5. Energy efficient lighting implementation

5.1 Overview

A Compact Fluorescent Light (CFL) uses five times less energy than an equivalent incandescent bulb

It has been estimated that electricity for lighting consumes almost 20% of the output of the world's power stations. The use of energy efficient lighting is one of the best and most cost effective ways of reducing our national energy consumption. Efficient lighting programmes can be implemented in several areas within cities:

- Replacing traditional incandescent bulbs with compact fluorescent light bulbs (CFLs).
- Replacing old fluorescent tubes with efficient fluorescent tubes 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 light emitting diode (LED) technology wherever possible. This is getting steadily cheaper and more accessible. LED's have several energy and cost saving applications, such as traffic lights and downlighters.
- Making streetlights more efficient through the use of high pressure sodium lights instead of the old mercury vapour light. Sodium lights operate on just over half the power of the mercury vapour light, and last up to 6000 hours longer.

5.2 The case

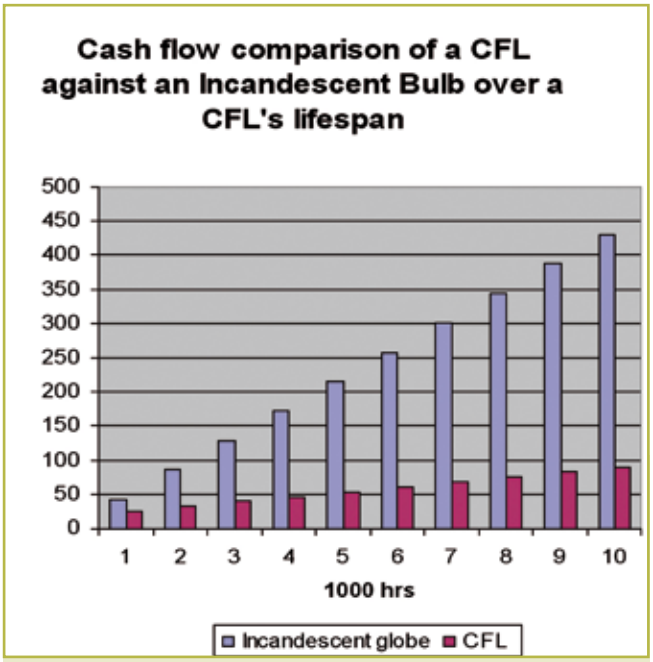
The residential and commercial sectors in South Africa together consume 21% of the country's electricity. Lighting makes up approximately 12% of the total electricity used in this area. By replacing existing incandescent light bulbs and fluorescent tubes with compact fluorescent light bulbs (CFLs) and efficient fluorescent tubes, this figure can be reduced by up to 75%. Further reductions can be expected from the installation of electronic ballasts and lighting control systems. LED installation where relevant and feasible should also be considered.

From a city and national perspective this will have the following benefits:

- The reduction in energy consumption and in particular peak demand from the use of efficient lighting will improve the energy security of a city through reducing the dependence that the city has on the national grid.
- Reduction in demand from the residential, local government and commercial sector means that fewer power stations need to be planned for in the future. Eskom has recognized that efficient lighting will play a major role in its demand side management (DSM) process.

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

- A Compact Fluorescent Light (CFL) is expected to last 10 times longer than an incandescent bulb. Over the life cycle of a CFL, its capital cost (approximately R25) is less than that of the capital cost of 10 incandescent bulbs (approximately R40). The longer lifecycle of a CFL also means lower maintenance costs to a business or a local government building.
- A CFL is 80% more efficient than an incandescent bulb. This means that the same amount of light can be generated using 1/5 of the power. Over the lifetime of one 18W CFL (the equivalent of a 100W incandescent) which is approximately 10 000 hours, a saving of 800kWhrs of electricity will be achieved amounting to R480 of electricity saved per CFL (using today's rates).
- From an environmental perspective, approximately 800kg of CO_2 will be saved over the lifetime of one CFL compared to the equivalent incandescent, assuming that the electricity source is a coal based power station.



