Resource Efficient Built Environment: methodologies and Lesson learned

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Presentation Overview

- Rapid Urbanization and Increase demand for resources
- Ecological Footprint of buildings
- Designing a Green City
- The Green Building
- East African project on Promoting Energy efficiency in building.
- Sustainable building design strategies
- Conclusions

Rapid Urbanization and increasing demand for more Resources

- In 1900, **10 %** of the global population lived in cities;
- In 2007, **50%** of people lived in cities;
- In 2050, **75%** of the world population estimated at 9 billion people, will be living in cities.

- To accommodate the **new urban population in the next 40 years**, an equivalent of **a new town with one million people** will be built every week!

- Out of the over 3.5 billion people living today in cities, ***one billion live in informal settlements in poor shelter***.

- **Urbanization = increasing demand for resources (energy, water, material and land etc.)**
- Growing number of **energy poor.**

Ecological footprint of the built environment

- Majority of the world building stock was built when energy was cheap!;
- Environmental considerations are very often absent in those building stocks.
- Today, buildings are responsible for:
  - 40% of electricity consumption;
  - 40% CO_2 emissions
  - 40% waste generation
  - 20 % water

- With the business as usual,
  - energy consumption in building will reach 50% by 2030
  - Emissions will reach 70% by 2030

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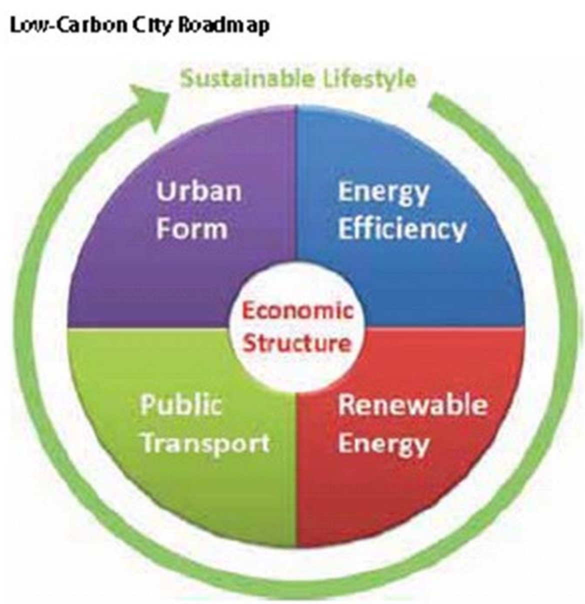
Green Cities

- **Cheap oil and gas** are not going to last for more!

- Modern cities are fossil fuel driven cities.
- Very few urban planners take into consideration bioclimatic elements (sun path and prevailing wind) in their urban plans. New buildings and streets are aligned along main roads, rivers etc. This results most often in **high energy dependent**.

- **Green city** or **low energy urban design** aims at minimizing demand for resources (energy, water, land, material, etc.).
- The objectives of green city are to:
  - Optimize the energy efficiency of the urban structure;
  - Minimize **energy and water demand** and **transport need;**
  - Maximize the efficiency of energy supply;
  - Increase the share of renewable energy in the energy mix;
  - Promote recycling and recovering of resources from the waste.

Green Cities or Low carbon cities



Low carbon cities promote the use of :
energy efficiency;
renewable energy;
sustainable waste management;
public transport as opposed to private transport system;
urban form (**compact and density**);
green economy etc.;
Equity and social mix;
Mix economic use.

The concept of **low-carbon cities** rests on the concept of a sustainable live-cycle process.

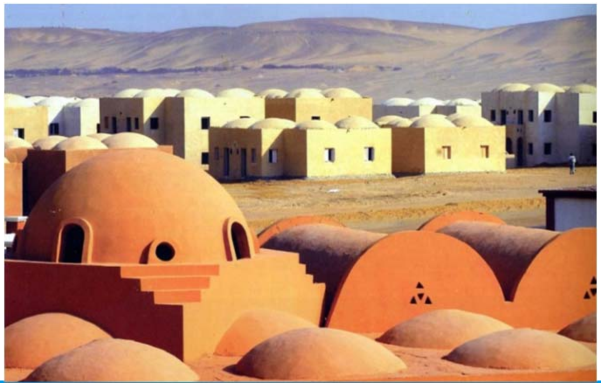
Resource Efficient Built Environment

- A resource efficient building has the following characteristics:
  - Low energy demand
  - Low CO_2 emission and pollution
  - Low ecological footprint
  - Efficient water consumption
  - Low waste generation with the integration of the 3 R
  - High indoor quality (comfort);
  - Major use of local material and resources;
  - Use of passive building design elements and principles;

- A resource efficient building or **green home** is a sustainable built environment that combine **economic aspects** (energy, water, land, local material etc.); **environmental considerations** (reduction of pollution, climate) and **social context** (use of traditional architecture, culture, etc.)

Resource Efficient Built Environment

- Designing of a green home, requires a **combination of several analysis** including: **local climate**, **wind**, **sun paths**, **landscape and topography**, local material; shadows and surfaces illumination; etc.
- This is needed to optimize the shape, orientation and distance between buildings and to obtain maximum solar radiation, natural light and **wind protection in winter** and **minimize solar radiation** in summer.
- **Energy demand** of an individual building can **be reduced significantly** if **bioclimatic analysis** are carried out at the early stage of **urban planning** and are used for building orientation and shape.



Energy consumption of Modern Buildings

Energy used in buildings in Africa is estimated at 56% of the total national electricity consumption.

Majority of buildings in most African countries with tropical climates - are replica of building designs of western countries with cold and temperate climates.

