



University of Nairobi

8TH ANNUAL EAST AFRICA WORKSHOP & EXHIBITION

Transition towards low carbon buildings in Africa: Promoting Energy and resources Efficiency in Buildings in East Africa

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UNIVERSITY OF NAIROBI DEPARTMENT OF ARCHITECTURE & BUILDING
SCIENCE 8TH ANNUAL EAST AFRICA WORKSHOP & EXHIBITION



Presentation Overview

- Energy use in buildings in Africa
- Global housing stock forecast
- Introduction of the program on ***Promoting Energy Efficiency in Buildings in East Africa***
- Achievements
- Conclusions

Energy use in buildings in Sub Saharan Africa



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

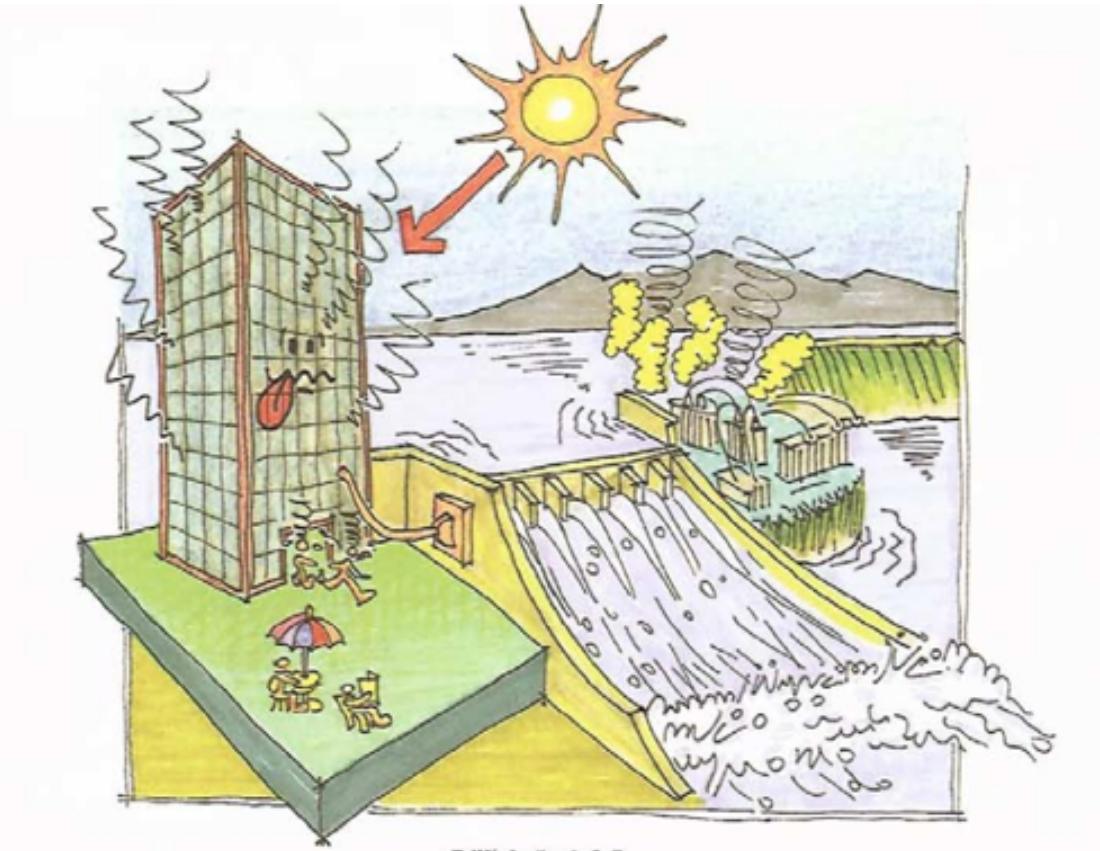
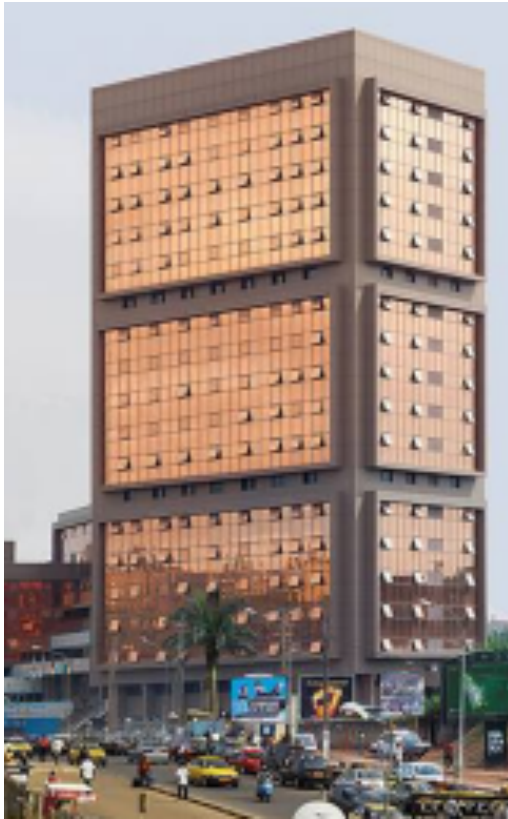
Modern cities are **fossil fuel driven cities**.

Very few **urban planners** take into consideration **bioclimatic elements or passive methods** in their new urban plans.

New buildings are aligned along main roads, rivers and the resulting settlements are **high energy dependent**.



Energy use in buildings in Sub Saharan Africa



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

Over 70% of energy is consumed in cities alone and in some cases, more than 50% of the national energy is used in the capital city alone.

