SAMSET brief on Energy Efficient Lighting

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

Lighting currently is responsible for 19% of global electricity consumption. By 2020 it is predicted that the lighting market will grow to £94 billion of which 80% will be generated from general lighting.

Domestic lighting

Solar home systems and solar lanterns (or pico-lighting systems) are a high profile success story of recent times. Their success is due to advances in several technologies – batteries (falling costs of lithium ion batteries in particular), PV cells (falling prices), mobile payment systems (enabling pay as you go services), and LED lights.

In the last five years, advances in Light Emitting Diode (LED) based lighting have been dramatic – falling prices, increased light output, and improved quality of light. LED lamps are replacing Compact Fluorescent Lamps (CFLs) as the efficient technology of choice because they are even more efficient and are becoming cheaper. GE have even stopped making CFLs. LEDs are also emerging as the technology of choice for street lighting. Low energy consumption means that streetlights can be powered by integrated PV panels, eliminating the need to install electrical infrastructure.

For the last two decades, CFLs were considered energy efficient lights. CFLs are a cost-effective option for most general lighting requirements. Replacing a traditional light bulb with a CFL of the same brightness will save you about $8 per year, or $100 over the lifetime of the bulb.

Street lighting

Street lighting as a service to be provided by municipalities offers a range of benefits. It increases security and improves safety, but there are also economic benefits as enterprises in 'safe' areas can stay open longer after dark. Whichever bulbs are used, it is important to move away from incandescent bulbs and mercury vapour streetlights.

Business efficiency

Efficient lighting programmes can be implemented in several areas within cities, including the following:

Replacing traditional incandescent bulbs with LEDs (or compact fluorescent light bulbs (CFLs)).

Replacing old fluorescent tubes with efficient fluorescent tubes or the new LED based tubes

Case study: LED Traffic lights

Some new traffic lights are being made out of arrays of light emitting diodes (LEDs). These are tiny, purely electronic lights that are extremely energy efficient and have a very long life. Each LED is about the size of a pencil eraser, so hundreds of them are used together in an array. The LEDs are replacing the old -style incandescent halogen bulbs rated at between 50 and 150 watts. LED units have three big advantages:

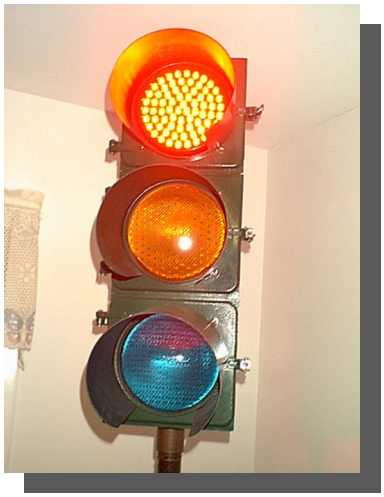


Image © Autronic Plastics Inc

LEDs are brighter. The LED arrays fill the entire "hole" and have equal brightness across the entire surface, making them brighter overall.

LED bulbs last for years, while halogen bulbs last for months. Replacing bulbs costs money (trucks and labour costs) and it also ties up traffic. Increasing the replacement interval can save a city a lot of money.

LED bulbs save a lot of energy.

The energy savings of LED lights can be huge.

Assume that a traffic light uses 100-watt bulbs today. The light is on 24 hours a day, so it uses 2.4 kilowatt-hours per day. If you assume power costs 15 US cents per kilowatt-hour, it means that one traffic signal costs about $0.40 a day to operate, or about $130 per year. There are perhaps eight signals per intersection, so that's almost $1,000 per year in power per intersection. A big city has thousands of intersections, so it can cost millions of dollars to power all the traffic lights. LED bulbs might consume 15 or 20 watts instead of 100, so the power consumption drops by a factor of five or six. A city can easily save thousands a year by replacing all of the bulbs with LED units. These low-energy bulbs also open the possibility of using solar panels instead of running an electrical line, which saves money in remote areas.

in local government and commercial buildings.

Replacing magnetic ballasts with electronic ballasts in fluorescent tube systems.

Installing lighting control systems (people and lux level sensors)

Using LED technology wherever possible. This is getting more accessible as more LED appliances come on the market. LED's have several energy and cost saving applications, such as traffic lights and downlighters.

LEDs also appear to be emerging as the technology of choice for streetlighting. High pressure sodium lights still offer savings over the old mercury vapour lights, but LEDs have become even more efficient, and offer good light quality.

Simple awareness campaigns encouraging people to turn lights off when not needed can make a big difference.

The Case

Residential consumption in sub-Saharan Africa is estimated to be 22% of the total electricity demand (2010 figures). However, residential demand is expected to grow faster than industrial / commercial demand so that it will account for around 30% of electricity by 2040. Lighting will make up a substantial proportion of residential demand, in particular.