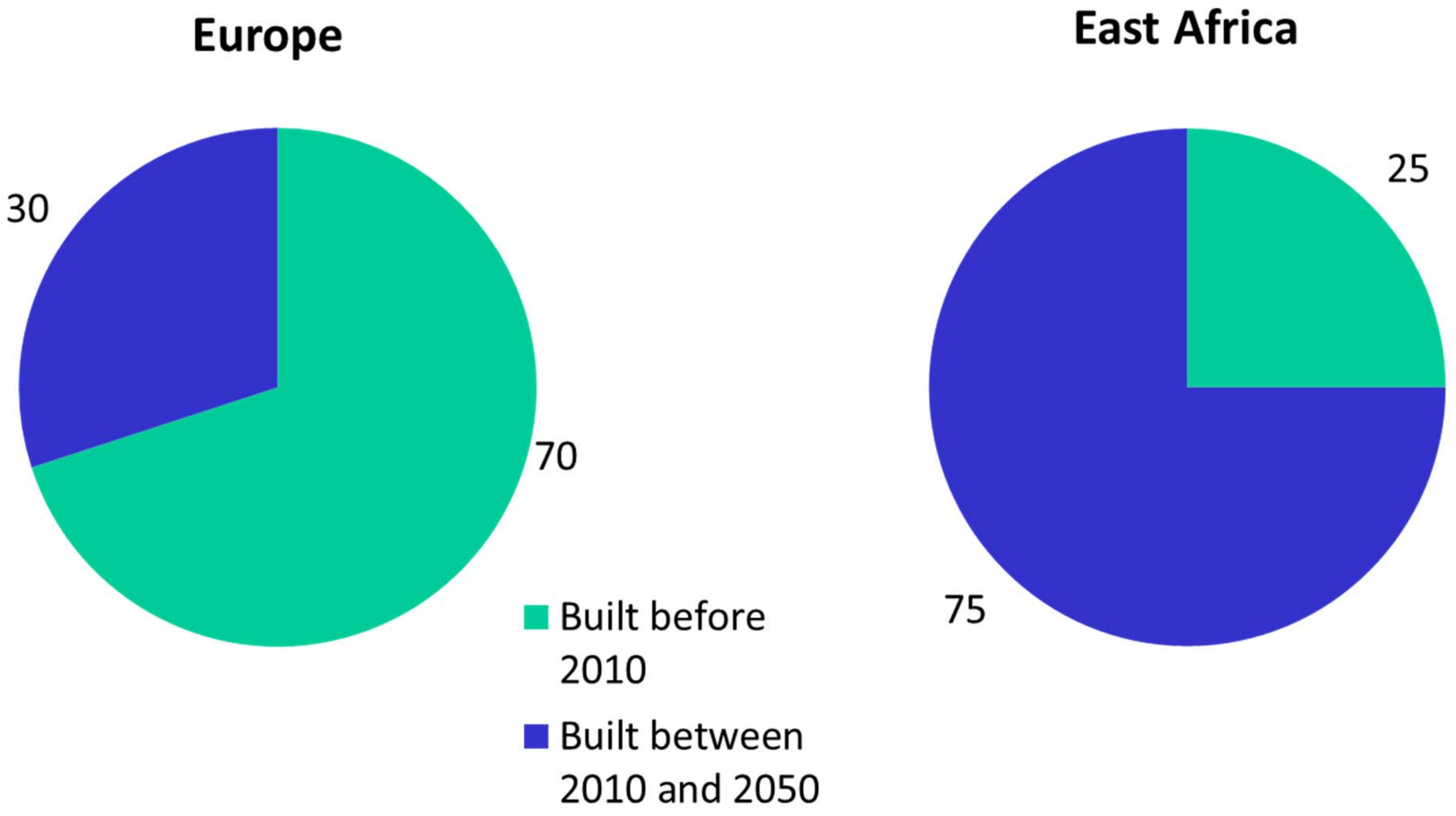
Energy generation's capacity is being stretched by rapid population growth, increased urbanization, climate change and growing energy demand (7% annual).





African Building Stock Forecast

About 75 % of the buildings expected to exist in Sub Saharan Africa in 2050 have not been built.



Project on Promoting Energy Efficiency in Buildings in East Africa

- This project is an initiative of UN-Habitat in collaboration with UNEP and the five East African countries: Kenya, Tanzania, Uganda, Rwanda and Burundi.
- The program is designed to address the **energy crisis** in the region through the **promotion of energy conscious building designs and energy demand management**.

Objectives of the Programme

- To Mainstream Energy Efficiency Measures into Housing policies, Building Codes, Housing finance and building practices in East Africa;
- To achieve considerable avoidance of GHG emissions as a result of improved energy efficient building practices.

Targets:

- **400,000 units (including government mass housing, real estates, private home etc.),**
- **100 buildings retrofitted (commercial and private sector), built under energy efficiency standards.**
- Estimated Emission Reduction in 20 years:
  Direct CO2 reduction: 3,629,996 ton;
  Indirect CO2 saving: 3,937,500 ton.

Main Components

1. Baseline Data, Energy Audits and Benchmarking on Energy Efficiency (EE)in the Building Sector.

2. Adoption of Energy/Resource Efficient Building Codes in the region.

3. Awareness Raising; Capacity Building, Guidelines and training tools.

4. Appropriate Financial Framework and Mechanism for the Promotion of energy efficient Measures in Buildings.

5. Integration of EE measures in **all new government housing projects**, donor funded housing projects and encourage such practices in the **private sector**.

1. Baseline data and Benchmarking on energy use in buildings

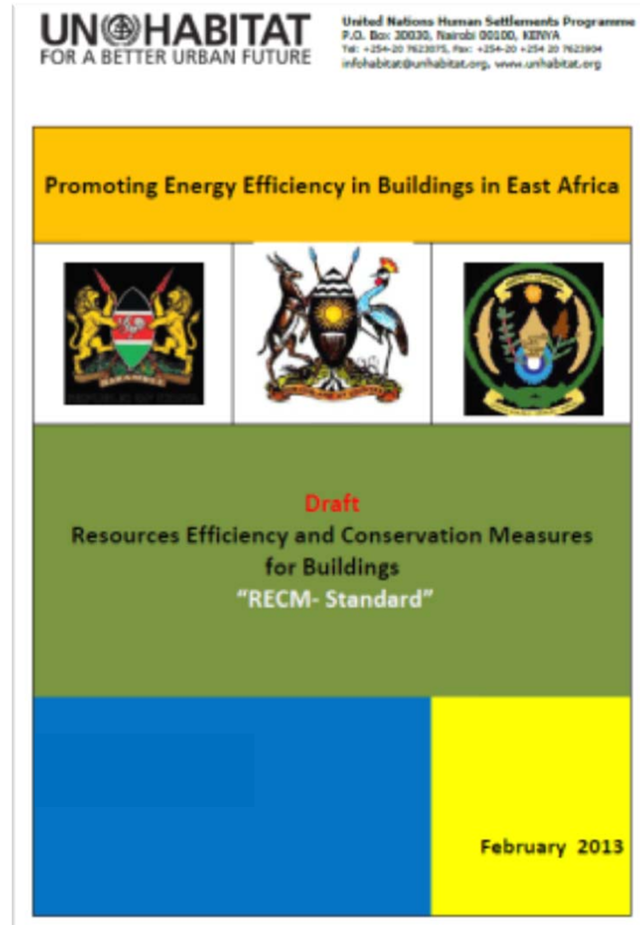
- Assess energy consumption trends in buildings.
- Conduct energy audits in residential, public and commercial buildings.
- Establish energy consumption benchmarks per categories and typologies of buildings and climatic zones.
- Identify energy saving potentials.

Eastgate: Sustainable building in Harare.

