

# The South African efficient lighting initiative (ELI): Evaluation of the implementation field studies leading up to full implementation

Barry Bredenkamp

Bonesa Electricity (Pty) Ltd, P O Box 12208, Hatfield, 0028, South Africa

bbredenkamp@bonesa.co.za

## KEYWORDS

global environment facility, efficient lighting initiative, peak demand, revenue losses, compact fluorescent lamps, evaluation, distribution utility, Eskom

## ABSTRACT

The South African Efficient Lighting Initiative (ELI) is a 3-year, US\$10 million dollar effort jointly funded by the International Finance Corporation (IFC) – via a grant from the Global Environment Facility (GEF) – and Eskom (South Africa's parastatal electric utility). The ELI is a demand-side management (DSM) activity that seeks to transform South Africa's lighting market through the promotion of efficient lamps and luminaires.

The paper will describe the objectives and evaluation of the Hartbeespoort field study that Eskom conducted (along with four other field studies) in 1999, to inform the design and implementation of the full-scale ELI. In Hartbeespoort, Eskom sought to determine whether (1) efficient lighting can provide distributed utility benefits; offsetting lost energy sales with reduced peak demand charges and (2) financing for efficient lamps and distribution through utility depots was an effective means of selling the technology into the market.

The evaluation of the field study showed that the ELI would have a negative impact on South African distribution utilities bottom lines, but that the avoided costs of peak demand could offset most of the revenue lost by reduced kWh sales. As for financing program, few residents of Hartbeespoort availed themselves of the lease option, preferring to buy the lamps with cash. Finally, with respect to sales through utility depots, the office hours and loca-

tion of the municipal offices offered limited accessibility and the municipal staff voiced objection to the additional workload.

## INTRODUCTION

In 1999 the Global Environment Facility (GEF) set up and funded a seven-country project to promote the use of energy-efficient lighting. The ultimate aim of this "Efficient Lighting Initiative" (ELI) is to increase awareness of the problem of global warming, and to help reduce greenhouse gas emissions, through the widespread promotion of efficient lighting technologies in the participating (developing) countries.

GEF was formed in 1991 to address four critical threats to the global environment: biodiversity loss, climate change, degradation of international waters, and ozone depletion. GEF receives its funding from a sub-set of its 166 member countries.

The South African component of the Efficient Lighting Initiative (ELI) is a 3-year, EURO 7,4 million effort jointly funded by the International Finance Corporation (IFC)—via a grant from the Global Environment Facility (GEF)—and Eskom, (South Africa's parastatal electric utility). The ELI is a demand-side management (DSM) activity that seeks to transform South Africa's lighting market through the promotion of efficient lamps and luminaires, in all market sectors, with a specific focus on the residential market.

The seven countries participating in the overall ELI are Argentina, the Czech Republic, Hungary, Latvia, Peru, the Philippines and South Africa. Total GEF funding for the ELI is \$15 million, with South Africa receiving US\$2,5 million.

Although the ELI was established primarily as an environmental project, it can also yield significant economic benefits in terms of a reduction in required generating capacity and a reduction in the use of energy resources. Given South Africa's heavy reliance on coal for electricity generation, the reduction of greenhouse gas emissions stemming from the use of energy-efficient lighting in South Africa may be regarded as similar in importance to its economic benefits.

This paper focuses on the objectives and evaluation of the initial pilot program that Eskom conducted (along with four other pilot programs) in 1999, to inform the design and implementation of the full-scale ELI (Eskom 2000a). In these pilots, Eskom sought to determine whether (1) efficient lighting can provide distributed utility benefits; offsetting lost energy sales with reduced peak demand charges and (2) financing for efficient lamps and distribution through utility depots was an effective means of selling the technology into the market. The evaluation of the pilot program showed that the ELI would have a negative impact on South African distribution utility bottom lines, but that the avoided cost of peak demand could offset most of the revenue lost by reduced kWh sales. As for financing programs, few residents availed themselves of the lease option, preferring to buy the lamps with cash. Finally, with respect to sales through utility depots, the office hours and location of municipal offices limited accessibility and the municipal staff voiced objection to the additional workload. This particular phase of the program was co-funded by a GEF Project Development Facility (PDF) grant of US\$225 000-00 and matched by Eskom.

Following this introduction, the paper presents a brief review of the lessons learnt about the various delivery mechanisms tested during the pilot programs. It then briefly discusses how these lessons were put into practice, as part of the implementation of the full-scale ELI in South Africa.