This graph compares the cost of purchasing and using a CFL with the cost of purchasing and using an incandescent bulb over the same time frame. In this case an 18W CFL (costing R18 with a lifespan of 10 000 hrs) is compared with a 100W incandescent bulb (costing R3 with a lifespan of 1000 hrs).

Lighting Behavioural changes

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

- 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.

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.

LEDs (light emitting diodes) of the future?

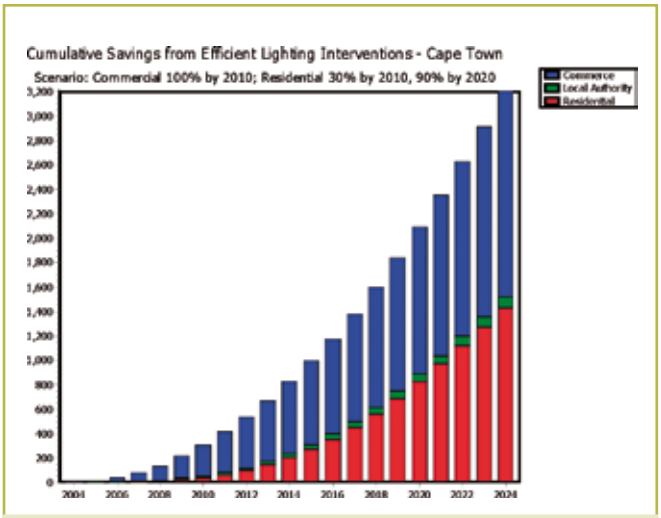
LED downlighters are much more efficient than the conventional halogen downlighters. They typically use 2 Watts, compared with the 35 Watts of a halogen. They also last much longer – over 50 000 hours. LED prices are still relatively high, but decreasing fast as this technology becomes more mainstreamed. Besides downlighters, LEDs can be used in traffic lights and streetlights too.

5.3 Potential for rollout

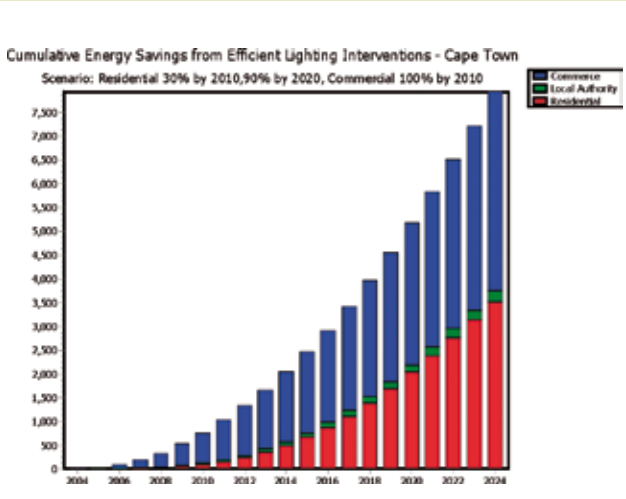
There is great potential for a mass rollout of efficient lighting in cities throughout South Africa. The technologies are tried and tested, and are available on a large scale if required. To demonstrate the impact of a mass rollout of CFLs and efficient fluorescent tubes within a city, we will consider the case of Cape Town

Cape Town has the following penetration targets set for energy efficient lighting in its energy strategy:

- Commercial and Local Authority 100% by 2010,
- Residential 30% by 2010 and 90% by 2020



Energy savings
Achieving city targets will mean 8 million MWh of electricity saved by 2024.



Carbon savings
On the carbon saving side, if the city achieves its targets, over 7.5 million tonnes of CO2 will have been saved by 2024.

Financial analysis

Considering rollout from a project cost perspective using the same scenario, R882 million will be saved from both reduced capital costs and energy saved, based on today's electricity and light bulb costs.

