SAMSET brief on Energy Efficient Buildings

This briefing note has been designed for use by city officials and planners working in sub-Saharan Africa. It is a practical guide, which identifies easy to achieve energy interventions that will save money (for cities, businesses and households), promote local economic development, and enhance the sustainable profile of a city. This note is specifically aimed as a support tool to achieve the implementation of key interventions within municipalities across sub-Saharan Africa.

African municipalities need to be prepared to deal with an explosion in demand for services from burgeoning populations caused by two factors – high population growth in Africa as a whole, and rapid urbanisation. An interesting feature of population growth in sub-Saharan Africa is that it is expected to take place mostly in small and medium sized cities, rather than capitals (UN-Habitat, 2010). These changes are taking place at a time when many countries are devolving administrative powers to local governments, yet municipal authorities lack the skills and expertise to address challenges, to manage resources, and to implement and enforce policies.

Energy is only one of many services that municipalities need to address in the face of increasing urbanisation, but it is crucial to any form of urban development – planned or otherwise. People need energy as part of their every-day lives. The supply of energy is closely linked to economic development, health and individual wellbeing, as well as to local and global environmental sustainability.

Recognising the emerging role of municipalities, with limited capacity, in addressing energy provision in urban centres, the "Supporting African Municipalities in Sustainable Energy Transitions" (SAMSET) project seeks to build capacity and develop a practical and effective knowledge exchange framework for supporting actors involved with municipal energy planning. This note is an output of the SAMSET project.

The purpose of the note is to give planners an idea of the range of energy interventions that it is possible for them to implement at the municipality level. It provides enough information to give a basic understanding of different energy technologies – enough to start making enquiries and engage in discussion. More detailed technical expertise will, however, be needed in order to design a bankable project.

Full guide can be found at africancityenergy.org/uploads/resource_101.pdf

More info can be found at africancityenergy.org/

More project info can be found at samsetproject.net

Overview

According to some reports, buildings are responsible for about 20% of global energy consumption. They therefore represent a significant arena where energy savings can be made and clean energy introduced.

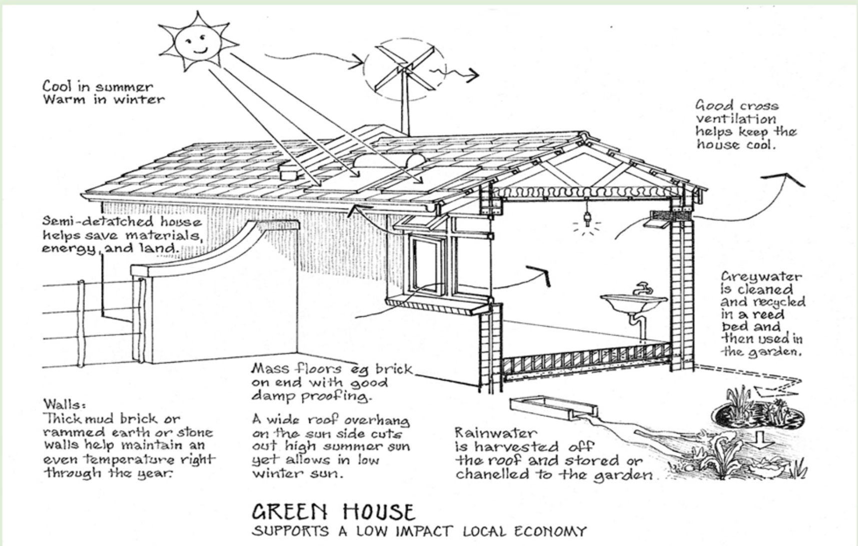
When a building is built some of its design commits the user to a certain level of energy consumption for the next 20 to 40 years. Some efficiency measures can be undertaken, but sometimes the core design cannot be mitigated. For instance, a large office block with many glass windows in a tropical location demands air conditioning to keep its inhabitants cool. This stands in contrast to planning a set of offices with passive solar cooling at the design stage.

While the best energy transitions will be considered at the building design stage, this note suggests some ways in which energy transitions can nevertheless be retrofitted to buildings. Energy efficient building encompasses efficient design and orientation methods through to the technology used inside a building to make space cooling (or heating) more efficient.

This brief draws heavily on work by UN Habitat who have detailed documentation on possibilities.