#### THE COMPACT FLUORESCENT LAMP

Firstly, it is important to understand some basics about the predominant lighting technologies promoted under the program, i.e. the CFL. Although the incandescent lamp is a remarkably simple and inexpensive device that provides high-quality light in hundreds of millions of homes around the world, it has two major drawbacks. Its efficacy in converting electricity to light is relatively low, and it generally lasts for no more than 1000 hours of operation. That is equivalent to about one year of normal use.

Fluorescent tubes have been available for decades. Their efficacy is superior to that of incandescent lamps, and they generally last longer. But because of their tendency to flicker, and because their appearance is regarded by many as unsuitable for the home, incandescent lamps have remained the most commonly used form of domestic lighting.

The development of the compact fluorescent lamp (CFL) is probably the most significant advance in domestic

lighting technology since the invention of the incandescent lamp. As its name implies, the CFL is in concept, simply a compact form of the fluorescent tube. It enjoys the two main advantages of the fluorescent tube over the incandescent lamp, namely relatively high efficacy (typically five times that of an incandescent lamp), and a longer life, (typically 8000 hours). Furthermore, because of its electronic control circuitry, the CFL produces high-frequency light that does not flicker. Depending on the coating applied to the lamp, the CFL will produce an acceptable range of colour "temperature", thus overcoming a common objection to the domestic use of fluorescent tubes.

CFLs are designed to fit into most domestic lamp-holders and fittings as direct replacements for incandescent lamps. The CFL's electronic circuitry is accommodated in its slightly enlarged base.

The initial retail cost of a CFL can be a barrier to its acceptance, but a CFL that is to be used as a main household light will pay for itself in one or two years, even in countries like South Africa, where electricity is relatively cheap. For example, consider a 20 watt CFL costing say EURO 6 as a replacement for a 100 watt incandescent lamp. If the light burns 3 hours a day, and domestic electricity costs say 4 EURO cents per kWh, the entire purchase cost of the CFL will be recovered in less than two years.

#### BACKGROUND INFORMATION

The South African lighting market is dominated by inefficient incandescent lamps with a very low penetration of efficient lighting products, (Eskom 1998, 2000a). To begin to remedy this situation, in May 1998, Eskom—South Africa's parastatal electric utility—signed a contract with the International Finance Corporation (IFC) to develop a business plan for a South African Efficient Lighting Initiative (ELI). The objective of the 3-year, EURO 7,4 million (R63 million)<sup>1</sup> ELI was to promote the penetration of efficient lamps and luminaires into the South African market, which consists of three broad segments:

- low income and previously-disadvantaged communities that are currently being electrified at a rate of over 1000 homes per day;

- “normal” existing and new household markets with multiple light points per dwelling; and

- commercial and institutional building markets and industrial plants.

The ELI, the Global Environment Facility (GEF) through the IFC, and Eskom jointly proposed to address technical, marketing and institutional barriers that had to be overcome to create a cost-effective, robust market for energy efficient lighting in South Africa. The IFC/GEF contribution to the ELI is \$2.5 million (R16 million) over two years.<sup>2</sup> Eskom's contribution is R48,8 million (EURO 4,88 million) over three years. The IFC and GEF's interest

1. The exchange rate in February 2002 was 1 EURO = 10 South African rand, (R ).

2. South Africa is one of seven countries participating in the IFC and GEF funded ELI (IFC 1999). The other countries are Argentina, the Czech Republic, Hungary, Latvia, Peru, and the Philippines.

in the ELI is to reduce greenhouse gas emissions from South Africa's power plants, most of which are coal-fired. Eskom's interest is to reduce its evening peak demand which is highly coincident with household lighting use. As a first step of the ELI, in December 1998, Eskom initiated four "phase 1" pilot programs—Soweto, Kutlwanong, Albertinia/Heidelberg and Hartbeespoort—to test methods for improving the awareness, accessibility and affordability of CFLs for both low- and mid-to-high income households. These pilot programs ran for various durations throughout 1999, but activity on all four pilot programs came to a close by December 1999. This paper presents the findings from all four pilot programs, with a specific focus on Hartbeespoort<sup>3</sup>, and outlines the recommendations that were made to Eskom and the IFC for full-scale ELI program implementation. Section 4 provides an overview of the objectives of the Hartbeespoort pilot program. Section 5 presents the evaluation plan and criteria/matrix for the pilot programs and sections 7-14 contain the process and impact evaluations for the pilot program. Section 16 presents the lessons learned from the pilot program, that could be applied to full-scale ELI program implementation.

#### PILOT PROGRAM OBJECTIVES

Hartbeespoort is a small town west of Pretoria<sup>4</sup> with approximately 3000 middle- and high-income customers. The pilot CFL program was part of the town's larger program to promote the wise use of energy and the conservation of natural resources. The Faculty from the Department of Architecture at the University of Pretoria designed this larger program. The University also played a large role in designing and implementing the pilot program, (Holm 1998).

