ENERGY EFFICIENT LIGHTING FOR SOCIAL DEVELOPMENT

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1. Introduction

In the run-up to the 2000 local government elections in South Africa, President Thabo Mbeki announced that all residential consumers would be entitled to 50kWh of electricity and 6000 kilolitres of water "free of charge" on a monthly basis. The aim of this rebate was to assist in poverty relief, through the provision of free basic services.

However, there has been a lot of media coverage relating to the implementation of these concessions, both negative and positive. The main problem and delay in implementing this initiative was the difficulty and costs relating to the systems required to be developed, in order to implement the [1]EBSST (commonly referred to as the "poverty tariff"), on a national scale, together with the fiscal implications on the service providers, both from an implementation and a "revenue loss" point-of-view. A number of pilot programs were conducted in different parts of the country, to measure the impacts and to determine an optimum solution for implementing the EBSST in South Africa. Two of these sites, Zwelitsha and Dengwane in the Eastern Cape, were assigned to Bonesa, to determine the feasibility of opting for an efficient lighting - based solution to the problem, and to assess the social and developmental impacts associated with such a solution..

1.1 Key objectives

- Obtain feedback from residents as to whether or not the provision of energy-saving Compact Fluorescent Lamps (CFLs) could serve as a suitable alternative (or partial implementation strategy), for "free electricity";
- Measure sustainability ie. willingness of communities to participate, local pride in success, understanding of technology, long-term sustainability of technology including general maintenance, repair/replacement and manufacture of new products as a possible small business;

- Bonesa would need to test different solutions in at least two of the nodal areas ie. integral vs modular CFL – options;
- Check on existing lighting technologies used ie. potential for additional retrofit opportunities through SMME's;
- Identify, develop and train existing unemployed people within the villages for possible luminaire assembly, marketing and communications skills, and product distribution;
- Measure the impact of reduced demand on existing "overloaded" networks;
- Test the technical, economical and financial feasibility of "local assembly" of luminaires, by receiving the components in a kit form;
- Test the implementation of existing delivery mechanisms for this option, as well as the development of suitable control procedures required to maintain the system;
- Establish a protocol to possibly offset the CO^2 savings as part of a "Carbon Trading mechanism", with the appropriate stakeholders.

1.2 Measurement

- Measure load profiles with the present situation, including the peak coincidence factor of lighting on the overall load;

[1] *EBSST refers to the Electricity Basic Support Services Tariff.*

- Determine the demographics of the affected areas and develop algorithms to predict the load in similar areas;
- Both the above factors were tested before and after implementation.

2. BONESA and the Efficient Lighting Initiative, (ELI)

The IFC/GEF Efficient Lighting Initiative (ELI) was a three year program supported by the International Finance Corporation (IFC) and funded by Eskom and the Global Environment Facility (GEF), to accelerate the penetration of energy-efficient lighting technologies into emerging markets in developing countries. South Africa was one of [2]seven developing countries taking part in the Efficient Lighting Initiative (ELI). The aim of the ELI was and still is to increase awareness of the features and benefits associated with efficient lighting, as well the impacts of global warming, the need for demand-side management interventions and the creation of jobs through this new-found opportunity in South Africa. The main thrust of the ELI however, is to promote access to, and the use of modern and quality efficient lighting technologies, such as the Compact Fluorescent Lamp (CFL).

The potential exists in South Africa to replace some 31,5 million old-fashioned incandescent light bulbs with CFLs. This would cut the peak load on the national grid by 820 megawatts, which is almost equivalent to the peak load of a city the size of Cape Town. The ELI will thus not only reduce greenhouse gas emissions, but could also [3]save the country approximately Rand 100 million in new generating plant. In essence, the ELI program is an electricity efficiency initiative, which is providing the economic thrust, drive and foresight to find solutions to link household energy initiatives with other development objectives. Bonesa, as local implementing agency in South Africa, was positioned to support the international vision, through implementing local educational, marketing and awareness and limited retrofit programs.