Using low energy devices, modern controls, and good lighting management (switching off when not needed) can all help reduce electricity consumption. From a city and national perspective this will have the following benefits:

- The reduction in energy consumption, and in particular peak demand, will improve energy security of a city by reducing the load placed on the national grid, resulting in reduced load shedding and blackouts.
- Reduction in demand from the residential, local government and commercial sector means that fewer power stations need to be planned for in the future.
- Lower costs to consumers

From a home owner's, a business owner's, or local government's perspective, installing efficient lighting technologies also has several benefits:

- Although efficient lamps are more expensive to buy, they tend to last longer. Typical lifetimes are 1,000 hours for an incandescent bulb, 10,000 hours for a CLF, and 25,000 hours for LEDs. The longer lifecycle of efficient lamps also means lower maintenance costs to a business or a local government building.
- Roughly speaking, a 13W CFL will produce the same amount of light as a 60W incandescent bulb, but LEDs are even more efficient, so a 7W LED bulb will produce the same amount of light. Replacing a traditional light bulb with a CFL of the same brightness will save you about $8 per year, or $100 over the lifetime of the bulb. However, replacing with an LED bulb will save $9/year but because the life is so much greater, it will save over $200 over its lifetime. These figures are based on an electricity cost of 17 US cents/kWh, so savings will be higher in countries with higher electricity costs (e.g. Kenya, Uganda), and lower in countries with lower electricity costs (e.g. Nigeria, South Africa).
- At this point in time, CFLs are roughly two or three times the price of an incandescent bulb (i.e. $1.50), and LEDs are about five times the price ($3.00). However, the price of LEDs continues to fall, and it will get more difficult to find CFLs as they get phased out.
- From an environmental perspective, lamps that use less electricity will reduce the amount of CO2 released to the atmosphere. Estimates of the amount of CO2 that a low energy bulb will save vary enormously (e.g. 40 kg – 800 kg over the lifetime of the lamp). The actual amount saved will vary from country to country depending on the mix of fuels used to generate electricity, so CO2 savings will be high in South Africa, for example, where most electricity is generated from coal, but savings will be negligible in DRC, which depends almost exclusively on hydroelectric power.
- Improved quality of life through a reduction in electricity costs for a low income household where the proportion of energy costs to income is very high.
- A 36W efficient fluorescent tube provides the same amount of light as a standard 40W fluorescent tube. Installing electric ballasts will also improve efficiency. Using both will improve efficiency by as much as 25%.
- Installing sensors in the building which only switch on lights in the presence of a person and insufficient lux levels have reduced the lighting electricity component of buildings by up to 80%.
- Studies have shown that through behavioural changes, up to 10% reduction in lighting energy consumption can be achieved in a building.

CFL bulbs are an effective efficient light source and as shown above have many benefits. They are more economically and environmentally friendly than translucent bulbs and are already being implemented in African cities of which their effectiveness has been noted. However, LEDs should be preferred over CFLs as they are yet more efficient, and they are more environmentally sustainable as they do not contain mercury or any other hazardous substances.

Lighting Behavioural changes:

- If room is well lit use natural, not electric, light.
- Turn off lights in unused rooms
- Use task lighting over ambient lighting wherever possible

Real business experience from implementing such interventions in buildings has shown the technologies paying for themselves in anything up to 2.5 years. These real examples make a very strong case for energy efficient lighting implementation wherever businesses, households or government buildings are trying to cut back on costs.

Potential for Rollout

As stated earlier, CFL lighting is currently dominating markets in Africa and is replacing incandescent bulbs. Despite this being an improvement, there is room for further improvement as LED lighting is set to become a dominant feature in the lighting industry.

LED technology has been an instrumental part of the success of solar home systems, which get their electricity from PV solar cells. PV itself is the conversion of light into electricity - a resource which Africa isn't lacking. A Lighting Africa report estimates that in 2012, only 4% of off-grid households in Africa had lighting systems, so there is plenty of potential for further growth.

For street lighting, high pressure sodium (HPS) is a suitable and improved light source when compared to older technologies, but LED streetlights offer another step forward in improving light efficiency.

Barriers to Implementation

Building owners will not pay for efficient lighting interventions when their leaseholders are the ones who gain financial benefits: Most commercial buildings are occupied by businesses which pay rent to the building owners. The businesses are responsible for their own electricity bill. It therefore makes no sense for the building owner to implement efficient lighting systems as they do not reap a financial benefit from the intervention. Businesses planning to occupy the rented office space for a period of two years or longer should investigate making the financial investment, even though it is not their building. Businesses which have implemented efficient lighting interventions typically show a return on investment within 2.5 years – a very attractive business proposition. Building codes should specific minimum lighting efficiency standards for new buildings

Lack of information and awareness: There is the perception that low energy lamps are expensive, and this is particularly a problem for low income electrified households. Although the lifecycle savings of LEDs are well documented, the initial cost seems to be the deterrent. However, this price is only decreasing on the market and the price of bulbs is becoming affordable. Awareness around the benefits of LEDs and CFLs needs to increase with mass rollout programmes and energy efficiency advertising campaigns. The CDM methodology for large scale efficient lighting projects for low income houses will be approved shortly and this will subsidise the installation of LEDs in these areas.