As is typical in South Africa, the Hartbeespoort municipality (or "munic") serves as the local electricity distributor, buying electricity in bulk from Eskom and selling it on to its residents. For Hartbeespoort and many other munics, electricity sales are an important source of revenue. Few munics understand that DSM programs can shave their peak load and thus reduce the peak demand charge they pay to Eskom. Rather, they are concerned with lost energy sales from the proliferation of efficient technologies, (Eskom 2000a). This pilot program was primarily designed to show how efficient lighting can provide distributed utility benefits; offsetting lost energy sales with reduced peak demand charges. In addition, the pilot program sought to determine whether CFL financing (with loan repayment through customers' monthly electricity bills), and CFL sales at utility depots and pay points were effective means of selling the technology into the market,

together with widespread and associated education programs supporting the above.

After conducting a focus group to provide a baseline against which to gauge changing consumer perception, the Eskom implementation plan consisted of entering into a contract with General Electric (GE) Lighting and Osram whereby these CFL manufacturers would sell lamps to Eskom for EURO 2,9. Eskom, in turn, would provide the CFLs to the municipality at the subsidized price of EURO 2,5 per lamp, as well as provide the municipality a EURO 0,5 commission for every two lamps sold.

Customers whose accounts were paid in full, would be able to buy lamps from the municipality at the price of two for EURO 5 and would have the option of paying for the lamps through a line item on their monthly bill. The municipality would encourage customers to use the CFLs in luminaires operating at peak times, (18:00-20:00), and in luminaires operating for more than three hours per day. The town's load profile was to be monitored during and after implementation, which (similar to the Albertinia/Heidelberg pilot programs<sup>5</sup>), would provide insights into the distributed utility benefits of residential DSM.

#### EVALUATION CRITERIA/PLAN

The International Institute for Energy Conservation (IIEC) assisted Eskom in conducting a process evaluation to assess the effectiveness of the planning and implementation of all the pilot programs. IIEC also assisted in conducting an impact evaluation of the Hartbeespoort pilot program, to quantify the demand and energy savings from this specific pilot program. The process evaluation was principally conducted by interviewing individuals involved in planning and implementing the pilot program. The process evaluation investigated whether the pilot program:

- was implemented as planned;
- effected customer attitudes to CFLs; and
- provided adequate data.

The impact evaluation relied on reports provided by the Eskom staff and consultants who ran the pilot programs and the outputs of the impact evaluation included the:

- number of CFLs sold;
- impact of CFLs on energy sales and thus on customer savings and munic revenue; and
- impact of the CFLs on the munic's maximum demand and hence on the maximum demand charges the munic pays to Eskom.

3. The Hartbeespoort pilot program was deemed to be the most representative of all the pilot programs, in terms of being able to test the various delivery mechanisms associated with the objectives of the overall program.

4. Pretoria is the capital city of South Africa.

5. Albertinia and Heidelberg are small communities in the Western Cape with little industry and relatively high electricity tariffs. As with Hartbeespoort, the Albertinia and Heidelberg pilot program tested how efficient lighting can provide distributed utility benefits, off-setting lost energy sales with reduced peak demand charges, as well as the impact of harmonic distortion on the utility network as a result of widespread saturation of CFLs within a ringfenced community.

## EVALUATION FINDINGS

In terms of units sold and relative smoothness of implementation, Hartbeespoort was the “model” pilot program. Hartbeespoort provided insights to both consumer interest in leasing CFLs and data on the ELI’s distributed utility costs and benefits.

The mayor of Hartbeespoort municipality formally launched the pilot program on 14 December 1998. Prior to that date, Eskom provided assistance to the municipality by (1) obtaining bids from major lighting manufacturers to supply CFLs, (2) evaluating those bids and (3) entering into contracts with two suppliers to buy lamps. Osram and GE Lighting were selected as suppliers and contracts were signed in November 1998. Just prior to the launch, the pilot program coordinators conducted focus groups to gauge existing consumer awareness of the CFLs. The focus groups showed that there was no unaided awareness of the lamps at that time, either among end-users or among the municipal staff. The consumer reaction was overwhelmingly positive to the technology and to the proposed program. Participants viewed CFLs as attractive, high-technology products and appreciated the fact that the program would make the CFLs available to them at below-market prices.