2. Housing policies and regulations: building code / standards

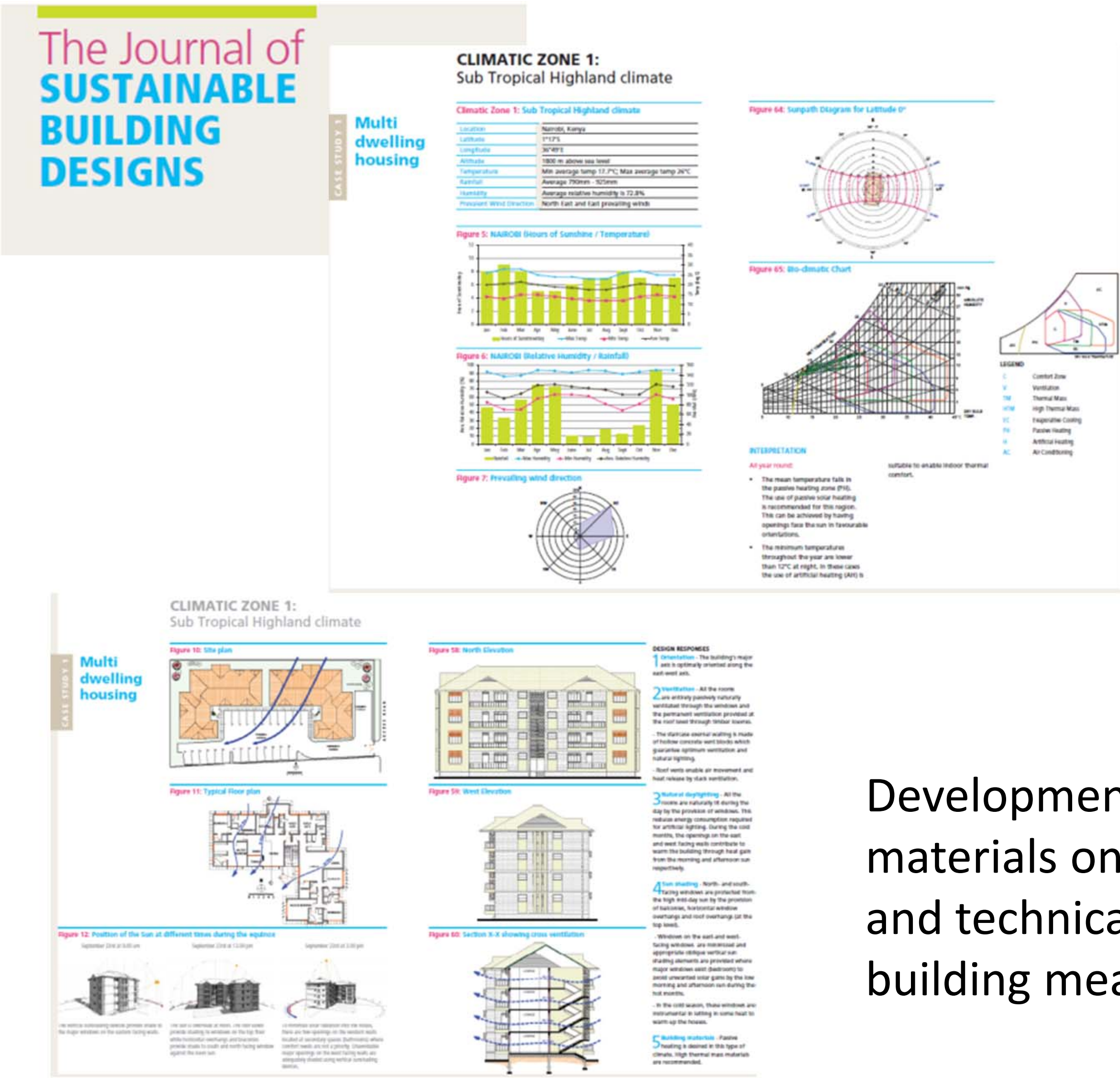
- Review country specific housing policy to include EE measures.
- Prepare EEB policies, session papers and by-laws for enactment, adoption and enforcement.

Energy/Resource efficient Building Code has the highest potential of saving energy in buildings over a long run.



Energy Efficiency in Building Codes Workshop (EEBC) Kigali – April 2013.

3. Education: Awareness creation and capacity building in EEB




PROMOTING ENERGY EFFICIENCY IN BUILDINGS IN EAST AFRICA

01

Urban Energy Technical Note

Guidelines for Green Building Design

Over 70% of the world energy generation is consumed in human settlements, resulting in an emission of more than two thirds of CO2 that contributes to climate change. Widespread energy poverty and the increasing cost of fossil fuels are impacting negatively on the economic development and the living conditions of people.

The way buildings are planned and designed today has a direct implication on their energy bills.

To address the global challenges of climate change and the high cost of energy it is essential to adopt urban planning and building design methodologies that are energy conscious and environmentally friendly. This document acts as a guideline to provide some of the mandatory criteria that should be taken into consideration. These criteria include:

- Optimization of the structure's energy efficiency;
- Minimization of the energy demand of buildings;
- Maximization of the efficiency of energy supply;
- Maximization of the share of renewable energy sources.

To design an energy efficient built environment involves minimizing the wastage of resources while maximizing the use of renewable energy sources and passive building design options.

This technical note introduces a simplified path to sustainable design, accessible through 7 Steps.

Step 1: Site Analysis

Site analysis helps to identify opportunities or constraints which will influence the outcome of the urban design.

Sun Path: Understanding the movement of the sun during the day and throughout the year allows for a qualitative analysis of the sunlight or shading of a site or part of a building. It is very useful for estimating the effects of the neighbouring buildings' shading or sunscreen needs. In the tropics, the orientation of the main road path should be developed along the East-West axis.

Prevailing Winds: Knowledge of the speed and directions of the prevailing winds will facilitate natural ventilation. The main road orientation should follow the prevailing wind direction to assure natural ventilation and dust removal to all buildings along the road. A compromise should be taken in case the prevailing winds direction are in conflict with the sun path.

Site Topography: The existence of rivers, streams, valleys, hills, mountains; may assist or obstruct natural cooling, wind and sun shading. Proper site analysis is required to maximize the use of the existing micro climate.

Fig. 01 Ecobuilding

Development of tools and awareness materials on sustainable building design and technical notes to promote passive building measures/strategies.

Training Workshop on Energy Efficiency in Buildings Kampala – June 2012.

Sustainable Integrated Building Design for Tropical Countries Dar es Salaam – May 2013.

4. Financing instruments of EEB

- Sensitize financial institutions, investment banks, private developers and power utilities on the economic benefits of EE measures.
- Facilitate the adoption and establishment of green mortgage systems.
- Encourage governments to create **fiscal** and **administrative incentives**; subsidies program and to allocate **national budget** for promoting EEB.