Rapid Urbanization: Housing shortage and inadequate housing

- Housing deficit is estimated globally at one billion.
- There is a mismatch between the supply and demand for housing:
- **Adequate** shelters are **unaffordable!**

and
- **Affordable** shelter are **inadequate.**



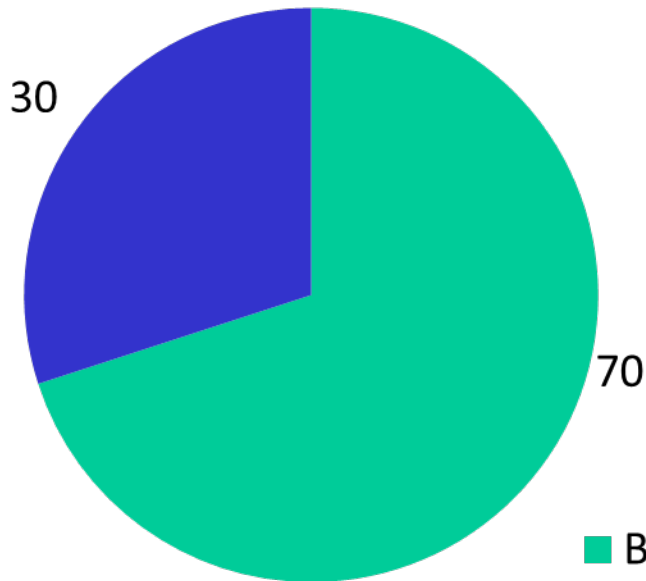
Rapid provision of housing on large scales that are not always environmental friendly.

- Mass housing with poor environmental considerations:
- Poor orientation, no sun shading devices, poor ventilation and day lighting, poor use of building material;
- No green spaces and open.
- Emphasis is put on **quantity** and not **quality**.

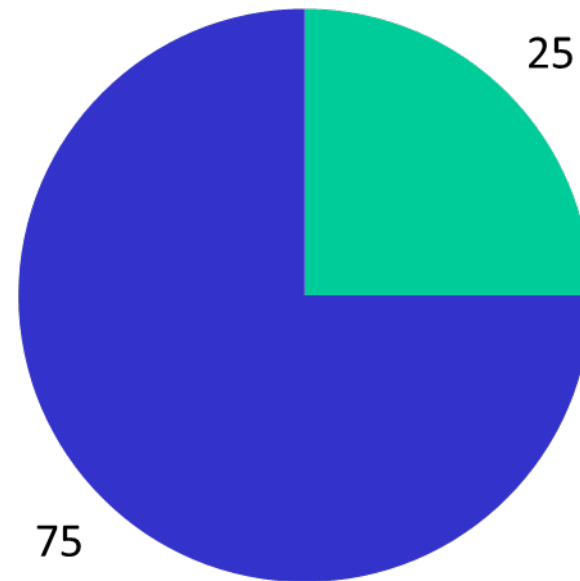


Global Building Stock Forecast

Europe



East Africa



- Built before 2010
- Built between 2010 and 2050

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.



Regional program on Energy Efficiency in Building in East Africa.

The components of the program are:

- Baseline Data, Benchmarking on EE in the Building Sector and Energy Audits.
- Formulation and Adoption of Energy Efficiency Codes in Buildings: EE standards & certification.
- Awareness Raising; Capacity Building, EE guidelines and training tools.
- Appropriate Financial Framework for the Promotion of EE Measures in Buildings.
- Incorporate EE measures on all government housing projects, and 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 Saving Potentials.

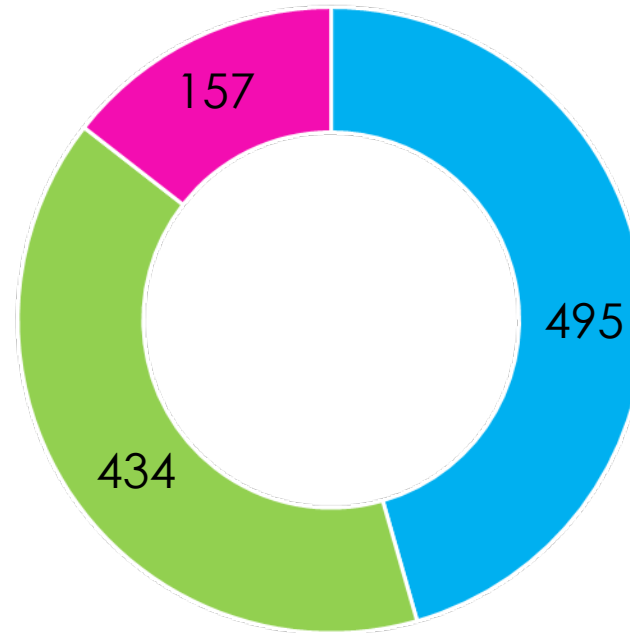


Eastgate: Sustainable building in Harare.