The CFLs were sold through the Rates and Taxes counter at the municipal offices. Prior to the initiation of the pilot program, the team coordinating the pilot program redesigned the Rates and Taxes hall to serve as an “Energy and Water Efficiency Information Center”. The center helped to create public awareness at a very appropriate moment—when customers pay their electricity and water accounts. A special exhibit demonstrated the consumption of CFLs compared with that of incandescent lights. In addition to the fixed display, during the first three months of the program, the municipality sent electricity bill inserts with information about the CFLs to all customers. Additional publicity included articles in the local newspaper, and public relations campaigns developed by the two participating manufacturers. Eskom also developed a public education campaign, which municipal staff in Hartbeespoort thought was much less relevant and successful than those sponsored by the manufacturers.

The municipal staff handling the electricity and water accounts also handled the CFL transactions and educated potential customers on the benefits of CFLs. Municipal workers received training about two months into the pilot program. The delay in providing training was attributed to the Christmas holidays. The training appeared to be useful because since February, sales from the municipality’s offices increased, and municipal staff resistance to the pilot program (previously perceived as additional unnecessary work), decreased.

In Hartbeespoort, customers had two different options of paying for their CFLs:

1. buy one CFL for EURO 5 cash and get one free, with a maximum total of six; or
2. buy up to six CFLs on credit, repaying this loan (plus a small handling fee), through a line item on their monthly electricity bill over a maximum period of ten months.

Regardless of the payment method chosen, residents had to fill in a form that requested a minimum amount of information. The municipality offered five different integral CFLs ranging from a 13-watt GE to a 21-watt Osram (either in Edison screw or bayonet type), all at the EURO 2,5 per lamp price. In addition, a 20-watt high power factor CFL was available at a price of EURO 6. Typically, CFLs sold for EURO 4-6 (and sometimes as high as EURO 8), in South Africa at that time.

A further condition, aimed at improving payments by RDP (low-income) households, was that buyers must have their electricity account fully paid up, which was checked by the municipal clerk. However, in spite of the strained economy, Hartbeespoort residents do pay their municipal accounts, rendering the above incentive to pay one’s electric account in full somewhat unnecessary. In other areas of the country, non-payment rates can be as high as 10-15 percent.

An important component of the program was Eskom’s guarantee of the CFLs. By agreeing to replace any failed lamps within a period of one year, Eskom’s gesture raised customers’ confidence in the technology and allowed the municipality to participate with less resistance from customers, from a technology quality point of view.

## PROCESS EVALUATION-IMPLEMENTATION

The pilot program’s launch in December posed some challenges. Few Eskom staff were available to provide assistance, and the municipal staff were not pleased with the idea of extra work. Time constraints on the part of Eskom staff made co-ordination among all the parties more difficult. While the CFLs were available for purchase just before Christmas, the program did not really get started until mid-January, the middle of the South African summer.<sup>6</sup>

Moreover, the detailed monthly reports that the University requested of the municipality, proved to be difficult to procure. Municipal officials stated that they were overworked and the sale of lamps constituted an additional temporary workload that might not reflect on their performance assessment. As a result, it took several months before the municipality could provide the University with data on lamp sales, returns, broken lamps, etc. The problem was compounded by the fact that the municipality only kept paper records, and did not have the capability to record the information electronically. Nevertheless, the municipality seemed to be enthusiastic about the program. The University made a monthly report to the municipal board about the lighting and other DSM programs, and board members have used their support of the lighting pilot program for positive public relations. Ultimately, Hart-

6. CFL programs are usually run during winter months when lighting needs are the greatest. Eskom, however, deemed its need to start collecting data on potential ELI activities as more important than perfect timing.

beespoort asked Eskom if it was possible to extend the pilot program for several months beyond its initial April end-date. The University and municipality wanted to use the additional time to gauge whether consumers' interest in the lamps would continue to increase as the public education sunk in. Eskom agreed to a two-month extension.

Based on the success of the second promotional campaign, the University's research team proposed another promotional drive between the local media and the CFL manufacturers. Although this additional activity never took place, the pilot program nevertheless remained active until October 1999. The information drive had impacts beyond Hartbeespoort. Requests for information from the research team were received from as far afield as the towns of Knysna and Port Elizabeth both of which lie on South Africa's southern coast some 1000 kilometers from Hartbeespoort.