Poverty alleviation

Each CFL used in a low income house will save more than R300 over its lifetime. This is a substantial saving for an impoverished household.

5.4 Barriers to implementation and efforts to resolve these

Building owners will not pay for efficient lighting interventions when their leaseholders 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.

Effort to Resolve

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.

Lack of information and awareness: There is the perception that CFLs are expensive, and this is particularly a problem for low income electrified households. Although the lifecycle savings of a CFL are well documented, the initial cost seems to be the deterrent.

Effort to Resolve

Awareness around the benefits of CFLs has increased thanks to Eskom's various 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 CFLs in these areas.

MFMA makes cities reticent to enter into contract agreements with ESCOs: The Municipal Finance Management Act makes it difficult for Cities to enter into contracts with service providers that last longer than three years. Most shared savings agreements will last longer than this.

Effort to Resolve

The MFMA allows for a revision of a contract, provided the correct process is followed. Treasury will also consider an exemption clause should a compelling case be made for the contract. There is also a strong case for government building management to rather finance the retrofit and recover the money spent within three years.

City electricity departments want to 'sell' not 'save': Many cities depend heavily on their income from their electricity departments, and are more interested in selling electricity than saving it.

Effort to Resolve

Municipalities as large power users have been directed by national government to reduce their energy use by 10% over the next 3 years. This national directive has placed pressure on cities to find effective ways to reduce energy use, and will heavy hand electricity departments to develop strategies to save electricity.

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.

The City of Tshwane has green procurement guidelines. Download these at www.cityenergy.org.za/resources/green-procurement

Cheap technologies have given good quality CFLs a bad name.

CFLs cannot be used in dimmer applications.

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.

Responsible CFL disposal

In 2006, over 5 million CFLs were distributed within the Western Cape as part of Eskom's DSM programme. Many stakeholders, however, raised concern about the safe disposal of these lamps at the end of their life, because of the mercury found in the lamp. CFLs are hazardous waste and will need to be disposed of safely.

A task team, made up of Eskom, government, lighting manufacturers, waste disposal experts and NGOs has been established to look at safe ways of disposing CFLs. A recycling plant for CFLs is being planned and the safe disposal of CFLs will be implemented. To view the CFL disposal strategy document go to **www.cityenergy.org.za/resources/useful-documents**

5.5 How to go about 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 CFL 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.

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:

a) Locating responsibility for retrofit with a specific line department.

b) Identification of building stock and a programme of retrofit.

c) 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 and Eskom DSM

d) 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.

Voltage reduction devices to dim the lights are a viable approach to further daily energy reductions. For an update on streetlight technologies, go to www.cityenergy.org.za/resources/lighting

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 CFLs, 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.

ESCO programme with Working for Energy and EPWP

There is a strong case for ESCOs to operate in both residential and commercial areas. Not only will an increase in ESCOs in the country result in a reduction in national energy use, but it will also be a major employment creator. The government driven Working for Energy and Expanded Public Works (EPWP) Programmes have recognised this, and are looking to partner with Cities in driving ESCO development within the municipalities, with an initial focus on residential areas. Funding can be accessed for training of ESCO teams, as well as ongoing technical and business support. Cities can provide awareness to specific urban areas through notices in the rates bills, city newspapers and local bulletins to support the ESCO energy efficiency rollout programme.

Utility

Eskom, as part of its demand side management (DSM) programme, has indicated that it will subsidise suitable CFL projects by 50%. The money will only be made available subject to a project feasibility study done by one of ESKOM's approved energy services companies (ESCOs) and its subsequent approval from Eskom DSM. These projects can also have CDM benefits if they are large enough.

Eskom DSM provides a source of funding for cities striving to achieve efficient lighting targets.