Audited
1,086
Housing Units

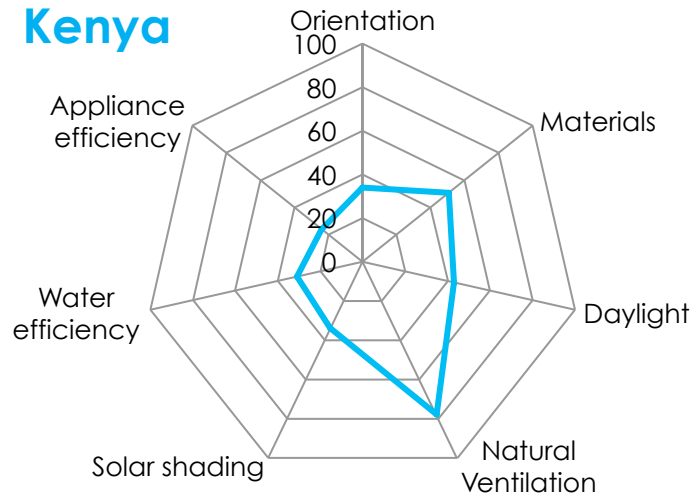
AUDITED SAMPLE SIZE



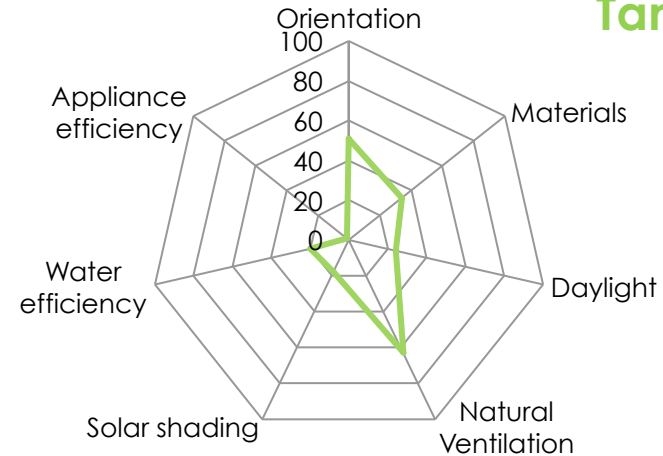
■ KENYA ■ TANZANIA ■ UGANDA

Audit findings: Current situation

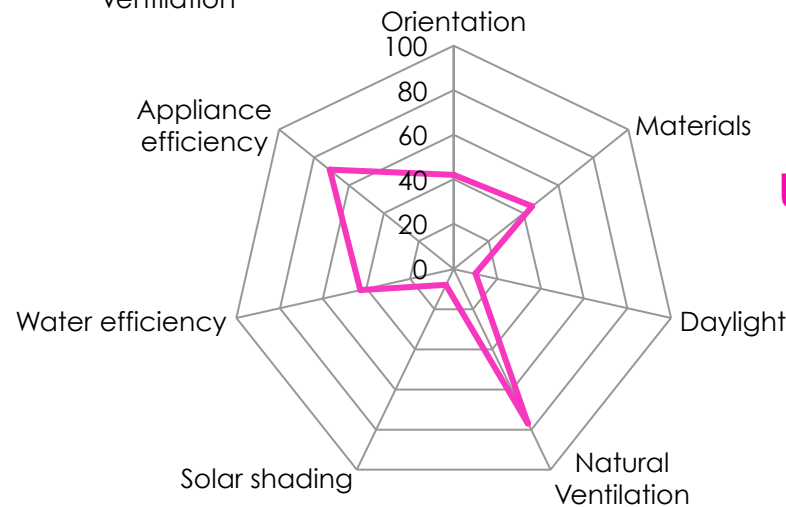
Kenya



Tanzania



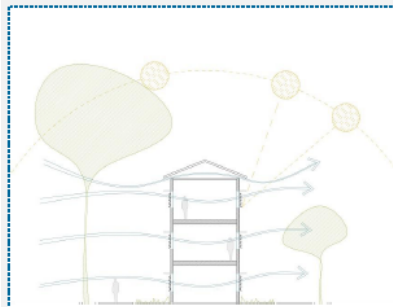
Uganda



Sample size:
1,086 Buildings

2. Housing policies and regulations: building code / standards

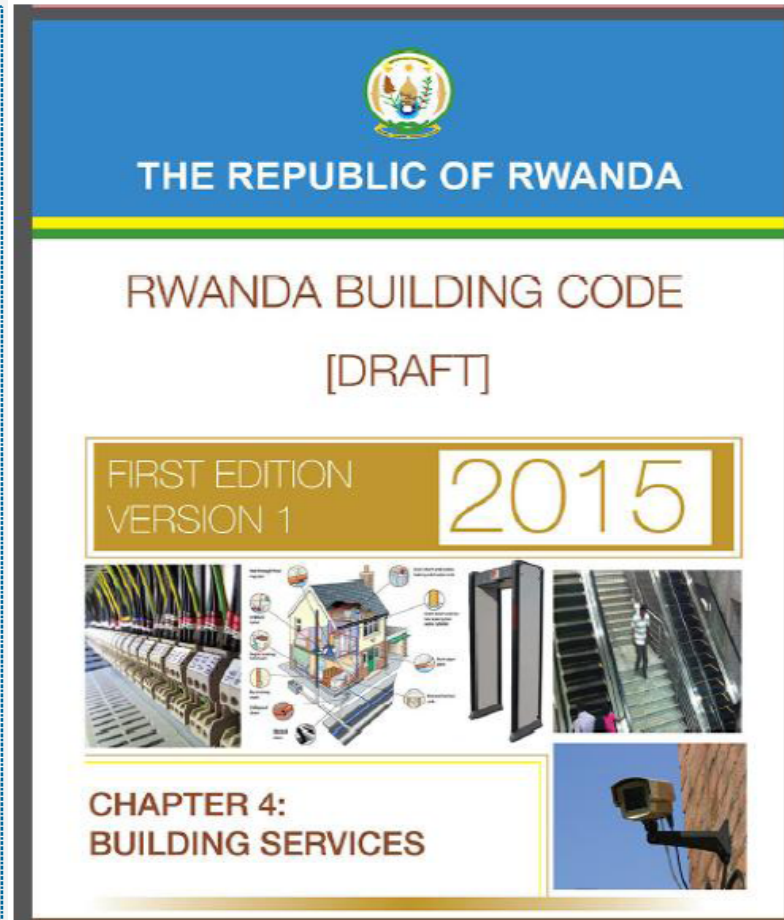
- Review country specific housing policy to include EE measures.
- Prepare EEB policies, session papers and by-laws for enactment, adoption and enforcement.