Inertia in procurement process (use existing suppliers and technologies): Governments and large corporations are often tied to procurement policies which dictate that a particular supplier or technology must be used. In the case of lighting, these suppliers often don't supply energy efficient options. Staff involved with procurement are often not aware of the energy efficient options available. Some buildings are tied to maintenance contracts with similar problems.

Cheap technologies have given good quality CFLs a bad name. Many countries are introducing appliance energy performance standards as well as labelling schemes. These are aimed at giving consumers confidence that appliances they buy will last a minimum time.

CFLs contain mercury vapour, which makes safe disposal difficult. The safe disposal of CFLs is an important environmental issue which cities, within an efficient lighting programme, need to give serious consideration. Any efficient lighting programme MUST be accompanied by a safe disposal programme.

Seasonal weather: Due to geography, many countries can experience electricity blackouts, especially during the dry seasons. For example, Ghana is heavily dependent on its hydroelectric output and regular droughts can affect electricity production which relies on the Akosombo Dam.

Design: LED units often produce a narrower beam of light, so simply replacing existing lighting with LED replacements could cause low levels of light. A poor design may also then lead to the lighting solution actually consuming more energy than an alternative lighting source. This won't provide a problem if there is a good, well thought out lighting design.

Implementation

The business case for energy efficient lighting is so strong that all buildings should be implementing appropriate efficient lighting technology wherever possible. Paybacks of a few months for a low energy lamp replacement to 2.5 years for a commercial retrofit are typical.

Typically an energy services company or ESCO should perform this work. In most cases the ESCO will arrange the financing of the project and implement it, while the end user and the ESCO share the energy savings resulting from the work. Alternatively the ESCO will merely implement the required interventions at the end user's cost. ESCOs can operate in both large commercial or government buildings, as well as in residential areas. ESCOs typically offer a suite of energy efficiency interventions, but efficient lighting is often the most attractive starting point from a payback perspective.

Case Study: Solar Home System Kit

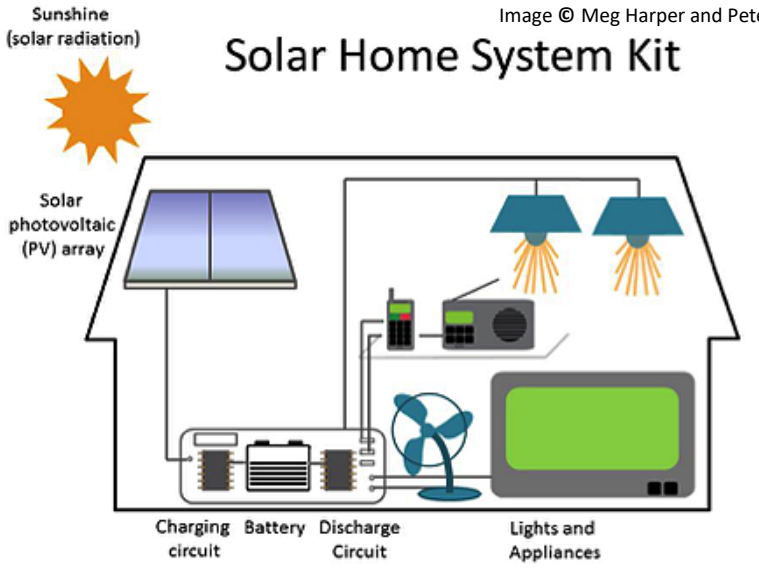
Decreasing costs not only in LEDs but also solar PV modules and rechargeable batteries has enabled and facilitated the development of larger solar home systems which are made affordable to many of those in the off-grid market.

Organisations including Lighting Africa will enable the spread of such LED products such as the solar system kit as well as other appliances across sub-Saharan Africa. As of the end of 2014, eight million quality verified pico-solar lights have been sold.

Ghana is one country that is aiming to adopt these solar home systems, which shows that such a programme feasible, for countries within sub-Saharan Africa and can be achieved in a short space of time.

In Ghana, there are plans which aim to deploy up to 2 million solar lanterns and 30,000 solar home systems by the year 2020.

The Uganda Renewable Energy Policy has set the target to increase the share of their modern renewables in total energy consumption to 61% by 2017. Although this isn't directly involving energy efficient lighting it highlights how Uganda is aiming to promote and achieve more efficient practices which will include lighting efficiency.



