# Urban Energy Technical Note

## Key Strategies for Sustainable Building Design in the Tropics

<table>
<thead>
<tr>
<th>STRATEGY</th>
<th>DESCRIPTION</th>
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</table>
| 1 Site selection | • Use of existing buildings - to reduce energy required for new buildings  
• Brownfield sites preferred over undeveloped green field sites  
• Special consideration for disaster prone areas (floods, landslides etc.) |
| 2 Building footprint | • Should conform to the permitted site coverage  
• The remaining area should be permeable to ensure rainwater infiltration |
| 3 Building orientation | • Buildings should be designed so that the long axis is along the east - west axis. |
| 4 Building form / shape | • Buildings that are narrow in plan help to achieve maximum natural light penetration, good cross ventilation and minimal heat gain. |
| 5 Allocation of spaces within the building | • Location of building services - toilets, staircases, lifts, lobbies, stores, ducts etc. - on the east and west facing walls to act as buffer zones against heat gain. |
| 6 Openings | Window sizing (according to the prevailing climatic conditions)  
• Window to Wall Ratio (WWR) of 0.2 - 0.3 is acceptable  
• Hot and humid - to allow for maximum air movement large openings are recommended  
  - at least 50% of north and south facing walls and glazing should not exceed 20% of the wall area  
• Hot arid and hot semi-arid/ savannah - 10-20% of the area of north and south facing walls should be operable  
• Lakes region - openings should be 25-40% of the area of north and south facing walls. The glazed part of the openings should not exceed 15-20% of the whole  
• Upland / High upland - north and south facing windows should be large to allow for passive heating. 15-25% of the wall area should be operable  
Window placement  
• They should be placed in the north and south facing walls for easier sun control  
• They should be avoided in the east and west facing walls - it is difficult to control shading |
| 7 Day lighting | • Openings should be provided in the north and south facing walls  
• Narrow plans should be used to aid in day light penetration into the building  
• Clerestory windows, atriums, solar tubes, mirror ducts etc. can be used to enhance natural day lighting  
• Light shelves can be used to redirect daylight and control glare  
• Staircases, toilets and kitchens should always be provided with day lighting |

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Building orientation of The Learning Resource Center © Musau Kimeu  
Orientation along east-west axis. Local building materials © UN-Habitat / Marja Edelman  
Skylights and clerestory windows © UN-Habitat / Zeltia Blanco
## STRATEGY

### 8 Sun shading / Solar control
- Design appropriate shading devices for glazed surfaces using sun shading devices - roof overhangs, vertical and horizontal sun-shading elements, balconies, screens, vegetation etc.
  - Horizontal shading devices are appropriate for north and south facing facades
  - Vertical shading devices are appropriate for east and west facing facades
  - Egg-crate shading devices are appropriate for south west, north west, south east and north east facing facades

### 9 Ventilation and cooling
**Passive**
- Use of operable windows, thermal chimneys, roof vents, louvered fenestrations etc.
- Use of passive ventilation strategies for natural ventilation – cross ventilation, stack effect, solar chimneys, clerestory windows etc.
- Provision of openings and manual operable windows in all habitable spaces
- Use of narrow plans to allow for cross ventilation
- Use of passive cooling strategies – evaporative cooling, vegetation, wind turbines, rock bed heat exchanger, ground cooling, green roofs etc.

**Active**
- In the case of artificial cooling make provision for proper insulating material to avoid additional heat gain

### 10 Heating
**Passive**
- Suitable for upland / high upland climates
- Medium weight walls, floors and ceilings are recommended for the best exploitation of passive solar gains
- Design should allow for penetration of sun into the building during the cold season for passive heating

**Active**
- In case of artificial heating, make provision for proper insulating material to avoid additional heat loss

### 11 Building envelope
- Should be selected according to the local climate:
  - Materials with low U-values are appropriate for hot and dry climates
  - Materials with high U-values are appropriate for hot and humid climates

#### FOUNDATIONS
- Foundations should be appropriate for the conditions on the site - topography, water table level, soil type and depth of bedrock
- Foundations should be designed to meet the necessary structural, thermal, termite and moisture or water control (water proofing) requirements
- Porous back fill material (gravel, sand) should be used against the foundation walls to promote drainage

#### SLAB
- Ground floor slab
  - Waterproof membrane (ground floor) for moisture control
  - Specification of appropriate floor finishes for acoustic considerations

- Suspended floor slab
  - Light coloured to enhance day lighting
  - Specification of appropriate floor finishes for acoustic considerations
  - Provision of acoustic treatment of the slab (ceiling) depending on the use of the room or area
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<td><strong>Hot semi-arid / savannah</strong></td>
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<td><strong>Upland/ high upland</strong></td>
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| **ROOFS** |
| **Hot and humid** |
| • lightweight roofs with low thermal capacity and high reflectivity |
| • well ventilated or well insulated to reduce heat gain |
| **Hot arid** |
| • heavyweight roofs with high reflectivity |
| • ventilated |
| • if roof is lightweight, the ceiling should be heavyweight |
| **Hot semi-arid / savannah** |
| • medium weight roofs with high reflectivity |
| • ventilated |
| **Lake region** |
| • medium thermal mass roofs |
| • well ventilated |
| **Upland/ high upland** |
| • medium weight roof with good insulation value |

12 Choice of building materials
Recommendations taking into account climate and sustainability:
• select materials with low embodied energy and low energy construction systems
• use naturally available materials
• use durable materials and components
• use locally available materials and technologies
• use materials with greater potential for reuse and recycling
• use adhesives with no/low Volatile Organic Compound
• use materials that are non-toxic and with minimal indoor pollution

13 External finishes
• use of light coloured external finishes to reflect unwanted solar radiation
• use of green walls to reduce overall temperature of the building

14 Renewable energy
On site generation of renewable energy:
• solar energy (solar PV and solar water heaters)
• wind energy
• biogas from biodegradable waste
• hydropower
STRATEGY

15 Water efficiency
Incorporation of water efficiency strategies such as:
• rain water harvesting – to be used for cleaning, watering plants, flushing toilets etc.
• recycling of grey water – use of dual plumbing system
• use of water saving fixtures – dual flush systems, low flow taps etc.

16 Sanitation
• provision of environmentally friendly toilets and sewerage systems: bio-digesters, reed bed sewage systems, oxidation ponds etc.

17 Solid waste management
• Recycling non – biodegradable waste
• On site sewage treatment for institutions / buildings in absence of Municipal sewage systems
• Producing biogas using biodegradable waste
• Sorting of waste generated

18 Landscaping
Soft landscaping
• use of indigenous plants that require minimal irrigation should be incorporated in the design

Hard landscaping
• provision of permeable or porous paving materials (open joint pavers, porous concrete, paving stones, permeable clay brick pavements etc.) where appropriate

19 Storm water management
• provision of drainage
• provision of measures to mitigate storm water / rainwater run-off and replenish the water table - permeable paving, rain gardens, soakaways, ponds, swales, infiltration trenches etc.

20 Energy efficiency / appliances
Use of:
• solar water heating systems
• energy efficient bulbs, appliances etc.
• light level sensors
• occupancy / motion sensors
• behaviour change

REFERENCES

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