The key objectives of the overall ELI project are as follows:

- The lowering of household energy costs, thereby making more disposable income available, particularly to South Africa's previously disadvantaged population;
- The creation of employment and economic benefits arising from a robust, energy efficient lighting market; and
- The conservation and preservation of the environment, through the reduced demand for electricity during the peak consumption period, ie. between 18:00 and 22:00.

3. Technology Issues

The incandescent light bulb (the ordinary globe), is a remarkable device that has served us well for over 100 years. But it has three main drawbacks; it is inefficient, it doesn't last very long, and it is environmentally unfriendly!

Almost all the electricity a GLS globe uses is converted into heat rather than light, but a compact fluorescent lamp (CFL) gives out the same amount of light, using only 20% as much electricity, so that you can replace a 100 watt globe with a 20 watt CFL. The filament in a globe melts and evaporates as it burns, and a globe burning three hours a night normally lasts about a year, whereas most CFLs are designed to last between six and fifteen years.

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[2] *The other participating contries are Argentina, Peru, the Czech Republic, Latvia, Hungary and the Phillipines.*
[3] *This figure was calculated as part of Eskom's overall Integrated Strategic Electricity Plan, (ISEP).*

As its name implies, a CFL is a compact form of the common fluorescent tube. But it uses a sophisticated control circuit to give it the advantages of the fluorescent tube (efficiency and long life), without the conventional tube's two major drawbacks - the CFL does not flicker, and it produces an attractively coloured light, either cool white or a warm yellowish colour similar to a normal globe.

A CFL initially costs more than a GLS globe, but increasing demand for CFLs is bringing the price down rapidly. A 100 watt globe generally costs about R3-00, and over its one-year life (burning three hours a night), it uses in the region of R30-00 worth of electricity. An equivalent 20 watt CFL would retail at about R30-00, but while burning three hours a night, it uses only about R6-00 worth of electricity a year. The CFL thus generally pays for itself in just over a year. Over the next five or more years of its life, it saves hundreds of Rand in lamp replacement and electricity costs, not to mention the costs to the environment.

Even though Compact Fluorescent Lamps (CFLs) are widely recognized as the major solution for reducing energy consumption for domestic lighting, most programs focus on easy to replace screw-based CFLs. Pin-based CFLs however, have the potential to offer a more sustainable solution – with less electronic waste, lower costs, and no risk of being replaced by incandescent lamps after lamp failure. Perhaps the most important advantage lies in the luminaire design – the typical characteristics of pin-based CFLs – form and light distribution – offer new possibilities in this respect.

3.1 Why pin-based?

Pin-based CFLs perform like the others in terms of energy saving, but have a separate ballast (the electronic part needed to produce light); this is no longer part of the light bulb, but incorporated into the fixture. This reduces the price of the lamp when the bulb must be discarded and replaced, since the ballast (which generally lasts three times as long), can be retained. In addition, pin-based fixtures will help to make the switch to fluorescent lamps irreversible.

Why are similar lighting initiatives worldwide and Eskom directly involved in fostering this new product? The explanation is quite simple; Eskom wants to set off a revolution that would lead to dramatically reduced residential electricity consumption in South Africa, over a 20-year planning horizon. Lighting uses a large amount of electricity in low-income homes, and CFLs can reduce this by a factor of four. According to the European Commission Delight report “the switch from incandescent lights to CFLs is as revolutionary as was the switch from gas to electricity in domestic lighting 70 years ago. The role of suitable fixtures is of similar importance”.

3.2 A new South African standard?

The creation of an innovative new product for this program could become a South African (or even international), standard. This is a big challenge that needs a joint commitment by manufacturers of luminaires and lamp components, designers, retailers and community members alike.