### PROCESS EVALUATION—CUSTOMER ATTITUDES

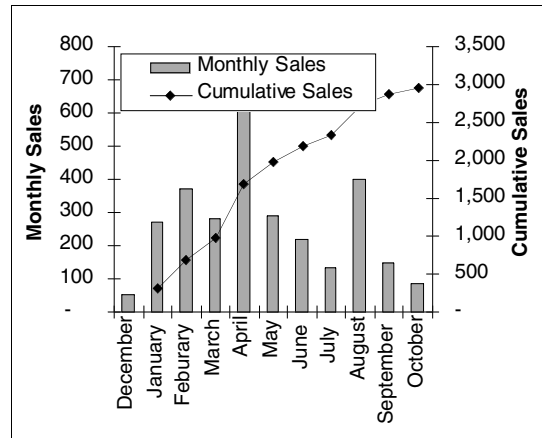
Most of Hartbeespoort's residents opted to purchase the CFLs outright, rather than lease them through the municipality. The most popular lamps were the integral 20-watt models from GE Lighting and Osram. Since power quality is not of direct interest to residential customers (they do not pay power quality fees), the higher priced, high-power factor models were of little interest to customers.

Overall customer awareness about CFLs has increased. In addition, some customers have expressed interest in purchasing more than the six lamps allowed under the program at this time. The staff interviewed believed that customers are willing to pay more for the CFLs than they currently were charged during the pilot program. That said, customers did have a number of concerns regarding the new technology:

1. Exterior bulkhead lights cannot be fitted with integral CFLs issued because the CFLs are too long.
2. Some residents wish to use dimmers on CFLs, which is technically not possible with the lamps sold through the program.<sup>7</sup>
3. Although favorably impressed with the reduced energy-related environmental impacts of CFLs (over its lifetime, a CFL in South Africa will reduce power plant water consumption by ~10,000 liters and power plant carbon dioxide emission by almost four tons), some residents questioned the environmental impact of dumping or recycling CFLs due to their mercury content.
4. The fact that CFLs are not locally manufactured in South Africa, concerned residents about local job losses, if locally manufactured incandescents were replaced on a massive scale by imported CFLs.

Finally, with respect to the option to lease CFLs, very few Hartbeespoort residents availed themselves of this opportunity. The program did not capture the residents rationale for preferring cash payments over leasing, but program staff hypothesize that Hartbeespoort's residents (who are

Figure 1. Monthly and Cumulative CFL Sales, (Holm 2000)



relatively high-income), were not interested in engaging in a lease for such a small sum of money. Staff further hypothesize that the popularity of CFL leasing mechanisms could be much higher in low-income communities.

### IMPACT EVALUATION—SALES

Figure 1 depicts the steady rise in sales that followed the launch of the pilot program in December 1999. From April (when the pilot program was initially envisioned to end), until July, sales fell as no new coupons were sent out and active promotion of the pilot program was interrupted. In August, when the program was re-launched and advertised, sales jumped before falling again as the pilot program came to a close.

Monthly sales by product type are shown in Table 1. The GE 15-watt High Power factor CFL costing EURO 6 each must be regarded as a special case. It cost more than double the other lamps and buyers did not understand the benefit of a high power factor. As seen in the table below, about one fifth of all sales were 13-watt CFLs, one quarter were 15-watt and 16-watt lamps and the balance (54 %), was taken up by 20-watt and 21-watt CFLs.

All CFLs that were returned by residents for whatever reasons, were accepted without question and replaced with others of the residents' choice. The GE 15-watt had the highest return rate while the Osram 16-watt had the lowest. Overall, monthly CFL return rates varied from a high of 3% in March 1999 to a low of 2% in May 1999.

### IMPACT EVALUATION—DISTRIBUTED UTILITY BENEFIT

As a part of the pilot program, the University of Pretoria assisted the municipality in measuring the impact from the lighting program and other DSM programs on overall load reduction. Over a period of eight months, the 2054 households in Hartbeespoort bought and installed 3000 CFLs. Using the same average monthly savings per lamp (7.2 kWh) and tariffs (EURO 0,03/kWh) as derived in the Albertinia and Heidelberg pilot program, the total monthly electricity savings by customers in Hartbeespoort comes to

7. Dimmable CFLs are available, but they are much more expensive than standard CFLs.

**Table 1. Monthly Sales by Model, (Holm 2000)**

	GE 13W	GE 15W	GE 20W	GE 15W HPF	Osram 16W	Osram 21W
December	2	14	36			
January	74	30	80		17	69
February	109	35	67		45	114
March	50	31	67		63	70
April	131	81	236	10	106	151
May	90	65	91	6	14	24
June	36	27	60		1	94
July	12	20	6		27	67
August	81	2	118		41	156
September	16	27	45		45	13
October	10	4	20	5	42	5
<b>Total</b>	<b>611</b>	<b>336</b>	<b>826</b>	<b>21</b>	<b>401</b>	<b>763</b>
Mkt. Share	21%	11%	28%	1%	14%	26%

21,600 kWh, netting customers (and costing the utility in lost revenue) EURO 710 per month (Eskom 2000b). On an annual basis this comes to EURO 8520 or EURO 2,8 per lamp.