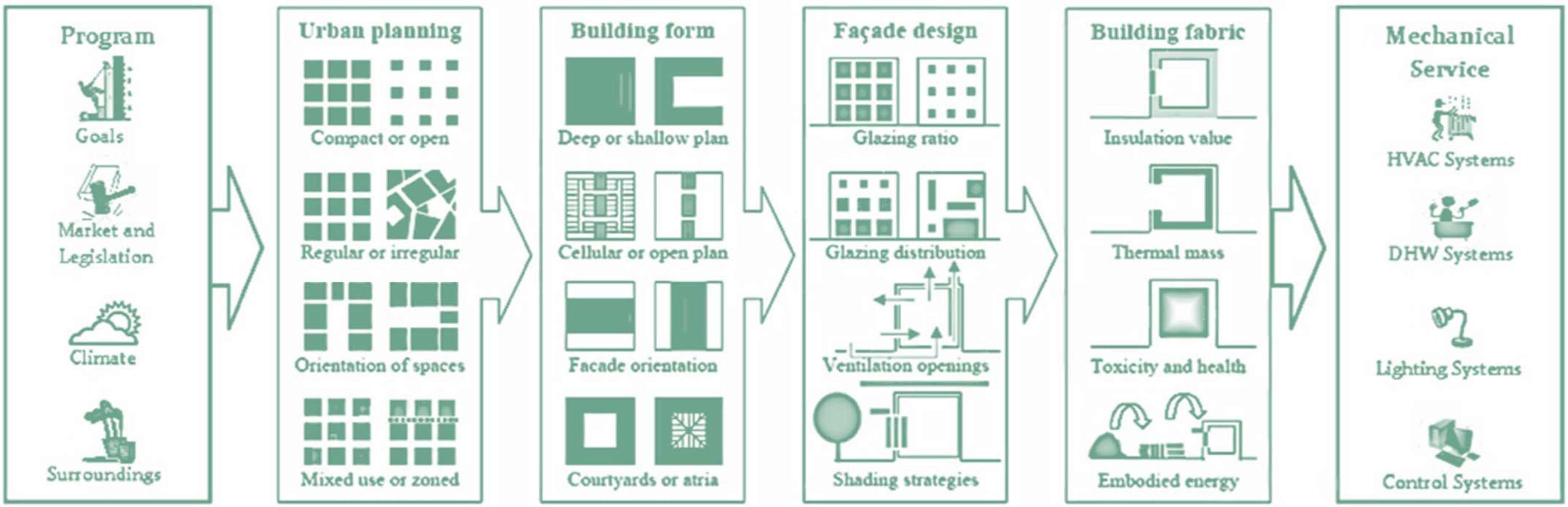
5. Demonstration projects

- Facilitate the construction of more EEB in the region through advocacy and capacity building;
- Ensure that majority of new buildings comply with EE principles;
- Work with governments, donors and developers to make sure that new housing projects are EE;
- Conduct practical training with real estate developers and other housing stakeholders to sensitize and provide them with technical assistance on EEB.
- Incorporated EE in all ongoing new housing schemes.

Pilot projects in Dar es Salaam Tanzania that integrate passive building design strategies

Sustainable building design strategies

The design Process



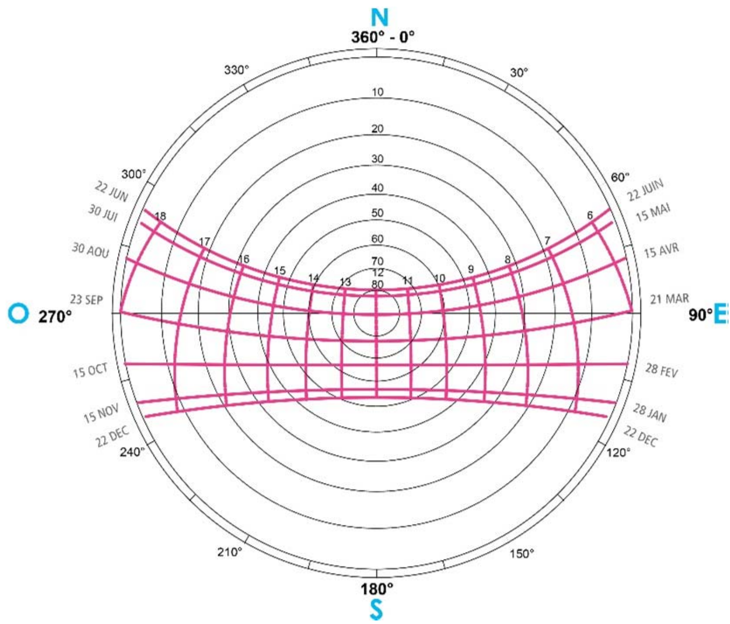
Main design concerns, with sub-categories of design issues. Adapted from (Steemers 2006).

1. Climatic Data Analysis

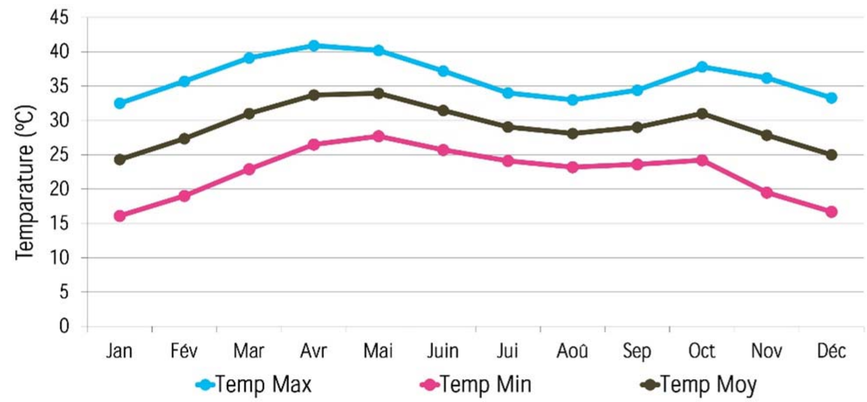
NIAMEY, Niger

Climate: Semi-arid / Savanna

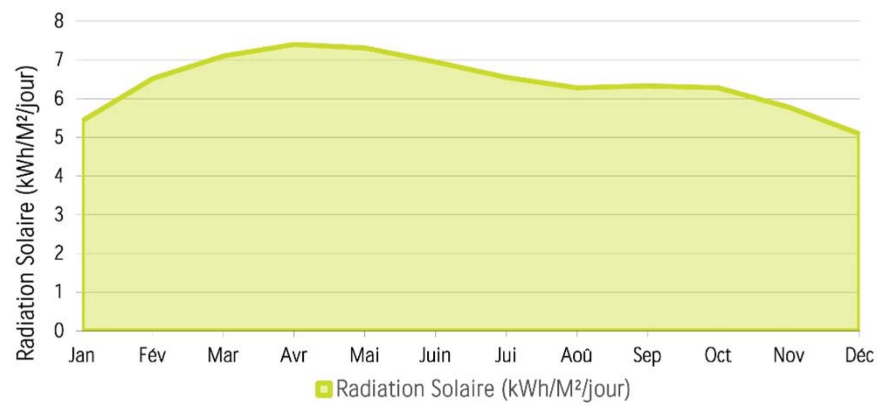
Altitude: ~207 m Latitude: 13º31'N Longitude: 02º06' W