Regulation

Given the advantages of efficient lighting over traditional tungsten filament bulbs, the Australian government has proposed placing a ban on the sale of tungsten bulbs. However, such action appears to be legally and procedurally complicated and at this stage other routes, such as voluntary programmes, internal procurement and building management decisions, 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.

5.6 Case studies

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:

- *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 40 cents per kilowatt-hour, it means that one traffic signal costs about R1 a day to operate, or about R365 per year. There are perhaps eight signals per intersection, so that's almost R2920 per year in power per intersection. A big city has thousands of intersections, so it can cost millions of Rands 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 millions 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.

Case study: Ekurhuleni Metropolitan Municipality – efficient

lighting in municipal buildings

The Ekurhuleni Metropolitan Municipality (EMM) presiding over 2.5 million residents, has been institutionalising a sustainable energy approach through conservation practices in its municipal buildings since 2005. The Germiston Civic Centre and EGSC buildings, serving as EMM's political head office and administration head office respectively, were identified for an energy efficiency retrofit in 2005.

Among the energy efficiency measures implemented in both buildings, was the replacement of conventional incandescent lights with compact fluorescent light bulbs (CFLs), the replacement of cool-beam down lighters with light-emitting diodes (LED) lights and the replacement of ninety-six, 8-foot double fluorescent light fittings with open channel-5 foot double fluorescent lights with electronic ballasts and installation of lighting timers.

In total 2003 CFLs, 90 LED lights and 2 lighting timers were used for the lighting component of the project. The CFLs were found to be highly efficient with a high return on savings after the initial capital outlay. The CFLs, designed to screw into standard sockets, made for an easy replacement of incandescent light bulbs. Substantial savings were amassed from the efficient lighting installations:

- *Pre retrofit energy use: 387 718 kWh/year*
- *Post retrofit energy use: 109 894 kWh/year*
- *Energy savings: 277 823 kWh/year*
- *Percentage of energy savings from the use of CFLs and LEDs: 75%*
- *Percentage of energy savings from the use of fluorescent lights with electronic ballasts: 13 %*

The emissions reduction for greenhouse gases represented in CO2 equivalent and other pollutants such as NOx and SOx were:

- *CO_2e reduction: 260 tonnes/year*
- *SO_x reduction: 2205 Kg/year*
- *NO_x reduction: 1 035 Kg/year*

This small scale retrofit project with regard to the lighting component alone resulted in 387 718 kWh of energy saved in one year, this represents an economic saving in the order of R369 126.00 with a payback period of less than year. This significant saving is enhanced by the additional benefits in GHG emission reduction: 260 tons of CO2e, 2.2 tons of SOx and 1.1 tons of NOx. Since the installation of the new lights, staff reported no equipment problems and had no complaints about the quality of lighting. Everybody seemed satisfied by the project.

EGSC Building

Germiston Civic Centre

8 foot double fluorescent lights

Lights timer set to switch on at 05h30 and switch off at 19h00

Lessons learned

It was found that in a retrofitting project involving the replacement of old equipment with new and more efficient technology was a swift way to save both energy and money. The project did not require a long time to implement. However projects involving municipally-owned buildings and municipal operations, may take more time due to council procedures and policies that need to be followed. Further challenges arise in interdepartmental collaboration within government, spanning the planning stage to the actual project implementation. It was also found that it was important to select appropriately skilled people and companies to perform the work. Since energy efficiency technology and equipment is relatively new in the South African market, difficulty arises in finding experienced tradesman to provide the necessary services. This is envisaged to improve as the demand from more local governments and institutions for energy efficient equipment increases.

Key replication aspects

The formulation of the policy on Energy Efficiency in Council Buildings and on Council Premises, the State of Energy Report, the draft Energy Efficiency and Climate Change Strategy of Ekurhuleni and the subsequent retrofit project are part of an easily-replicable strategy that can be applied to other South African cities interested in reducing energy costs and reducing the environmentally harmful impacts of their municipal operations.

