomes. This supports the creation of more mixed and inclusive developments.

16.3.6 Accessible Public Transport

Accessible affordable local public transport not only reduces the need for cars, it also ensures that everyone is able to access local work and education opportunities. Travelling on public transport can also support local social interaction and therefore improve trust and social cohesion (see Cohesion, page 56).

Housing should therefore have access to local regular, affordable and efficient local public transport. This transport must be accessible to old people, children, people with loads and differently abled people.

Local public transport systems should be linked to housing with accessible safe routes. These routes should not be further than 2 km away, but ideally are within 400 m of housing (see Transport, page 34).
SOCIAL COHESION

17.1 Objective

Housing supports social cohesion.

17.2 Introduction

Social cohesion refers to the extent to which individuals within a community understand each other and trust, collaborate and work together. It is valuable because it enables collective knowledge and resources to be used effectively and efficiently to achieve common goals. Ensuring that housing supports social cohesion has a range of benefits, including:

- Increased levels of trust and cooperation.
- More efficient and effective use of resources.
- Improved communication and coordination.
- Reduced wastage

17.3 Guiding Principles

17.3.1 Social Spaces

Social spaces such as parks, playgrounds, and sports fields can play an important role in encouraging social interaction and cohesion within communities. An appropriate number and type of social spaces should therefore be provided in and around the housing.

The location, design, management, and type of spaces should be determined through studies of existing successful social spaces and in discussion with housing occupants. In addition, discussions with neighbouring communities on the type and management of social spaces should take place. If the facility is widely supported by everyone with the local area, it is more likely that the spaces will be looked after, and will build local social cohesion.

17.3.2 Social Facilities

Social facilities such as community centres and sports and recreation facilities can play an important role in enabling social interaction and cohesion. Social facilities should therefore be included in or around housing.

The type and nature of these facilities should be determined through studies of existing successful social facilities and in discussion with housing occupants. In addition, discussions with neighbouring communities on the type and management of social facilities should take place. A social facility that is strongly supported is more likely to build social cohesion and be financially sustainable.

Care should be taken to ensure that the capital and operational costs of the shared social facilities are affordable. There should be strong community commitments and an appropriate organizational structure and business model to ensure the facility is run in an effective and inclusive way. Proposed organizational structures and business models will influence the design of the facility and should be taken into account in the adaptability and flexibility of the facility and in the design of access control systems.
17.3.3 Stakeholder Involvement

Involving people in decisions on issues that will have an impact on them is an important way of ensuring that there is support for an initiative or a process. Structured involvement of stakeholders can create a shared understanding and enable efficient implementation. For instance, in housing, the involvement of users, local government, the contractor and local service providers can be used to support goals such as improved energy efficiency, increased recycling and local employment by ensuring that objectives, and respective roles in achieving these objectives, are understood and supported.

In housing, it is particularly important to involve future users in the design of housing. An effective way of doing this is to walk users through examples of existing housing and discuss what aspects they would wish to include, or change, in new housing. It is also useful for new users to interact with users of existing houses and discuss designs with them in order to identify improvements. Constructing pilot or show units is also a valuable way of developing housing designs and ensuring that these work effectively. Pilot units enable professional teams, developers and contractors to refine designs and systems before full-scale implementation.

It is also important to ensure that households are effectively involved in the management of their houses and the surrounding area. The management of houses can be supported by building user guides and an induction process.

17.3.4 Residents’ Organizations

A residents’ committee, or organization, is an effective way of ensuring users are involved in the management of housing, shared facilities and common space. It also provides a structure for developing future plans for the local area and for interacting with neighbouring communities, adjacent land owners and the local municipality.

A range of best practice models exist for residents’ organizations and these should be understood and drawn on to ensure that organizational structures are effective, inclusive, and support local sustainability targets and plans.
Appendix 1: Layout of Energy and Water Facilities and Waste Disposal Receptacles
## Appendix 2: Sample Green Home Maintenance Schedule

<table>
<thead>
<tr>
<th>ITEM</th>
<th>HOME MAINTENANCE INSPECTIONS AND REPAIRS</th>
<th>COLD SEASON</th>
<th>HOT SEASON</th>
<th>RAIN SEASON</th>
<th>QUARTERLY</th>
<th>ANNUALLY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Test for proper operation of smoke detectors and replace batteries if necessary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Make sure that attic and/or ceiling space vents are open and clear</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Inspect, verify and test breakers and what switch they operate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Inspect each lamp, extension and appliance cord and plugs for wear and damage; replace if frayed or broken</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Remove and clean the kitchen exhaust fan filter. Clean accumulated grease deposits from the fan housing.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Clean refrigerator coil and drip pan. Clean and defrost freezer if necessary.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Check Dishwasher and Washing Machine for leaks.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Test Ground Fault Circuit Interruptor (earthing) outlets for proper operation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Inspect, verify and test the main cold and hot water shut off.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Inspect, verify and test each gas shut off.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Update caulking around tubs, worktops and shower units</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Repair/ replace loose or damaged wall and floor tiles, check and clean grout. Check interior and exterior faucets and shower heads for leaks. Clean aerators. Replace washers if necessary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Clean drains with soda. Pour water down unused drains.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Inspect visible pipes for leaks.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Check under and around Kitchen and bathroom cabinets for leaks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Check toilets for stability and leaks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Check area around water heater for leaks. If you have hard water, drain 3-8 liters of flush out hot water from geyser to remove accumulated sediment.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Check roof: Clean roof, check for leaks; damaged, loose or missing roofing material.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Clean and check gutters and down pipes for leaks, misalignment, or damage.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Clean out dirt and dust and check windows for chipped or missing putty, handle and trim shrubbery around walls. Remove tree limbs, branches, or debris that can attract check for cracks and deteriorating bricks/ blocks and mortar on exterior wall. Check painted surfaces for flaking. Scrape, prime and paint any areas on the house</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Check Concrete and Asphalt for cracks or deterioration. Reaseal or repair if necessary.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Apply a wood protectant to wood cabinets and wood Skirting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Lubricate Hinges to all Doors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Review your insurance policies to ensure coverage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Look for visible signs of Deathwatch Beetles, Powderpost Beetles, Termites, or any</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Check Porch Flooring and repair as required</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
References


UNEP SBCI, 2010a. The ‘State of Play’ of Sustainable Buildings in India, Paris: UNEP DTIE.


UN-Habitat, 2012a. Zambia urban housing sector profile, Kenya. UN-Habitat