Sun Path Diagram

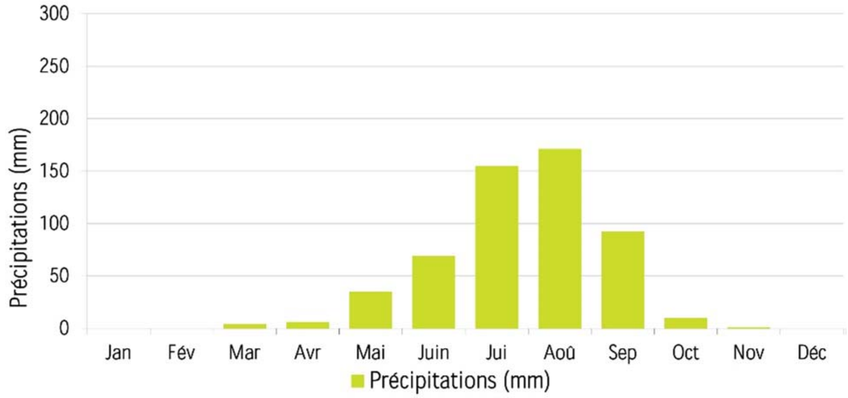


Temperatures

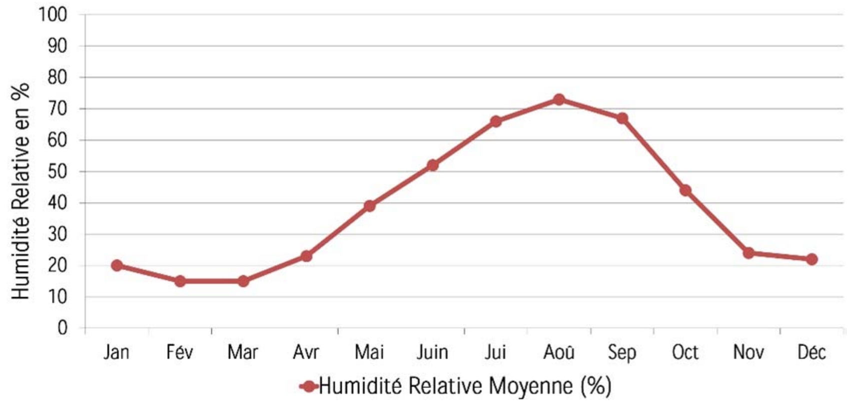


Solar Radiation

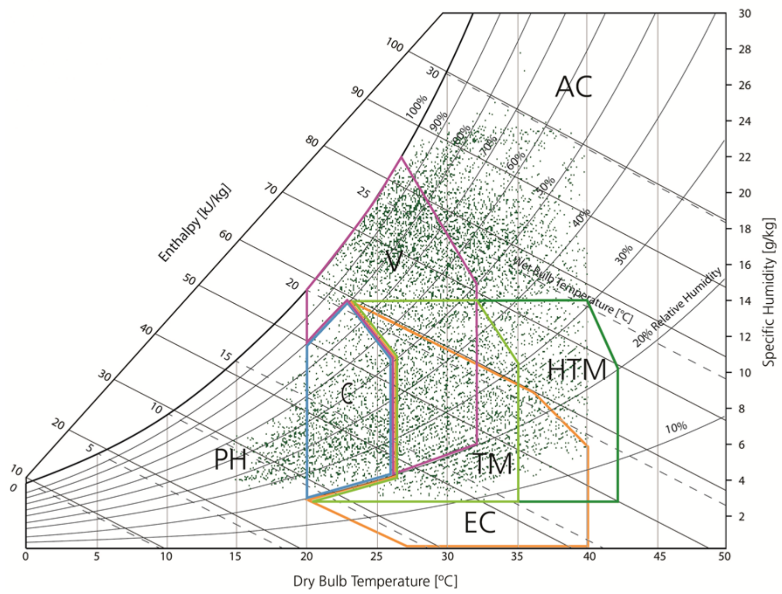
Sustainable building design strategies



Rainfall



Relative Humidity



Bio-Climatic Chart

Sustainable building design strategies

Design recommendations for the city of Niamey in Niger:

- Orientation with long axis running east-west to provide effective shading;
- Major windows should be oriented on North and South facing walls as they receive less solar radiation;
- Compact buildings to reduce the façade exposed to solar radiation;
- Use of medium to heavy weight materials with high thermal mass;
- Well ventilated and high reflective roofs of high thermal mass;
- Ventilation should be limited during day time, when the air is hot but allow for good natural night ventilation;
- Protection of all openings from direct and / or indirect solar radiation;
- Evaporative cooling in the hottest days is recommended;
- Passive heating of the building through thermal mass is desirable between November and February ;
- Air conditioning for cooling and dehumidification is necessary between the months of April and October as the maximum temperatures and humidity levels lie beyond the natural ventilation zone.

2. Cooling Strategies / Prevention of Heat Gain

1. BUILDING ORIENTATION – with the long axis along the **EAST – WEST** axis for maximum sun control.

Buildings that are NARROW IN PLAN enable maximum NATURAL DAY LIGHT penetration reducing electricity needs and promote good natural cross-ventilation.