Since the town's pre-program load profile was known, Eskom could predict that the winter peak demand reduction for 3000 CFLs would amount to 112 kW with a summer peak reduction of 61kW. Since the municipality pays a demand charge to Eskom of EURO 4,02/kVA, the annual demand saving total EURO 3,55  $([(9 \times 61) + (3 \times 112)] \times 4,02)$ . The saving by the municipality on its energy charges from Eskom comes to EURO 1920 per year. Together, this amounts to a saving of nearly EURO 1,82 per lamp per year. The net effect of the pilot program on the municipality is thus a loss of roughly EURO 1,02 per unit per year.

#### **DISTRIBUTION UTILITY ACTIVITIES**

The Hartbeespoort pilot programs showed that targeted DSM would have benefits as well as costs for distribution utilities, (in this case the munics). The Hartbeespoort numbers are not convincing from a purely profitability perspective (as compared to the Albertinia/Heidelberg numbers that showed that the financial benefits of reduced peak demand slightly out-weighed the financial cost of lost energy sales), but still show that the avoided costs of peak demand can partially make up for revenue lost by reduced kWh sales.

#### **SALES THROUGH UTILITY PAY POINTS**

To build customer interest in CFLs within a targeted area, the ELI could sell CFLs and CFL-dedicated fixtures from Eskom or munic pay points. Eskom tested this option in Soweto (via Eskom), and Hartbeespoort, (via the municipal utility). Difficulties in obtaining approval from Eskom management in Soweto resulted in that pilot program never getting started. In Hartbeespoort, sales through the local council were relatively brisk, but the office hours and location of the municipal offices limited accessibility and the municipal staff voiced objection to the additional workload. Despite the brisk sales at Hartbeespoort, problems in Soweto and staff complaints in Hartbeespoort sug-

gested that the ELI pursue other potential distribution channels in future.

#### **TRANSACTION SUPPORT AND FINANCING**

When buying lamps, most South African consumers make their purchasing decision based on the first costs rather than life-cycle costs. As a result, a relatively expensive CFL is much less attractive than its standard incandescent counterpart. To encourage consumers to make their purchasing decision on life-cycle costs, Eskom wanted to test customer acceptance of a CFL leasing program that would remove the first-cost barrier. Establishing a leasing program required the ELI to devise innovative methods to both extend credit and collect payment.

While Eskom planned several pilot programs to examine both of these aspects, only one of the planned pilot programs was comprehensively carried out and its results were inconclusive, (as described above, few customers availed themselves of the lease option provided in the Hartbeespoort pilot program).

#### **ESKOM (UTILITY) INVOLVEMENT**

The pilot programs, including Hartbeespoort, showed that ELI should avoid relying on Eskom as the primary implementor. The pilot programs that progressed most smoothly were those that required the least direct support from Eskom staff, (e.g., Hartbeespoort and Kutlwanong). The administrative issues that stopped implementation in Soweto and slowed it in Albertinia/Heidelberg suggest that when Eskom staff involvement is required in the ELI, the involvement should be formalized. This could best be accomplished by working with Eskom to revise its Key Performance Indicators, for measuring staff performance and providing associated rewards.

#### **CONCLUSION**

Eskom implemented the Hartbeespoort pilot program to provide data that would assist in the development of a comprehensive business plan to transform the South African lighting market. In Hartbeespoort, Eskom sought to determine whether (1) efficient lighting can provide distributed utility benefits, offsetting lost energy sales with re-

duced peak demand charges and (2) financing for efficient lamps and distribution through utility depots was an effective means of selling the technology into the market.

Eskom and its partners carried out the Hartbeespoort pilot program over a period of 10 months in 1999. To entice customers to purchase the high-efficiency lighting product, Eskom engaged in a bulk procurement with lighting manufacturers and also provided a subsidy to customers to further bring the retail price down. Eskom also provided a small (R5) handling fee to the municipality which sold the lamps through its Rates and Taxes counter at the municipal offices.

The implementation of the pilot program occurred without any major difficulties, although municipal staff did express irritation with the additional workload of selling and stocking the CFLs. Ultimately, Hartbeespoort residents bought nearly 3000 CFLs through the pilot program. Customers tended to prefer the higher-wattage, higher-lumen models. CFL return rates averaged roughly 2%.