As we were introducing technology which might be relatively unknown to newly electrified consumers, various issues needed to be addressed before actual implementation, eg. a comprehensive awareness and training campaign amongst the community-identified assemblers of the appropriate technologies needed to be launched.
It was therefore important that Bonesa held hands with the community during the pre-implementation stage, to give energy saving concepts additional credibility. Free hand-outs of CFLs and/or fixtures also score political points, from a poverty alleviation perspective. It was also stressed that CFLs are not an “inferior” light source but in fact, in many residential and commercial areas, they are regarded as being far superior to conventionally known and commonly used products ie. lamps and luminaires. CFLs are presently amongst the most advanced technologies available

for domestic lighting worldwide, and the amount of light output emitted from an 11 Watt PL-lamp is equal to a 60W incandescent lamp.

It was also important for a program of this nature, that the complete luminaire should be sourced locally and assembled at a community level

4. Basic Assumptions and International Experiences

After the commitments of the 1997 Kyoto climate change convention for the reduction of CO^2 emissions, the European Union estimated that in many countries a significant result could be obtained just by reducing the peak electricity demand caused by domestic lighting.

According to the EU Delight report (1998) on efficient domestic lighting in European countries, the total domestic lighting consumption currently accounts for 17% of all residential electricity use, and is expected to increase by the year 2020. However, several studies sponsored by the European Commission have shown that 43% of Europe's electricity consumption for residential lighting can be saved by the year 2020, simply by promoting technologies already on the market, such as CFLs. The average number of light bulbs is 24 per household across the EU. Around 70% of these are incandescent, with the remaining 30% being fluorescent or halogen bulbs. Only 30% of European households currently have at least one CFL. By implementing this proposal, South Africa could become the trend setter in the use of this economical and efficient lighting technology.

However, barriers such as the high initial price and the consumers' lack of confidence in the long-term availability of this technology is still a problem. In South Africa, the fluctuating exhange rate is also a problem, since all the lamps are presently imported into the country. According to the Delight research, only the promotion of well-designed fixtures that meet public tastes and overcome behavioural barriers can change the lighting market , favouring the introduction into the residential sector of pin-based CFLs, already largely used in the commercial market.

Although South Africa's greenhouse gas emissions are small compared to those of the major industrialised countries, perhaps we do also have a responsibility to lead by example in encouraging clean environmental practices on our continent, as this would not only cut greenhouse gas emissions, but would also save the country billions of rands in new generating plant. It would also send out a clear message to encourage foreign assistance in [4]NEPAD.

5. Pilot Site Implementation Strategy

5.1 Background information

The two villages Dengwane and Zwelitsha were electrified in 1997, as part of the Khoapa electrification project. The Khoapa electrification project consists of 1220 20 Amp prepayment connections. In order to avoid upsetting customers in the areas that may not reside specifically within Dengwane and Zwelitsha it was agreed that we would implement the pilot program in the total Khoapa electrification project, which is primarily constituted by these two villages, and which are supplied with electricity from the same network. Dengwane and Zwelitsha are situated in the Magadla Tribal Authority in the Eastern Cape, approximately 8km from Matatiele on the main road, to Mt. Fletcher.

The communities of these villages are largely farmers, who apply a combination of traditional and commercial methods of farming. Land is often tilled year after year, with no period of rest allowed in between. Residents in these villages are engaging in primitive production activities of vegetable, poultry and pig production.

[4] *NEPAD is the New Partnership for Africa's Development, which is being spearheaded by South African President Thabo Mbeki.*

Through the environmental upgrading of schools by [5]SEED, the youth in the area have already been brought on board regarding the importance of issues such as resource use and environmental concerns. This was further expanded by implementing the Bonesa/ELI Schools Curriculum at the 5 schools in the area.

This is a totally rural area, which has one major town in Matatiele. The people in this area are traditionally dependent on migratory labour ie. the men worked on the mines around Johannesburg, to send home money for their families. Some of the women also went to larger cities like Durban and Pietermaritzburg, in order to earn funds for the family. Now that the mines have begun to retrench their workers, we find that up to 65% of the population are unemployed. This is one of the main contributing factors towards the poverty situation in this area.