The equipment purchased and implemented in the municipal buildings of Ekurhuleni was proven to be cost effective and are readily available in South Africa.

It is noted that the achievement of successful and efficient project implementation lies in the allocation of enough time by cities for the project during the planning phase as well as the assemblage of a motivated interdepartmental task team.

Case study: International experience

Energy efficient lighting, particularly CFLs, is a readily available technology which can be easily installed by consumers throughout the world. At one time, the price difference between CFLs and tungsten filament bulbs was prohibitive but economies of scale from mass production have reduced the differential. Additionally, some governments have provided subsidies to assist the market in energy efficient lighting to develop. As a result, the widespread availability of energy efficient lighting and expanding knowledge of its benefits has led policy-makers, such as those in Australia, to propose a ban on the sale of tungsten filament bulbs.

Whilst the growing switch to energy efficient lighting is a welcome development, the initial high cost of CFLs is clearly a problem for poorer consumers. However, practical solutions exist to overcome this barrier. Many electricity utilities have found it advantageous to provide energy efficient lighting at a reduced price or free to their consumers. The benefits of subsidised energy efficient lighting to electricity utilities were first appreciated in the 1980's in the United States of America where such demand-side management (DSM) measures enabled these companies to avoid expensive investment in new power stations. This approach has been translated, for example, into a recent DSM scheme in Karnataha State in India. Faced with an increasing peak capacity deficiency caused mainly by evening lighting demand, the local utility is enabling domestic consumers to obtain 1 million energy efficient lights and allowing them to pay the costs by installments through their electricity bills.

5.7 Support organisations

Key role-players to support Implementation of Efficient Lighting projects

National Energy Efficiency Agency (NEEA), a division of CEF (Pty) Ltd

Technical and financial assistance, as well as 'aggregated bulk procurement' opportunities from accredited suppliers.

NEEA is a division of CEF (Pty) Ltd and will initially oversee various components of the national (Eskom) Demand Side Management (DSM) and energy efficient projects in the country. These would typically include the retrofitting of public facilities (at a National, Provincial and Local government) level, general awareness creation and the formulation and recommendation of policy and regulatory tools required to meet the targets set in government's National Energy Efficiency Strategy for South Africa. NEEA will also look at a broader energy mix than electricity alone, including the application of energy efficiency in liquid fuels for the transport sector, renewable energy and gas projects.

CEF Head Office

Tel: 011 280 0300

Fax: 011 880 9803

Website: www.cefgroup.org.za

Eskom

Financial assistance

Eskom Demand Side Management (DSM) provides financial support to energy efficiency projects and is firmly committed to SWH project development and investment. Eskom has a list of approves Energy Services Companies (ESCOs) to perform retrofits.

DSM Help Desk

Tel: 011 800 4744

Website: www.eskom.co.za

Lighting Companies

Suppliers of energy efficient lighting technology.

Technical support and advice also offered.

Able to assist cities with the supply of energy efficient lighting technology such as compact fluorescent light bulbs, LEDs (light emitting diodes) and fluorescent lights with electronic ballasts.

Able to also provide technical support and advice to cities with respect to energy efficient lighting technology.

Some of the big lighting companies have donated substantial quantities of lights to municipalities and can be potentially approached in this regard.

A list of lighting companies from which energy efficient light lighting technology can be procured can be accessed at the following website: www.cityenergy.org.za

PEER Africa

Residential ESCO experience

PEER Africa has experience in piloting the training and operating of ESCOs for residential implementation. Their current work involves working with the Working for Energy Programme and EPWP and Cities to establish large amounts of residential ESCOs in Cities.

Clinton Foundation: Climate Change Initiative

Programme to facilitate ESCO development in Joburg

An effort to facilitate the establishment of ESCOs in Joburg to retrofit government buildings using international expertise and reduced material costs. Can provide support to other cities but will only focus on delivery in Joburg.

JLess@clintonfoundation.org