The impact evaluation of the pilot program showed that the initiative had a negative impact on the Hartbeespoort municipality's bottom line, but that the avoided cost of peak demand could offset much of the revenue lost by reduced kWh sales. Eskom has applied this lesson to the full-scale implementation of the Efficient Lighting Initiative. The full-scale ELI will not rely on distributed utility benefits to sell the initiative to distribution utilities, but will point out that reduced demand charges from the proliferation of efficient lighting technologies can substantially off-set lost electricity sales.

As for financing programs, few residents of Hartbeespoort availed themselves of the lease option and finally, with respect to sales through utility depots, the office hours and location of the municipal offices limited accessibility and the municipal staff voiced objection to the additional workload. As a result, Eskom now prefers to use traditional retail channels to sell/distribute CFLs rather than, or in addition to, relying on utility pay points.

#### **LESSONS LEARNED**

In Hartbeespoort, Eskom examined a number of options designed to remove the *awareness*, *accessibility* and *affordability* barriers to higher levels of CFL penetration in the South African economy. (Prior to the pilot programs, Eskom already had found that CFLs were largely acceptable to South African consumers.)

#### **IMPLEMENTING THE ELI IN SOUTH AFRICA**

Following the pilot programs, Eskom and two partners (Africon International and Umongi-Karebo) set up a company, Bonesa (Pty) Ltd, as local implementing agent of the South African leg of the ELI, (Bonesa means "to lighten up" in seTswana).

Three broad market segments have been identified: (i) newly electrified households (some 3 million have been connected to the grid over the past decade); (ii) the middle- and upper-income sector; and (iii) the commercial and industrial sector.

Projects and promotions in various residential areas are backed by a multi-media advertising campaign and by dissemination of information in educational institutions at primary, secondary and tertiary level. New commercial and industrial installations will generally incorporate the latest available ranges of energy-efficient products. Bonesa assists in the economic assessment of retrofitting buildings with more efficient lighting technology, (as was done by Eskom at Megawatt Park some years ago). Megawatt Park is the corporate headquarters of Eskom. One of the difficulties faced by earlier attempts (in the US, for example) to promote the use of CFLs has been the uncontrolled availability of inferior products. Unsuspecting householders have bought these, only to find their lamps failing after a short time. This situation needs to be avoided, as it can do considerable damage. An important aspect of the GEF ELI is that no product is to be promoted unless it has passed various tests in an ELI appointed laboratory. ELI-approved CFLs must have a rated life expectancy of at least 6000 hours, and carry the official ELI-quality "green leaf" logo.

At present, 7 million out of 10 million South African households are connected to the grid. When the country's national electrification program has been completed, potentially there could be some 30 million CFLs in use in this sector, assuming that on average three main lights per household are usually on during the evening.

The reduction in power demand per CFL will vary between 40 and 80 watts, depending on the rating of the CFL and the rating of the incandescent bulbs that would otherwise be used. Taking this at an average of say 50 watts, and assuming that 20 million CFLs are burning at the time of peak demand, suggests that the Eskom grid could see a peak load reduction of the order of 1000 MW. This result is based on a number of assumptions, and can be regarded as being no more than speculative, but the order of magnitude is significant.

If each of those CFLs burns 1000 hours per year, and again assuming an average power reduction of 50 watts per CFL, the annual energy saving will be some 1500 GWh, which is just under 1% of South Africa's present total electrical energy consumption.

In greenhouse gas terms, the generation of one kWh in a South African coal-fired station results in the emission of about 1 kg of CO<sub>2</sub> into the atmosphere. The installation of 30 million CFLs would therefore reduce South Africa's CO<sub>2</sub> emissions by about 1.5 million tons per year. In terms of carbon trading credits, a figure commonly used is \$10 per ton of CO<sub>2</sub>. At that level, the reduction in emissions due to the ELI would have a market value of some \$15 million per year. The actual numbers are speculative, but the order of magnitude of the result is significant.

#### **THE ECONOMIC IMPACT OF A REGIONAL EFFICIENT LIGHTING PROGRAM**

The experience to date of the South African ELI suggests that the initial cost of CFLs is a serious barrier to their widespread use, despite their short pay-back period. This applies even among salary earners: participants in a survey conducted among Eskom employees several years ago in-

dictated that they regarded EURO 3,50 (about 100 times the cost of a kWh for residential customers), as the most they were prepared to pay for a CFL. At the time the retail price of a CFL was approximately double that. Even though good quality CFLs are now available for about EURO 3,50, take up is still slow, even among middle-income households. In low-income households, EURO 3,50 can represent half a day's wage, making it unlikely that such a sum would be allocated to the purchase of a CFL. In conjunction with various lamp suppliers and retailers, Bonesa has made available several hundred thousand CFLs at EURO 2 each. These have sold well!