Final Draft
Energy and
Resource Efficiency
Building Code for
Tropical Countries

Guidelines
30th May 2014

UN-Habitat



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

The project organised workshops and provided technical advises to Kenya; Uganda, Rwanda, Burundi and Tanzania on Energy efficient BC.

Recommendations for building code amendment

1. Environmental friendly design incorporating green building concepts and regulations (**passive building design as per climatic zone**);
2. Use of climate adapted and **sustainable building materials**;
3. Use of **energy efficiency appliances** such as mandatory use of Solar Hot Water (SWH), lighting, air conditioning and ventilation, HVAC
4. Water efficiency: **mandatory rainwater harvesting**, water reuse and recycling;
5. **Renewable energies** (mandatory use of solar PV in nonresidential building > 300m² for lighting and other electrical appliances);
6. Sustainable site planning: **sewage separation and treatment**; waste management; land/vegetation and landscaping; drainage, urban layout and street orientation; erosion prevention etc.
7. Energy management and conservation for buildings through **Energy Certification of Buildings**
8. Procedures for **building inspection** and **penalties** for non-compliances

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



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3. Education: Awareness creation and capacity building in EEB

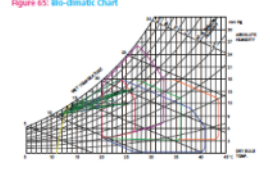
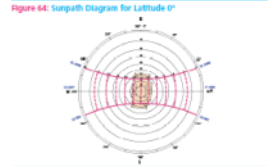
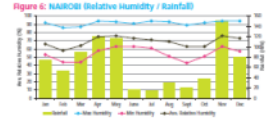
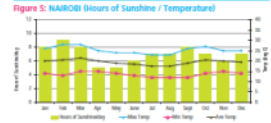
The Journal of SUSTAINABLE BUILDING DESIGNS

Multi dwelling housing

CLIMATIC ZONE 1: Sub Tropical Highland climate

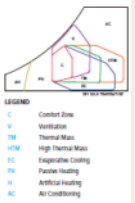
Climatic Zone 1: Sub Tropical Highland climate

Location	Nairobi, Kenya
Latitude	1°17'N
Longitude	36°50'E
Altitude	1600 m above sea level
Temperature	Min average temp 17.7°C; Max average temp 26°C
Humidity	Average relative humidity is 72.8%
Prevailing Wind Direction	North East and East prevailing winds



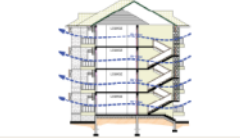
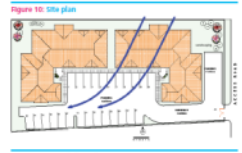
INTERPRETATION

- All year round: The mean temperature falls in the passive heating zone (PH). The use of passive solar heating is recommended for this region. This can be achieved by having openings face the sun in favourable orientations.
- The maximum temperature throughout the year are lower than 32°C, at night, in these cases the use of artificial heating (AH) is suitable to enable indoor thermal comfort.



CLIMATIC ZONE 1: Sub Tropical Highland climate

Multi dwelling housing



DESIGN RESPONSES

- Orientation:** The building's major axis is optimally oriented along the east-west axis.
- Ventilation:** All the rooms are airway opening naturally ventilated through the windows and the permanent ventilation provided at the roof level through timber frames. The clockwise stairwell is made of timber concrete wall studs which guarantee optimum ventilation and natural lighting. Roof vents enable air movement and heat release by stack ventilation.
- Shading & Disappearing:** All the facades are recessed during the day by the provision of windows. This reduces energy consumption required for artificial lighting. During the cool months, the openings on the east and west facing walls contribute to warm the building through heat gain from the morning and afternoon sun respectively.
- Shading:** North and south facing windows are protected from the high midday sun by the provision of balconies, horizontal window overhangs and roof overhangs on the high levels.
- Shading:** North and south facing windows are protected from the high midday sun by the provision of balconies, horizontal window overhangs and roof overhangs on the high levels. Windows on the east and west facing windows are protected from the high midday sun by the provision of balconies, horizontal window overhangs and roof overhangs on the high levels. Windows on the east and west facing windows are protected from the high midday sun by the provision of balconies, horizontal window overhangs and roof overhangs on the high levels.
- Shading:** North and south facing windows are protected from the high midday sun by the provision of balconies, horizontal window overhangs and roof overhangs on the high levels.

PROMOTING ENERGY EFFICIENCY IN BUILDINGS IN EAST AFRICA

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 profile.

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 waste 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

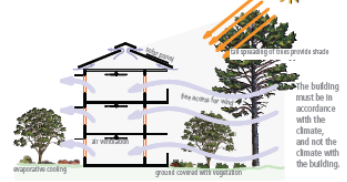
Site analysis helps to identify opportunities or constraints which will influence the outcome of the urban design.

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 screen 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 wind direction are in conflict with the sun path.