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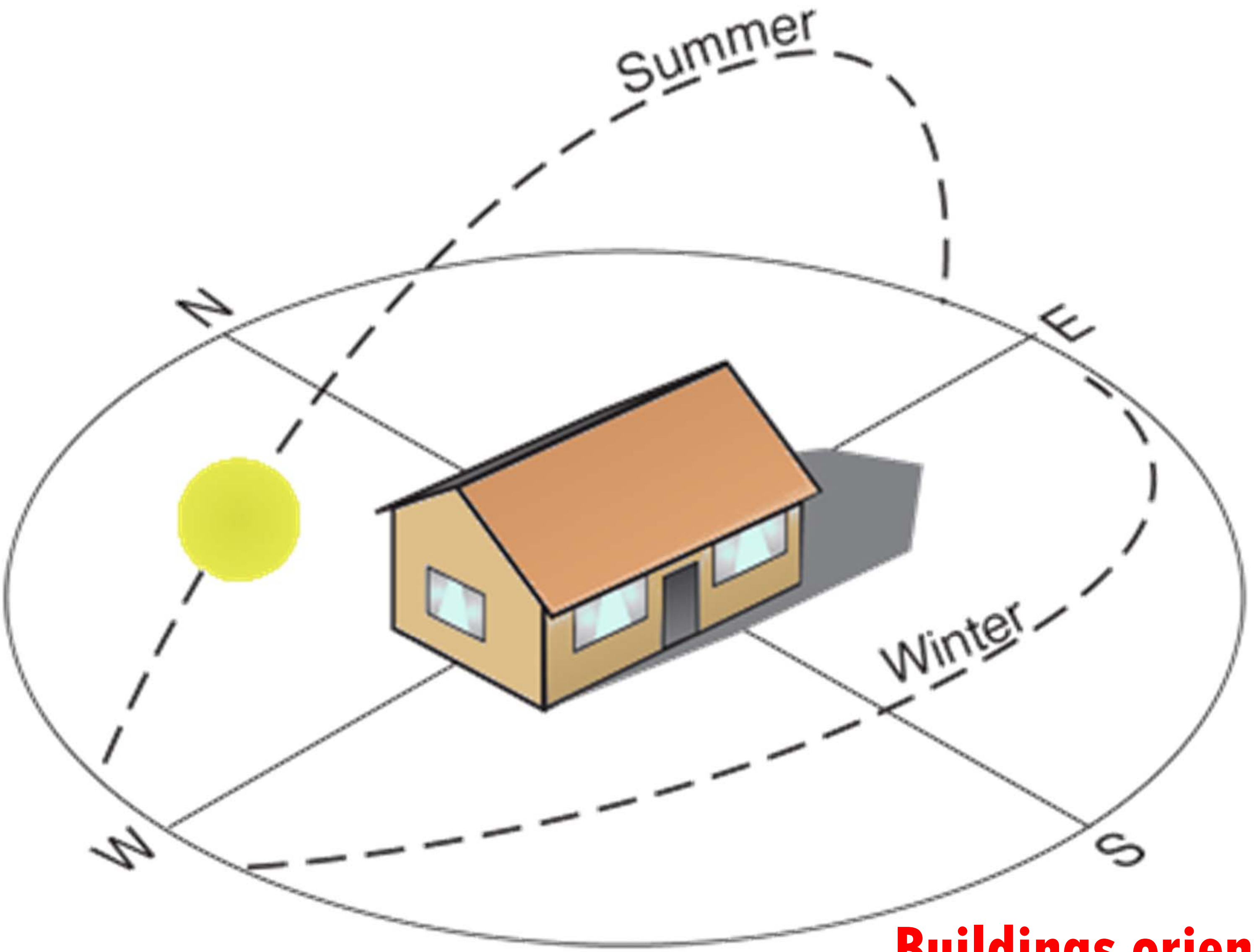


Buildings orientation

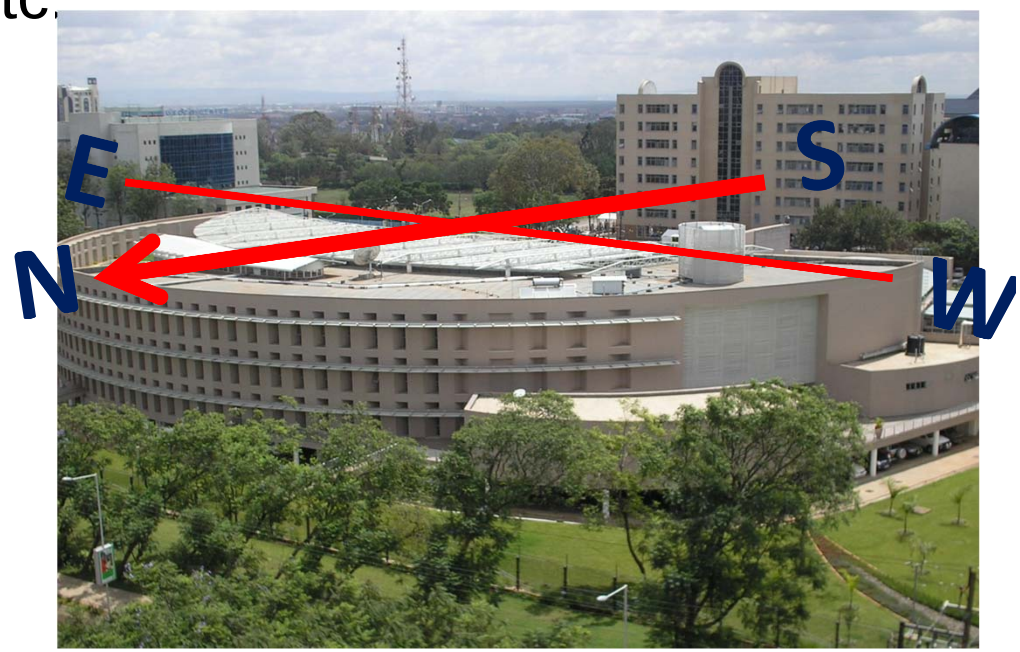
Long axis : East -West

Sustainable building design strategies

3. OPENINGS should be placed on the North and South facing walls as they receive less solar radiation.

4 SUN-SHADING should be done to all glazed areas by the use of vertical and horizontal sun-shading elements, roof overhangs, balconies etc.

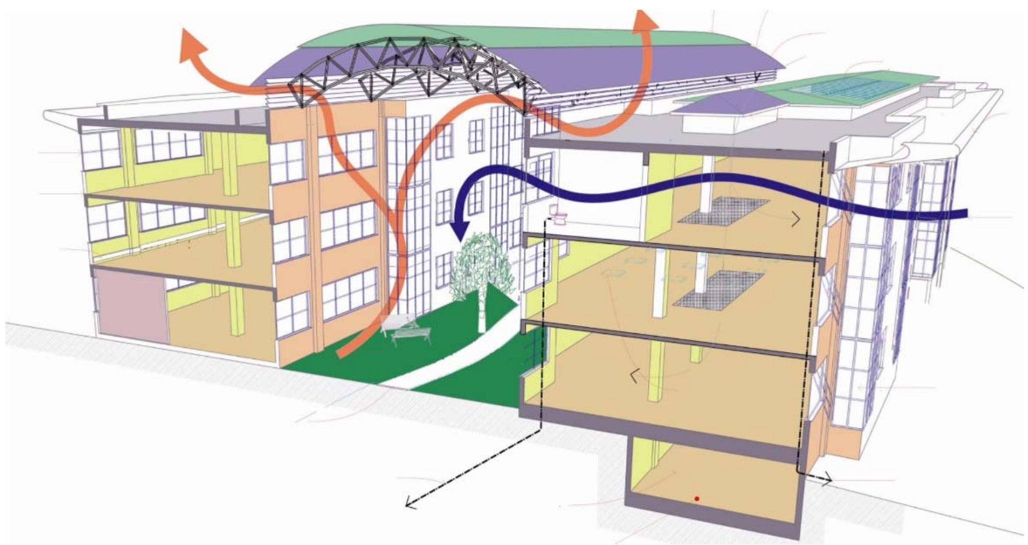
Baltra Airport, Galapagos Islands, Ecuador



Sustainable building design strategies

5. WINDOW SIZES should be correctly sized depending on the climate to enable maximum cross ventilation.

6. NATURAL VENTILATION should be used to provide cooling. E.g. use of operable windows, thermal chimneys, roof ventilation, vent blocks, louvered windows etc.