To succeed, it seems therefore that a sustainable efficient lighting program aimed at domestic users will require some subsidisation, commensurate with the economic circumstances of the target market. Any subsidies required to encourage the use of CFLs may then be regarded as re-distributive within a given national economy, without affecting the broader analysis of such a program. As before, this analysis necessarily includes a number of assumptions. While these will be made as "reasonable" as possible, the result they produce should be regarded as speculative, although possibly indicative of an order of magnitude.

A European lamp manufacturer has provided indicative prices for the supply and delivery in bulk to Southern Africa of various models of ELI-approved CFLs, (exclusive of local duty and taxes). The model chosen for this analysis is an 8000-hour 21 watt lamp (equivalent in light output to a 100 watt incandescent lamp). This wattage was chosen on the basis that the main household lamps would be the most likely to be replaced by CFLs. The price of this model is EURO 1,9 each. If the lamps were distributed through a network set up by the utility, the cost of getting the lamp to the household will be of the order of EURO 1,8. (As the distribution cost is internal to the country's economy, it should arguably not form part of this analysis.) There are two possible approaches to estimating the saving in costs to a country due to the use of CFLs. One method is to calculate and then annualise the cost of generating capacity that has been saved, and add to that the running cost. Alternatively, and more generally, we can make assumptions about the cost of electricity (whether generated within a particular country or imported), and simply apply these costs to the saving in electricity usage. This second approach will be used here.

Assume the lamps are burned 1000 hours a year, and that they will therefore last eight years. The benchmark CFL used here has a rating of 21 watts, (equivalent a 100 watt incandescent amp). But we shall assume a saving of only 50 watts (as before), to take into account the fact that many of the replaced incandescent lamps will have been rated at less than 100 watts. Each CFL will thus be regarded as saving some 50 kWh per year.

As a reference tariff, we shall for convenience use Eskom's time-of-use rates for large users. (The use of large-user tariffs is appropriate as the analysis is considering a large-scale effect. The use of the end-user price, rather than the underlying cost, will approximately compensate for distribution losses.)

Eskom's off-peak applies 50% of the time, and the rate is about 0.8 EURO cents per kWh. Standard rate applies 35% of the time, and the rate is about 1.5 EURO cents per kWh. Peak rate applies 15% of the time, and the rate is about 5 EURO cents per kWh.

We shall make the following broad assumptions regarding the times that households are lit: 200 hours per year in peak time, 500 during standard time, and 300 during off-peak periods. The annual saving per CFL may then be calculated as follows:

Peak:10 kWh at 5 c = 50 c  
 Standard:25 kWh at 1.5 c = 37.5 c  
 Off-peak:15 kWh at 0.8 c = 12 c  
 Total:99.5 c, or EURO 1 per year.

A program involving 1 million CFLs would thus cost some EURO 4 million (including CFL distribution costs), and would result in savings of some EURO 1 million per year. This implies a pay-back period of around 4 years, or half the rated life of the lamp.

#### REFERENCES

- G Boyle, Osram, Johannesburg. Personal communication.  
 Eskom.1998. *Efficient Lighting Initiative Research Project*, July 1998, Summary Report. Johannesburg, South Africa: Eskom.  
 2000a. *South African Efficient Lighting Initiative Business Plan*. Johannesburg, South Africa: Eskom.  
 2000b. CFL Pilot program in Heidelberg and Albertinia. Johannesburg, South Africa: Eskom.  
 Holm, Dieter. 1998. *Hartbeespoort Pilot program Implementation Plan*. Pretoria, South Africa: Eskom.  
*Energy Efficient Lighting Initiative Sub Program*. Pretoria, South Africa: Eskom.  
 [IFC] International Finance Corporation. 1999. *IFC/GEF Efficient Lighting Initiative: Tranche 1 (Argentina, Peru and South Africa) Project Document*. Washington, DC: IFC.  
 [IIEC] International Institute for Energy Conservation. 2000. *The Efficient Lighting Initiative: Pilot program Evaluation*. Johannesburg, South Africa: IIEC.  
 [KCIHT] Kutlwanong Integrated housing Trust. 2000. *Kutlwanong Field Residential Study Report [sic.]*. Kimberley, South Africa: KCIHT.  
 Price RF, Bredenkamp BG and Dingley CE 2000. *Evaluation of the Hartbeespoort Field Study Paper* presented at Association of Municipal Electrical Undertakings (AMEU), Conference at Mossel Bay, South Africa

#### ACKNOWLEDGEMENTS

The author wishes to acknowledge all stakeholders, including the Municipal Authority officials community members, Eskom and the Global Environment Facility (GEF), for their unending support during this phase of the ELI-program in South Africa.