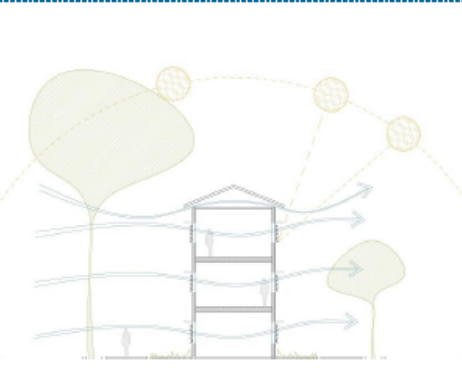
Site Topography: The existence of rivers, streams, valleys, hills, mountains; may assist or obstruct natural cooling, wind and sun shading. Proper site analysis is required to maximize the use of the existing micro climate.

Fig. 01 Ecobuilding



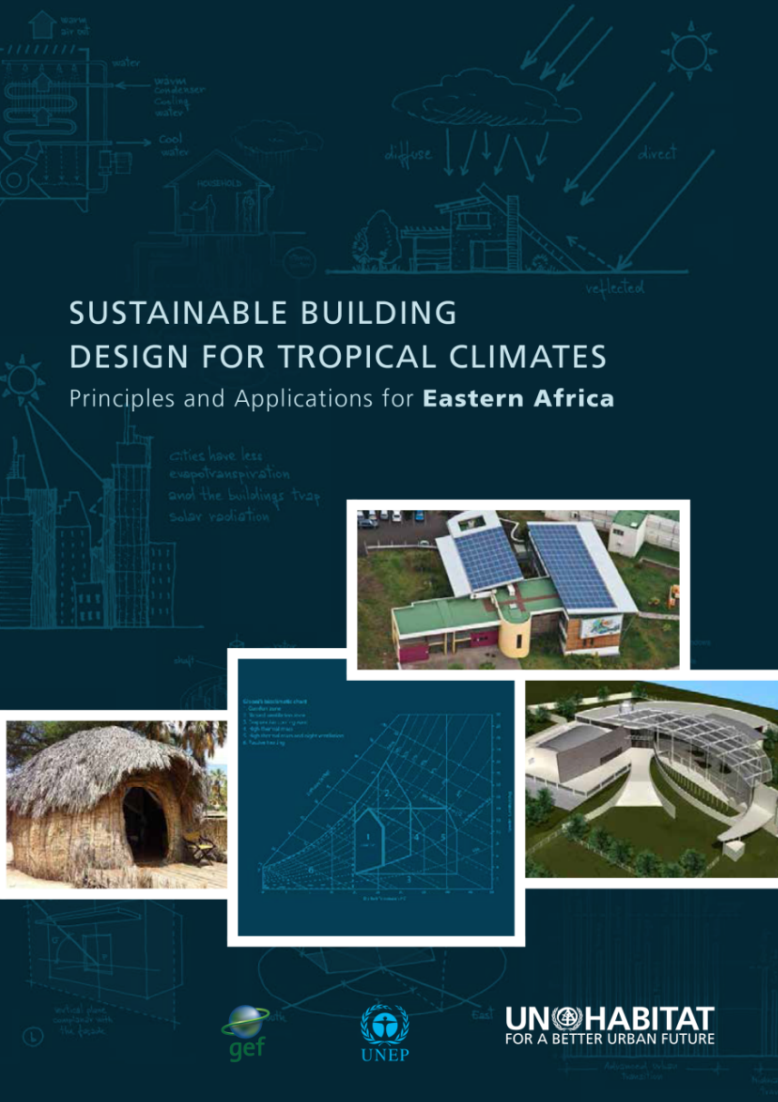
Development of tools such as handbooks on sustainable building design and technical notes to promote passive building measures.

3. Education: Awareness creation and capacity building in EEB



Final Draft
Energy and Resource Efficiency Building Code for Tropical Countries
Guidelines
30th May 2014

UN-Habitat



SUSTAINABLE BUILDING DESIGN FOR TROPICAL CLIMATES
Principles and Applications for **Eastern Africa**

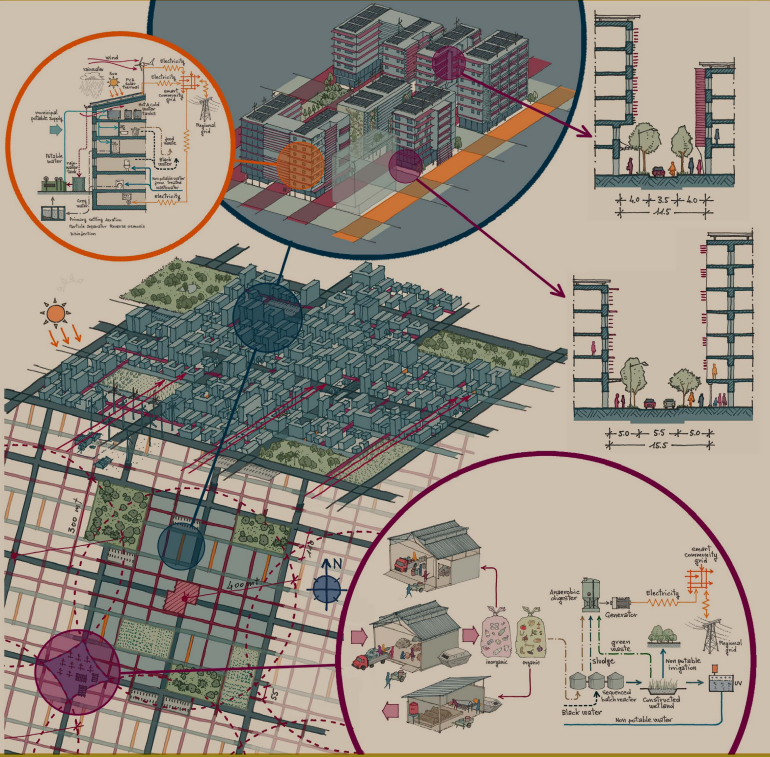
cities have less evapotranspiration and the buildings trap solar radiation