City buildings and council housing retrofits and ongoing procurement processes

Cities need to develop policy and strategies around energy efficiency in council buildings and premises and in council-owned housing. This will provide overarching direction to the city's intent to move towards energy efficiency in lighting. Implementation of the strategy then requires:

Locating responsibility for retrofit with a specific line department.

Identification of building stock and a programme of retrofit.

Identification of financing for building retrofit. This may come from internal sources through usual budgets for maintenance of building infrastructure costs (and making the case to city finance departments that future savings more than justifies the upfront additional capital costs). Additional capital costs can also be met through funding sources such as ESCOs

Longer term implementation requires that City procurement policies be adjusted to ensure that efficient lighting is routinely procured and installed. This may also require a capacity building process amongst staff involved in lighting procurement. Such capacity building would need to ensure that building maintenance staff is aware of the safe disposal requirements for CFLs.

City Streetlight Programmes

Replacement of old mercury vapour streetlights with high pressure sodium (HPS) streetlights is becoming the norm within cities, due to the huge energy and financial savings achievable. Efforts should be made to install LED streetlights wherever possible. Solar powered LED units offer a cost effective means of extending street lighting into new areas.

Voltage reduction devices to dim the lights are a viable approach to further daily energy reductions.

Awareness programmes

As the business case for energy efficient lighting is so strong, the city can assist in raising awareness generally and in focused areas of the city.

Awareness needs to be built amongst staff involved in the procurement and maintenance of lighting in government and large corporations, highlighting the sustainable benefits of using efficient lighting. There also needs to be continued education of the population at large of the benefits of using low energy lamps, as well as the need for careful disposal.

Cities can promote efficient lighting through environmental education campaigns, household environmental campaigns and building partnerships with business to address energy efficiency.

Distribution of Free LED Bulbs Projects

Distribution of free (or subsidised) LED bulbs can form part of demand side management strategies aimed at reducing the load on the grid. Projects like this have emerged in Uganda for example, where every grid connected domestic and small commercial electricity customer has received LED bulbs. Initiatives like this aim to effectively reduce energy consumption.

Regulation

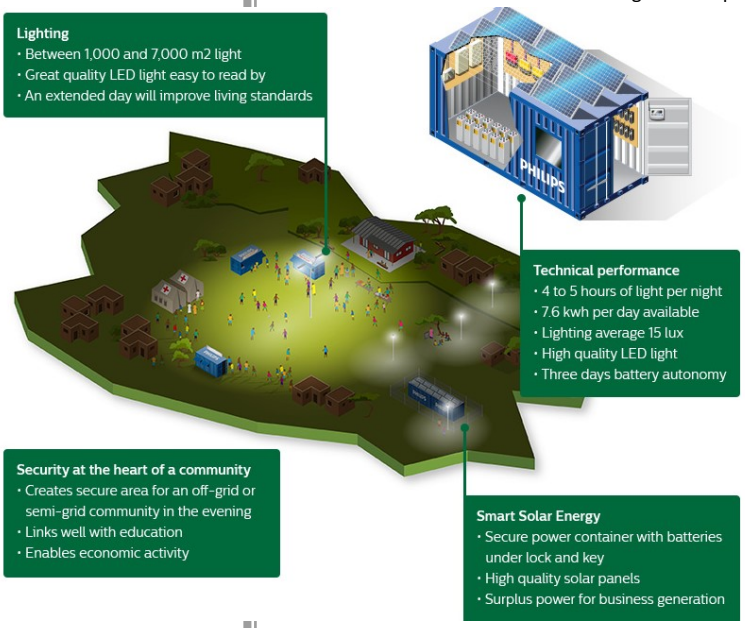
Given the advantages of efficient lighting over traditional tungsten filament bulbs, governments across the globe have initiated measures to ban incandescent bulbs. The European Union banned imports of 100W bulbs in 2009, and then 60W bulbs by 2011, and all incandescent bulbs by 2012. Some developing countries including India and the Philippines have also made moves to phase out incandescent lamps. Whilst banning products can be legally and procedurally complicated, other routes, such as voluntary programmes, internal procurement and building management decision, seem to be more appropriate.

CFL lighting disposal

Local authorities are responsible for waste disposal services and need to ensure that safe CFL lighting disposal programmes are part of their waste disposal campaigns.

Case Study: Phillips LED Lights

Image © Phillips



Benefits of Security Lighting:

Quick charging and long lasting working hours

- Takes only 5 – 10 minutes to install
- Can provide up to 100 square meters of light
- Easy to transport

Can be used for:

- Social activities
- Security companies
- Construction sites
- Emergency lighting

This LED security light offers a fast, sustainable source of light for night time activities. Due to its ease of accessibility and transportation it makes it readily available for both businesses and communities.

As well as aiding security issues, it can also be used for social activities for communities at times where usually they would not be able to have such access.

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