5.2 Existing Infrastructure

The villages are situated about 9km from the nearest two Eskom vending stations, for purchasing prepayment electricity coupons. Residents have to use taxis and pay R3.50 x 2 =R7.00 to get to their vendor, ie. return trip. A dirt road of about 7km connects the villages with each other and telephones, electricity and other services are generally available in the area. Running water is presently being addressed.

Firewood is very scarce and residents need to travel long distances, if they want to purchase this fuel source. Therefore, most households supplement grid electricity with paraffin and gas, for cooking and heating purposes. Eco-tourism is regarded as an area that could explicitly be developed in the area to facilitate job creation. The natural surroundings in the area offer a panaromic view of the Maluti and Drakensberg mountain ranges and the high density snow experienced in the winters, often attracts tourists to the area.

5.3 Job creation opportunities

In an area with limited avenues for self-empowerment, the implementation of an efficient lighting-based solution to the EBSST, combined with the development of a marketing/communications, assembly and distribution infrastructure within the communities concerned, has contributed to a substantial and sustainable improvement in the existing economic activity in the area. With time, this could even be extended to provide an even more comprehensive lighting/ maintenance business, through the provision of a broader range of locally designed and produced luminaires that are representative of the culture of that particular community. These could then be sold to local hardware stores, guest houses and tourists, to generate additional revenues. Households with more than two light points will also be able to purchase additional luminaires and lamps from these SMME's.

5.4 Training requirements

It was important that the community leaders in the respective villages, identify potential unemployed candidates that could be trained to assemble, distribute and supervise the activities within those communities.

It was estimated that an initial quota of 6 people per village would be required to attend the official training for this purpose, ie. 1 x Supervisor, 3 assemblers and two distributors. We also identified one individual with some basic computer and communication skills, to facilitate the development of the marketing-activities in the area, as part of the Potlako franchise pilot study. An overall local project co-ordinator was also appointed to facilitate the project interaction between Bonesa and the community.

[5] *SEED is the Sustainable Energy and Evironment Development program, which is funded internationally.*

5.5 Research requirements

Lighting, primarily with incandescent bulbs and candles, are the major end users of energy in the poverty stricken rural areas of South Africa. The introduction of Compact Fluorescent Lamps (CFLs) as a possible alternative to providing free basic electricity (50kWh per month), could significantly reduce electricity consumption in these households and contribute to the objective of poverty alleviation.

Likewise, South Africa is facing increasing residential electricity demand, due to the intensive electrification drive over the last decade. In this market, lighting is considered to be the largest end-use of residential electricity, and this demand for electricity is virtually 100% co-incident with South Africa's peak demand ie. between 18:00 and 20:00.

Residential electricity consumption contributes significantly to the current demand patterns in South Africa and its share is increasing with the continuing electrification program in the country. Future growth in residential electricity consumption will be due to the continued electrification program, construction of new RDP homes, and increased ownership of electrical appliances, such as televisions, kettles, irons, etc. At this stage (2002), about 60% of the South African population has been electrified, but that still leaves approximately 2 million homes and 100 million people without access to grid and off-grid electricity. Since most of these connections are presently using standard inefficient incandescent (GLS) globes, this presents a unique opportunity for conversion to more efficient CFLs, which only use approximately 20% of the electricity needed to provide the same amount and increased quality of light. Estimates of the savings possible from the current Efficient Lighting Initiative (ELI), are 820 MW of peak demand reduction, by the year 2019. This would involve the introduction of approximately 31,5 million CFLs into the South African residential market within the planning period.

The objective of the survey was therefore to verify the above assumptions and to estimate the electricity savings potential for both the consumer and the local authority/distributor/Eskom, in relation to the "free 50kWh" promised by government, to all residential users of electricity. It was therefore imperative that the research contractor was successful in:

- Determining the consumption and demand savings for all parties;
- Wattage preferences for lighting and lighting fixtures (shades) used;
- Colour preferences for lighting, (cool or warm white);
- Type and hours of use of existing light sources, (candles, paraffin, electricity), etc;
- Determine the existing number of light points per household and the potential lamps that possibly could be replaced with CFLs ie. to determine the quantities of product that would need to be procured, to implement this pilot program;
- Current electricity tariffs, metering (prepayment and conventional), and non payment/illegal connections in the area;
- Appropriate methods of media/ product information dissemination in the area, eg. local radio, etc.