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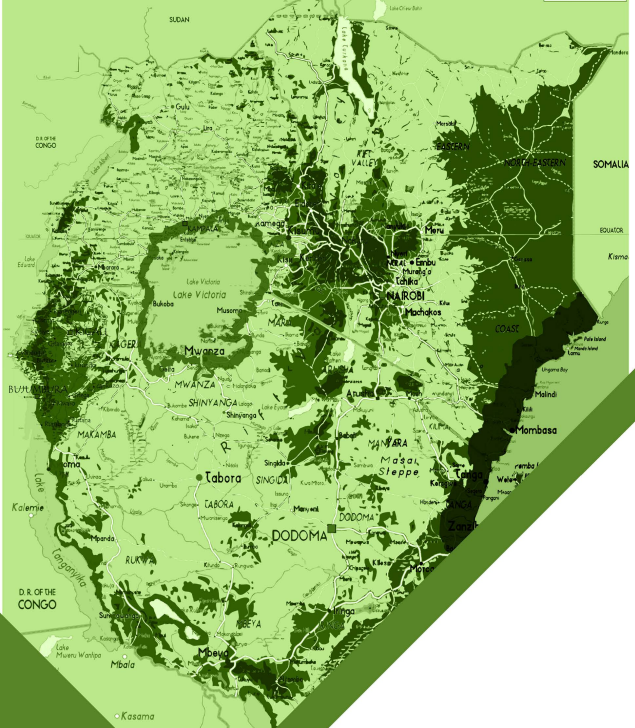
gef
UNEP

3. Education: Awareness creation and capacity building in EEB

ENERGY AND RESOURCE EFFICIENT
URBAN NEIGHBOURHOOD DESIGN
PRINCIPLES FOR TROPICAL COUNTRIES
Practitioner's Guidebook



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EAST AFRICA CLIMATIC
DATA AND GUIDELINES FOR
BIOCLIMATIC
ARCHITECTURAL DESIGN

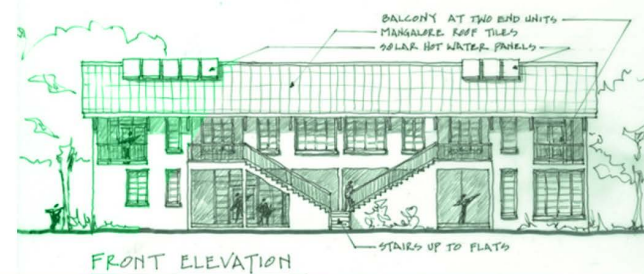
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3. Education: Awareness creation and capacity building in EEB

SUSTAINABLE BUILDING FINANCE:
A PRACTICAL GUIDE TO PROJECT
FINANCING IN EAST AFRICA



GREEN FINANCE MODELS:
ASSESSING FINANCE PRODUCT
CAPACITY TO LOWER
BARRIERS TO GREEN BUILDING
IN EAST AFRICA



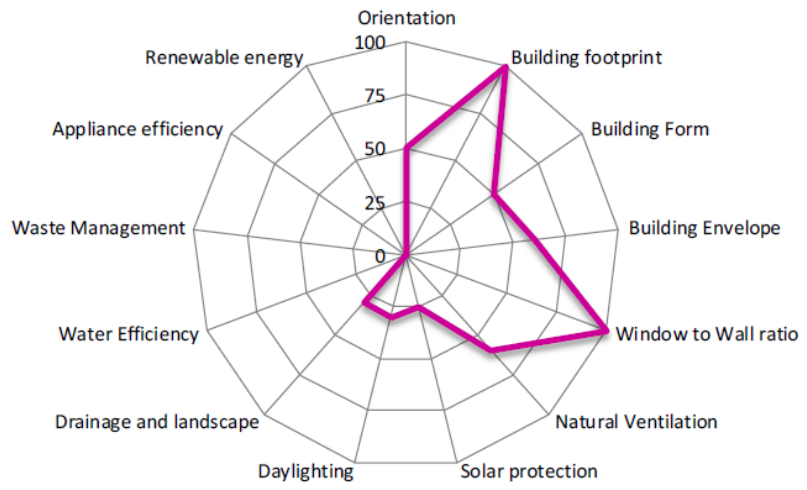
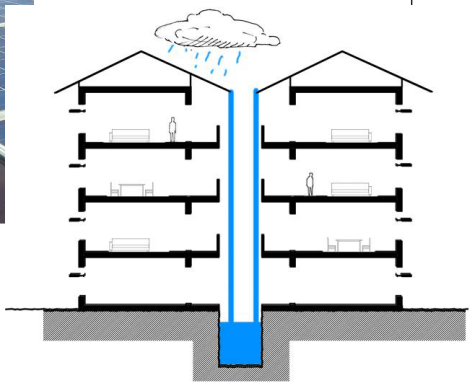
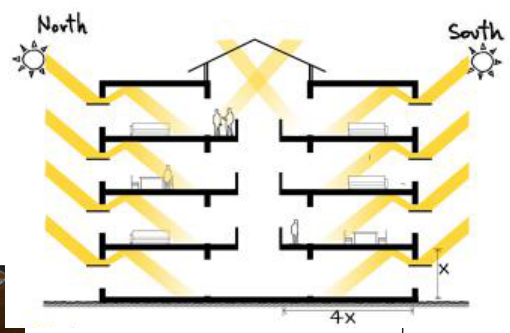
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Green building principles and a Radar table to assess the sustainable performance of the building