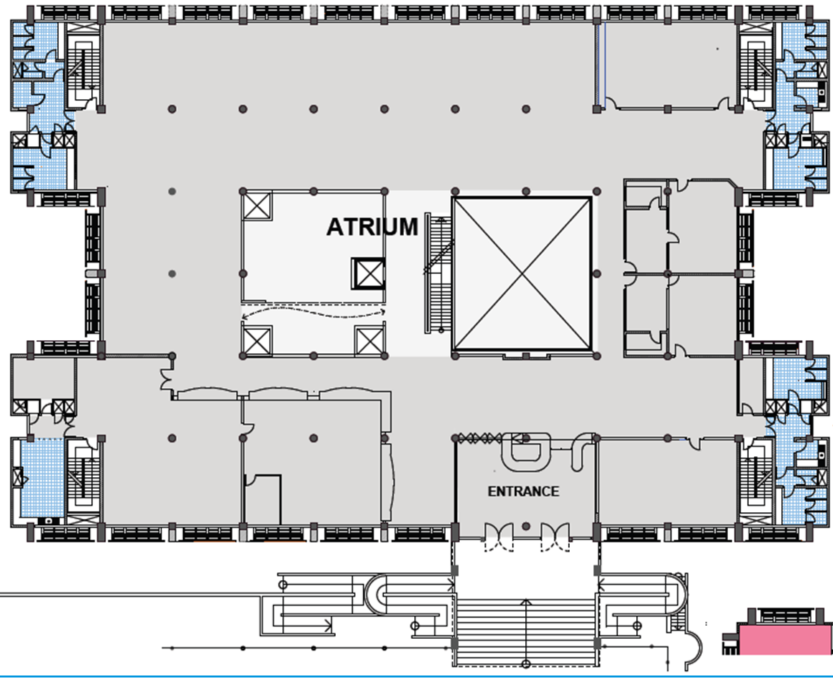


Sustainable building design strategies

7. BUILDING'S SERVICE AREAS (lobbies, washrooms, stores, lifts etc.) should be located on the East and West facing walls to act as buffer zones against the intense solar radiation.

8. Use of smooth and light coloured EXTERNAL FINISHES are desirable to reflect unwanted solar radiation and reduce solar heat absorption.

WEST



EAST

Sustainable building design strategies

9. BUILDING ENVELOPE

should be climate specific in order to limit energy demand needed to achieve thermal comfort.

10. CHOICE OF MATERIALS –

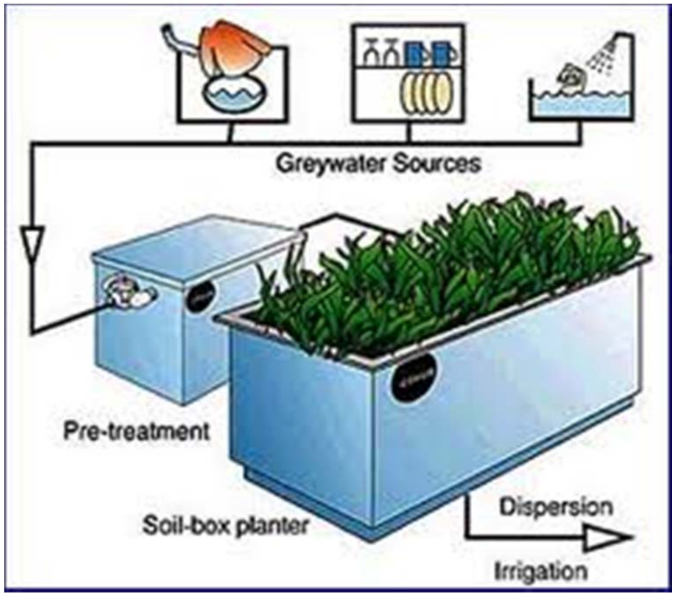
Sustainable and Locally sourced materials, with low embodied energy, that have minimal internal pollution and those that are easy to be re-cycled and re-used are recommended.

3. Resource Efficiency Strategies

11. WATER EFFICIENCY

through:

- 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.



Grey water recycling

12. LANDSCAPING

comprising indigenous plants that require minimal irrigation should be incorporated.

13. RENEWABLE ENERGY

incorporated:

- Solar power harvesting
- Wind energy
- Biogas from biodegradable waste

Wind turbines on roof of office building, Boston Logan International Airport, USA