Using students for this exercise, assisted in reducing the costs and at the same time, provided them with much needed practical experience ie. capacity building.

The research methodology decided upon, provided results that covered the following six critical areas:

- General customer information ie. income, unemployment levels, average age and total population in the affected areas, etc;
- A table showing current lighting equipment and useage patterns;
- A section on customer knowledge, attitudes (and understanding), of the Electricity Basic Support Services (EBBST), ie. free basic services, as well as their knowledge and attitudes towards CFLs in general, as a possible alternative to EBSST;

- A table that covers other appliances that are used in the houses and their usage patterns, including other areas where disposable income is used, eg. Lotto tickets, cellphone cards, etc;
- Use of dry-cell batteries for radio useage and the associated monthly costs;
- Present consumption levels and frequency, value and venue for purchasing prepayment electricity coupons/vouchers.

5.6 Barriers

The critical areas of the ELI-proposal that posed a potential threat to the full-scale successful implementation of the pilot programs, are as follows:

- Limited timing required to fast-track the entire program ie. "rushing" the implementation of the pilot programs, resulting in insufficient timing necessary for detailled planning, stakeholder involvement, monitoring and verification activities;
- The timing for implementation of the program in these particular two areas, commenced immediately prior to the festive season holidays, which traditionally, is not a good time to introduce new technologies, etc.
- Community resistance, due to the limited number of people that can be accommodated in the "job-creation" component of the pilot program, whereas the unemployment levels are estimated to be far higher than the number of people that can be accommodated ie. not all of the needy were able to benefit from this particular job-creation activity. The local councillors agreed to address this issue with the communities involved.

8.

6. Conclusions/ Recommendations

The plight of low-income households around the world displays some similar characteristics that transcend culture and geography. Among them are:

1) a struggle to make hard choices between basic needs for services such as healthcare and food;
2) decisions of which bills to pay when scarce unpredictable income materializes;
3) a desperate need for someone to recognize that all of the individual problems of such households can often prove overwhelming, when experienced as a whole.

Most importantly, however, families in poverty share a common desire for self-sufficiency and empowerment, as full participants in the marketplace of choices. Although we often presume to provide solutions to such problems, it does suggest that there is no single source of knowledge that exists regarding successful efforts to address low-income energy problems. Developing countries have a chance to avoid serious mistakes that have been made in addressing such issues in the West, and they have the added opportunity to employ advanced technologies toward the seeking of solutions. Simultaneously, the wealth of experience and lessons learned from countries with longer histories of attempts at addressing low-income energy issues, might reveal some ideas that can be equally valuable to emerging issues in developing nations. Above all, the interchange of ideas must continue and expand.

Finally, there will always be a need for a safety net, as it is impossible to imagine a community where everyone has been permanently lifted into economic self-sufficiency. Thus it is important for those involved in programs that aim to reduce dependency on subsidies, to beware of the double-edged sword of success, and ensure that an accurate picture of the families/individuals that remain in need is not lost in the "good news".

Based on the information provided in this paper, Bonesa strongly recommended the approval of this solution, as set out in the broader strategy of implementing EBSST in South Africa. The relative risk profile of implementing such an initiative is limited and the benefits are potentially very large, ie. socio-economic, environmental investment, political, etc.

So, whilst the proposed ELI solution to poverty alleviation will mean savings for individual consumers, it will also assist in boosting the South African economy, by providing savings for

the country as a whole. By using electricity more efficiently, energy will be freed up for growing demand elsewhere. Results in Mexico have also shown an improvement in the quality of supply, as a result of the widespread implementation of CFLs in rural communities. The nett effect of all these components of the program will result in the realization of a huge positive social and environmental impact for the country.

We are confident that the message of "energy efficiency" will be an exciting one in these market segments where services such as hot water and refrigeration are considered as luxuries.

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