BUILD GREEN

Charter for Sustainable Building, Neighborhood Design and Urban Mobility in Tropical Countries



- '0 - 25 Sustainable design measure not considered
- '5 - 50 Sustainable design considered but not effective
- '0 - 75 Sustainable design measure considered and effective
- '5 - 100 Sustainable design measure considered and combined with secondary function / i



www.unhabitat.org

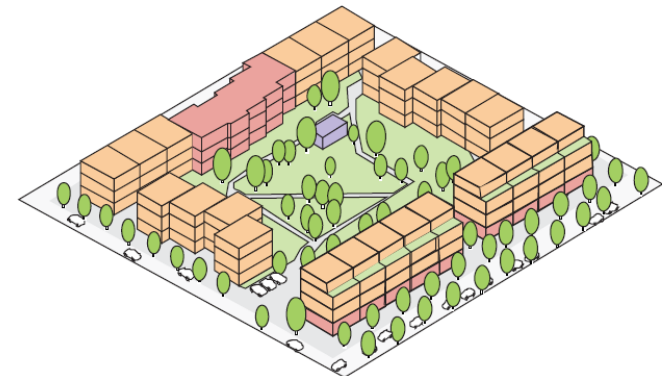


www.eebee.org

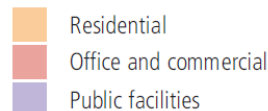


Green building principles and a Radar table to assess the sustainable performance of the building

- 1- Adequate allocation of open spaces for streets; public spaces and basic services. **(50% for the built and 50 % for open spaces)**
- 2- **Mixed land use** combining (economic and residential activities)
- 3- **Social mix** (integration of affordable houses and services)
- 4- **Adequate density and compact patterns** (an average of 150p/ha)
- 5- **Connectivity** (linking different cities spaces)



Density: 75 dwellings / ha
Medium building height
Medium plot coverage

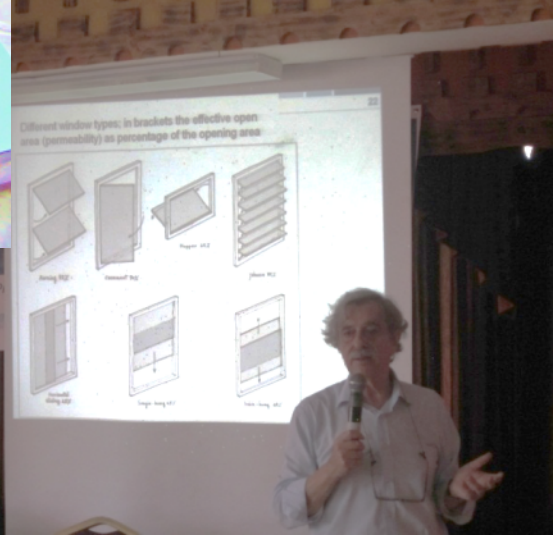
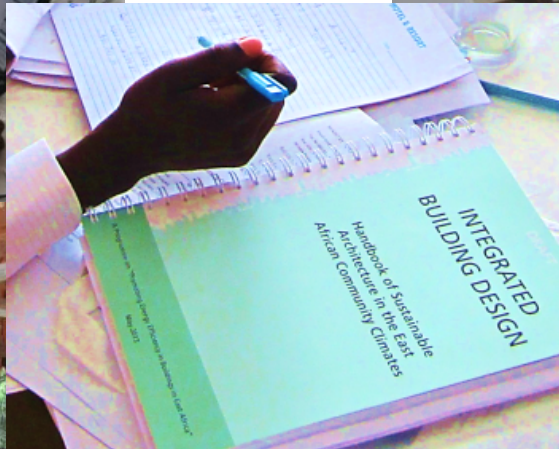


Over
500

Stakeholders trained

- ✓ Built environment practitioners
- ✓ Developers
- ✓ Students of architecture
- ✓ Journalists

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



10

Universities

Adopted UN-Habitat's Handbook on

Sustainable Building Design for Tropical Countries as a tool of instruction.



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.



Financing Green Building in Africa

STRATHMORE UNIVERSITY, NAIROBI
17-19 SEPTEMBER 2013

new opportunities for
an emerging market



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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.



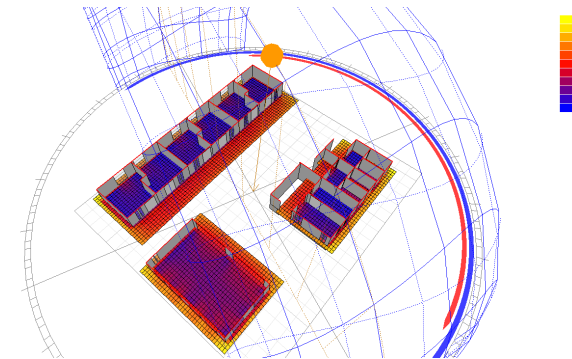
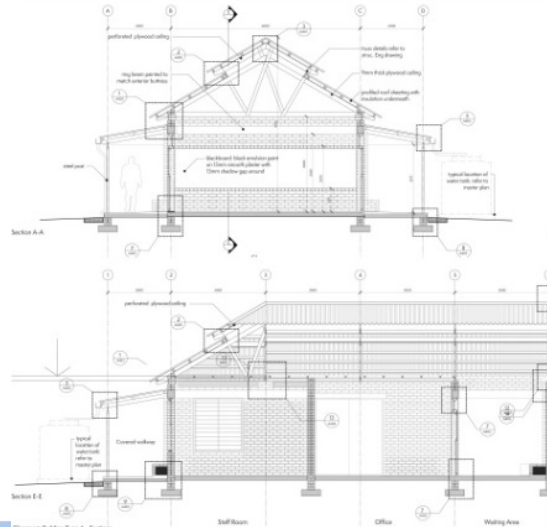
Pilot projects in Dar es Salaam Tanzania that integrate passive building design strategies