The Role of Municipalities

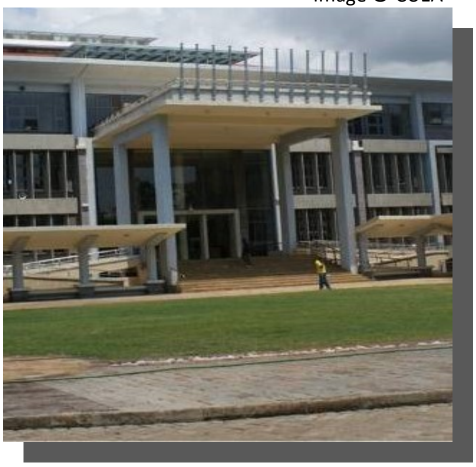
Municipalities have a more direct control over the building environment. It is generally the law that new buildings must comply with local planning and building regulations. This becomes a part of the authorities' resources to guarantee the right to sustainable cities and safeguard a healthy and comfortable urban environment.



Case study: The Learning Resource Centre at Catholic University of Eastern Africa

The LRC (Learning Resource Centre) at the Catholic University of Eastern Africa in Karen is an inspiring development. It is an example of ecologically sustainable design in the region. The LRC consists of three buildings namely a 3000 seater ultra modern library, a 1,200 seater state-of-the-art conference facility and a 500 seater cafeteria, all arranged around a 50m by 40m central square and tied together by a covered walkway with outdoor seating.

Image © CUEA



The strategies used include: **The Buildings orientation**: Sun-movement dictated the orientation of the buildings with their long axes along East – West with most of the windows on the North and South facing facades. **Sun-shading of glazed areas**: All glazed areas are fully sun-shaded throughout the project with diverse devices such as precast concrete fins, concrete egg-crate, and horizontal metallic sun shading devices to avoid monotony. **Use of natural ventilation to provide cooling**: The "Stack Effect" principle is used in removing exhaust air in all the buildings. The natural pressure difference between the buildings interiors and the rooftops is enhanced by the exhaust "chimneys" protruding from the top of the library and conference hall capped with ventilation cowls. The project uses **high thermal mass (thick walls)** to reduce solar heat gain through the external walling. **Choice of materials**:- The buildings use locally available materials, with low embodied energy, with none or minimal maintenance. **Renewable energy**: Wind energy is utilised in operating the ventilation cowls above the thermal chimneys. **Rainwater harvesting** is incorporated into the development, with an underground water storage tank whose top doubles up as the podium for an outdoor amphitheatre. The harvested water is used for irrigation and cleaning purposes. **Sanitation**: Use of environmentally friendly sewerage system. The sewerage system for the entire campus consists of oxidation ponds, which is environmentally friendly. Waste from the washrooms in the LRC is directed to these ponds, ensuring high standards of environmental sanitation. **Outdoor landscaping** has been done using evergreen local plants, especially fruit trees defining 'outdoor rooms' and creating unique visual interest. In addition, ramps for the physically challenged have been

Energy and Resource Efficiency in Buildings Codes are to achieve a rational use of energy and natural resources required for the construction, operation and demolition of buildings whilst providing indoor comfort, reducing consumption to sustainable limits and getting a portion of this consumption from renewable energy sources during their design, construction, use and maintenance.

The Case

The majority of modern buildings in sub-Saharan Africa are based on designs used in temperate climates in the Western world. Tall buildings with insufficient air flow and blocks of glass windows that trap the heat mean that buildings are heavily reliant on artificial means to create indoor comfort. The building is committed to mechanical air conditioning and always-on lighting in order to create a reasonable working environment. This intensive input of energy leads to inherently high energy consumption.

While 'modern' buildings may look good externally, the first step in creating a comfortable building without spending the money for mechanical equipment is to understand the relationship between the climate and the need for shelter. Commissioning a building is a complex process and there are many factors to consider, but a good architect, if asked to include energy efficient design, will be able to take into account the climate for minimal extra cost.

For instance, where the climate is hot and humid the walls can make a long term difference - lightweight walls with low thermal capacity will enable excessive heat to dissipate. Even painting can make a difference - a light colour exterior can reflect solar radiation (cooling the inside) and a light colour interior enhances the use of day light inside. In comparison, in a hot arid situation, heavyweight walls with high thermal capacity resist the dry heat building up.

Such action creates minimal extra expense and can often be done within the original budget. It is a role for the municipalities to encourage such building design.

Potential for Rollout

Passive solar design reduces energy consumption and ensures comfortable accommodation. It is perhaps at the forefront of energy efficient building design. The sun's movements, the prevailing wind direction, and changing temperatures and humidity are local climate conditions that vary from place to place and must be considered.