Solar ‘trees’ installed on the garage, Boston Logan International Airport, USA

Sustainable building design strategies

14. SOLID WASTE MANAGEMENT through:

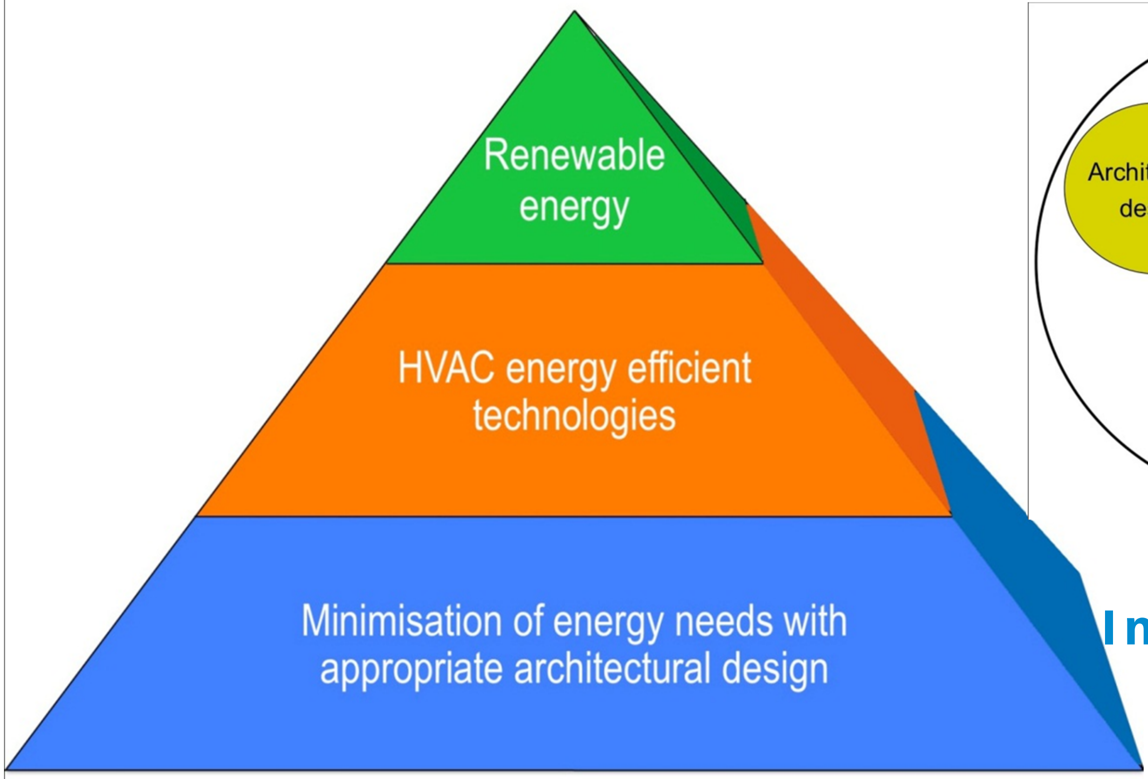
- Recycling non – biodegradable waste
- Producing biogas using biodegradable waste

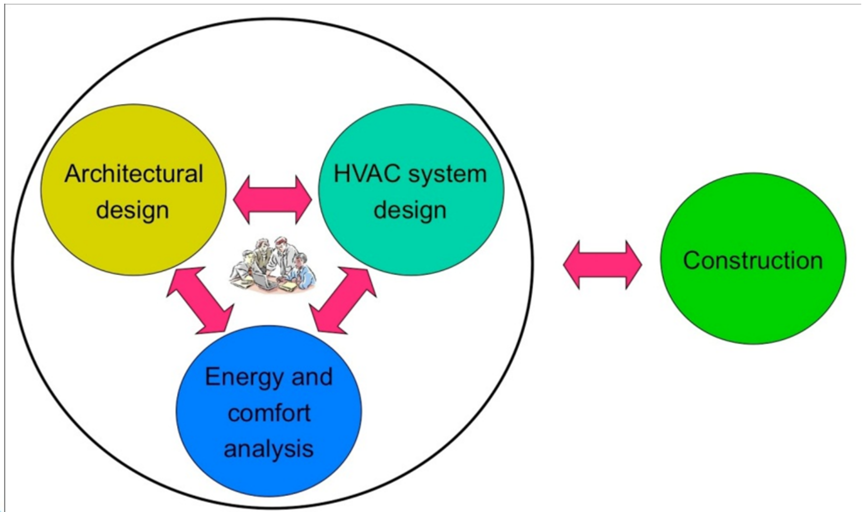
15. Using environmentally friendly WASTE DISPOSAL METHODS e.g. use of oxidation ponds, bio digesters, reed bed sewage system etc.

16. ENERGY MANAGER. An energy expert needs to provide technical inputs all the time

17. CARBON FINANCE can also be applied to recover part of the investment cost.

Sustainable building design strategies



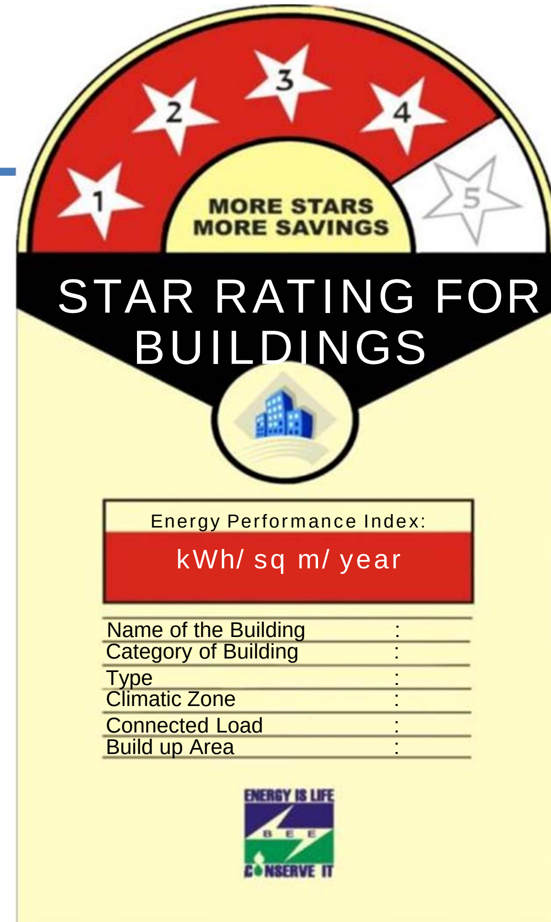


Integrated building design

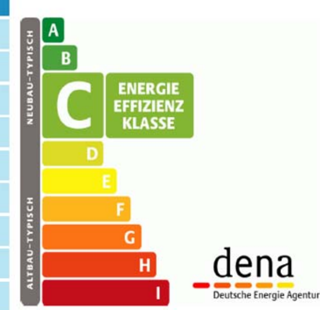
Design approach

East Africa Energy Efficient Building Award (EAEEBA)

- **UN-Habitat will establish a Regional Energy Efficiency Award Systems** to acknowledge best practices and reward excellent achievement;
- Using internationally agreed green building rating systems as criteria for the award;
- Develop Green building certification system for the region.
- Facilitate the creation of other awards and competition systems on sustainable architecture.



Class	Primary energy use (kWh/m²/year)
A	0-80
B	81-110
C	111-150
D	151-200
E	201-250
F	251-300
G	301-350
H	351-400
I	401 and above



Conclusion

- **Climate change** is a reality and the era of **cheap energy is over**.
- There is urgency to adopt cleaner ways of generating and using energy.
- Building sector being one of the major consumers of energy and consequently, one of the major polluters, they also offers huge **opportunities for resources saving and conservation and climate change mitigation.**
- **This is achieved through:** sustainable urban **planning; building design; adoption of energy efficiency** measures and use of **clean energy** systems.
- As modern cities were not designed with **sustainability considerations** in mind, there is a need for a **paradigm shift**.
- ***Resources Efficient Built Environment is the solution for today environmental and energy crisis***

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