Technical advice

Influenced 10,000 housing units directly

Influenced approx. 5000 units indirectly

Mostly government projects, developers and building owners



Cities as energy *prosumer* producer and consumer of energy: Energy transition

75 % of energy are consumed in urban areas. Cities are endowed with huge renewable energy potentials: solar, wind, biomass, hydro etc. Cities should produce at least 10 % of their energy needs from solar energy.



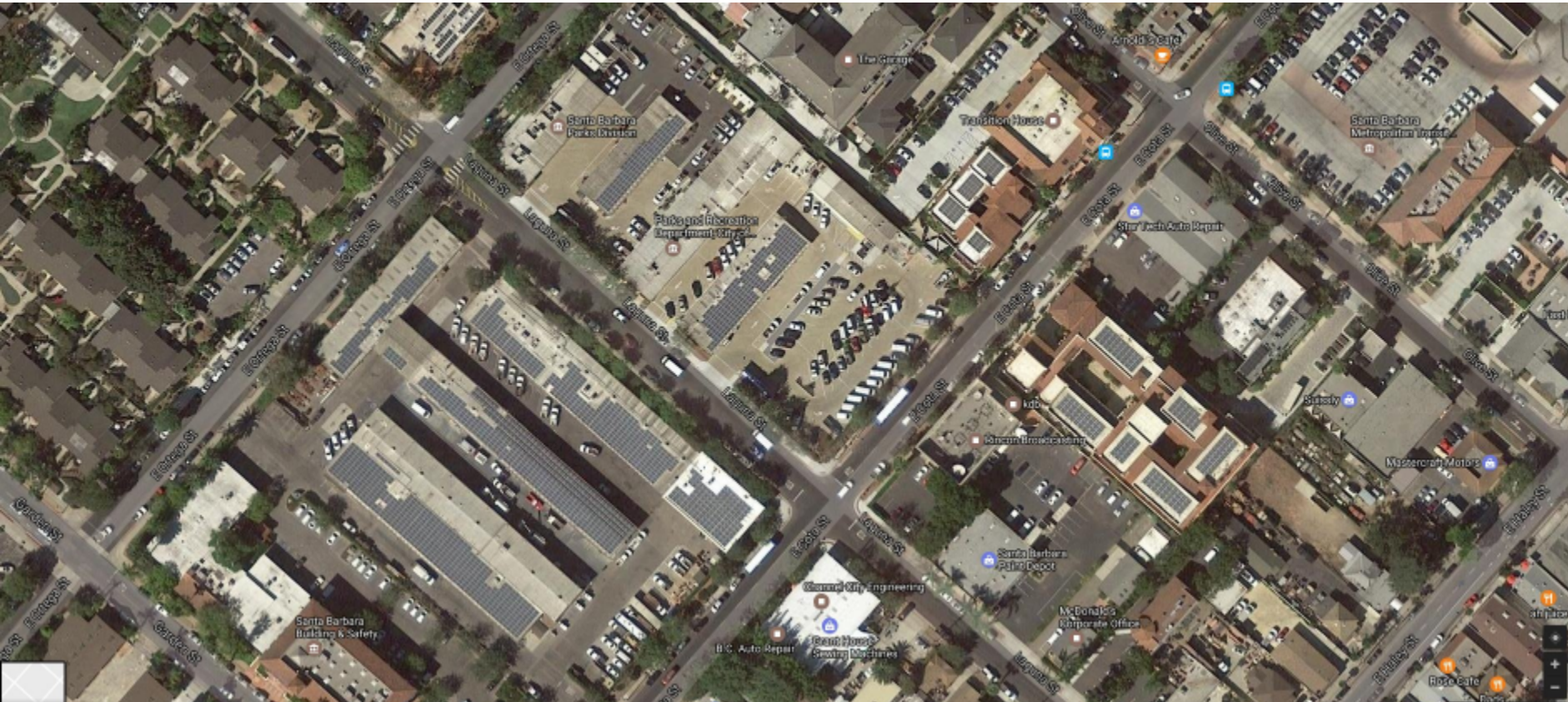
Ngong Hill Wind farm near Nairobi 24 MW



Solar farm near Kigali 6 MW



Cities as energy *prosumer* producer and consumer of energy: Energy transition



Use of solar rooftop in the city of Santa Barbara in the USA.

Conclusion

- This project is an ideal platform for promoting resources efficiency and green building concept in the housing sector in East Africa.
- The program has an integrated approach whereby all stakeholders are involved: from architects, building practitioners, decision makers, home owners, end users etc.;
- Tools are produced to assist architects in their new building design ;
- *Energy efficient building code* are also being promoted.
- The different passive building principles are being ***integrated in the building permit approval process.***
- Removal of **financial barriers through the creation of affordable line of credits** will accelerate the uptake of green building in the region.



THANK YOU FOR YOUR ATTENTION

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