Orientation: North-south alignment minimises solar gains into the building. This is more effective the further away from the equator you are. It has limited impact at the equator.

Shading: Suitable roof overhangs minimise solar gains through windows

Windows: Sensible fenestration (windows) let in light but capture heat from the sun. Limiting glazed area helps retain cool (or warm) air inside when needed.

Natural ventilation: Suitable ventilation provides fresh air and cool breezes, so rooms can be ventilated as needed using airbricks, forced ventilation or by opening windows.

Lighting: Natural lighting through windows and light wells reduces the need for artificial lighting.

Building Materials: Materials such as concrete floors and brick or clay walls absorb heat from direct sunlight and releases it again at night.

Insulation. High thermal inertia materials (in roof and walls) help keep building cool in hot seasons and warm in cold seasons.

Landscaping: Planting trees or shrubs to block strong winds, and to provide shade and reduce sunlight reflection, helps to reduce the need for artificial heating and cooling.

Solar home systems. Provide artificial

light and power for low capacity domestic appliances (e.g. radio, TV) where there is no grid connection. Electricity generated from PV panels avoids emissions associated with grid electricity generation (e.g. coal fired power stations).

Water management. Rain water harvesting and waste water recycling reduce demand on utility systems (and costs to consumer).

Technological Efficiency

As discussed above, most modern buildings have not been built keeping passive solar design in mind and rely on technology to regulate internal temperatures. Technological interventions can still increase energy efficiency in these buildings, as well as in passive solar designed buildings. Some technological interventions are:

Installation of efficient heating, ventilating and air conditioning (HVAC) systems if required.

Installation of solar water heaters. They are financially viable and result in substantial savings on electricity bills .

If needed, energy efficient lighting retrofits are financially viable, and can pay for themselves in anything from a few months to 2.5 years .

Using 'fresh' air to cool a building down at the start of the day. The outside air, even in summer, is fresh and cool early in the morning and by switching the air conditioning system's fans on, the cool, natural air is drawn into the building.

HVAC technology has also improved greatly over the last few years, and efficiencies of these systems are far better. For example some new air conditioning systems are 30% more efficient than their older counterparts.

Creating awareness is important. Educating building owners and eventual building owners on the benefits of passive solar design will make them aware of the potential energy savings. Building awareness programs can be launched within cities to promote passive solar design and to facilitate relationships among designers, suppliers, contractors, and buyers.

Municipalities can contribute to Green / energy efficient building guidelines or codes that are a key instrument in encouraging sustainable design e.g. SABS Green Building Standards in South Africa. Cities are mandated to enforce building regulations established by national government. As all new building plans must pass through the City for approval, this provides an important opportunity to intervene to either encourage (guidelines) or prescribe (regulation) energy efficient building interventions. Some cities have explored developing local energy efficiency building regulations, but have since abandoned this process given that building regulations are established nationally in order to promote uniformity within a vast sector, where a plethora of local standards creates conflict. Many national governments are in the process of exploring how to incorporate energy efficiency into the National Building Standards.

Often owners and developers of buildings are not the ones going to work or live in that building. They therefore do not particularly care if the running cost of the building is higher because of poor energy management since it is the tenant who will be paying for such costs. Demonstrating savings in ongoing costs could potentially make the building more attractive. If municipalities require developers to show the expected ongoing costs, they might persuade developers that they could command a higher rent and more profit from the tenant based on the savings made in utilities.

Developers believe that energy efficient buildings are more expensive than conventional buildings. However, there are many innovations that developers could

Case Study: Green Building, Cape Town

Being a promoter of sustainable energy approaches and practices, the founders of Sustainable Energy Africa wanted to show that a green office building could be built with limited financial resources. They aimed to do this through passive solar design and by reusing resources, recycling waste, reducing energy consumption, using clean energy sources, locally sourcing materials, and reducing water consumption.

Image © SEA

Interventions: - A number of passive solar design features were used to achieve the energy efficiency of the Green Building, including building orientation, shading and windows, and thermal mass. As a direct result, the energy required for heating and cooling has been dramatically reduced. Daylighting was maximized using clerestory, window area optimization, and avoiding deep office spaces. This has made the need for artificial lighting during the day almost obsolete. Hot water is generated with a solar water heater on the roof, where solar panels also generate electricity that is fed back into the City's power grid via a grid-synchronising inverter.

During the construction of the Green Building, recycled content was maximized by using recycled windows, doors, and timber flooring. Reconstituted bricks containing 92% recycled material were also used throughout the building. The materials and contractors were locally sourced, requiring minimum transport to the site.

Where water is concerned, the intention is to reduce water usage, and to collect and re-use water wherever possible. Water consumption has been reduced by using multi-flush toilet cisterns and low-flow taps and shower heads. Recycled grey water and harvested rainwater take care of the water requirements of the water-wise and functional garden. External paving in the parking lot of the Green Building allows water seepage into the aquifer.

The result of the Green Building's interventions is a building that surpasses most energy efficiency targets. An office building is considered efficient if it uses less than 100 kWh/m^2/year. The Green Building uses only 30 kWh/m^2/year, whereas conventional offices use 250 -400 kWh/m^2/year. The cost of building green was 30% lower than the cost to build a conventional building, and the value of the building increased by 32% after two years.

introduce that are cost the same as conventional buildings.

Contractors build the way they always have. It is common in SSA for contractors to ignore the designs of architects and build based on their own understanding. They are reluctant to try new techniques because if the new technique goes wrong they will be liable. Developers, architects and contractors need to discuss what can and should be done all throughout the design and build phases.

Contractors purchase what is available on the market. If low energy light bulbs are not available, contractors will default back to conventional light bulbs. The same applies to materials, water systems, air conditioning – contractors are often obligated to finish a job within a timeframe and if the market doesn't hold the right stock, substitutions will be made.

Municipalities can play a role in encouraging teamwork between developers, architects and contractors. They can assess the local market and see if energy efficient products and fittings are available, and give incentives to shop keepers to stock such items. They can run seminars and workshops, creating an awareness among the contractors. Even in a large city there are relatively few firms capable and qualified to build large buildings – it is therefore not impossible for planning officers to have an actual relationship with contractors and discuss green design.

Implementation

Municipalities can encourage energy efficient construction through a number of instruments.

Green buildings certification

Building codes and enforcement

Capacity building at the municipal level (planning applications and enforcement of building standards)

Awareness raising: persuade developers of the benefits of energy efficient construction and design

Advocate national government for fiscal incentives to encourage energy efficient construction and design

Green Building Rating System:

In order to objectively assess how "green" a building is, standards and benchmarks must set. This can be done using a system like that of Green Star from Australia.

Green Star is a rating system that evaluates the environmental design and achievements of buildings. It is a voluntary program that is in place all across Australia. It assesses the environmental impact resulting from a projects site selection, design, construction, and maintenance.

It has been customized for South African use, and is currently only applicable to commercial buildings. The Green Building Council of South Africa (GBCSA) is licensed by the Green Building Council of Australia (GBCA) to allow certification using the Green Star SA v1 rating tools in South Africa, Ghana, Namibia and Mauritius.

Green Star was developed in order to promote integrated, whole-building design, to recognise environmental leadership, to identify the life-cycle impacts of a building, and to raise awareness about the benefits of building green. A credit system results in a corresponding Green Star Certified Rating that is based on the following nine categories: Management, Indoor Environment, Quality, Energy, Transport, Water, Materials, Land Use & Ecology, Emissions, and Innovation.

Case Study: Heritage Place, Lagos

Heritage Place is Nigeria's most ultra-modern, advanced and eco-friendly development, employing the latest building principles and state of the art finishes. It is also the first environmentally certified building in the city of Lagos. This case demonstrates that new environmentally friendly buildings can matched the grandeur and elegance of modern building design.

Image © Heritage Place

Key attributes of the building include the environmental friendly approaches adopted in the construction of the complex. These include water recycling and reuse. Rain water is harvested, water is reused in the irrigation of the gardens and there is a condensate recovery of water from the building's cooling units. Accurate control systems were placed in the bathroom facilities to reduce water wastage all through the building.

The building is also very energy efficient which will have a positive impact on its tenants' bottom-line. Deliberately positioned to maximise natural light and ventilation and at the same time minimise solar exposure and the energy requirements for heating, cooling and air quality systems, the building offers its tenants a 30-40% reduction in energy use compared to that of other buildings in Lagos.

This document is an output from a project co-funded by UK aid from the UK Department for International Development (DFID), the Engineering & Physical Science Research Council (EPSRC) and the Department for Energy & Climate Change (DECC), for the benefit of developing countries. The views expressed are not necessarily those of DFID, EPSRC or DECC, or any institution partner of the project.

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SAMSET Supporting Sub-Saharan Africa's Municipalities with Sustainable Energy Transitions