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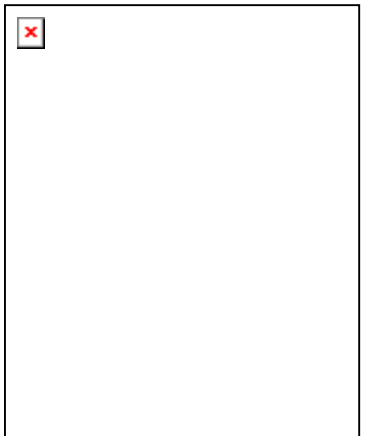
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Residential Energy Efficient Lighting Initiative

A case of Hlomendlini in Matatiele in the Eastern Cape Province of South Africa

Nomawabo Mtshabe



2008



DECLARATION

RESIDENTIAL ENERGY EFFICIENCY LIGHTING
INITIATIVES: A CASE OF HLOMENDLINI, MATA-
TIELE, OF THE EASTERN CAPE PROVINCE, SOUTH
AFRICA

by

Nomawabo Mtshabe

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF PHILOSOPHY (ENERGY STUDIES)

Faculty of Engineering and Built Envi-
ronment, University of Cape Town

2008

I, Nomawabo Mtshabe declare that this dissertation is my own original work. It is being submitted in partial fulfilment of the requirements for the degree of Master of Philosophy at the University of Cape Town. It has not been submitted before for any degree or examination in any other university.

N. Mtshabe

Dated at....Pretoria....this....07....day of....October....2008 (revised 08 April 2009).

Abstract

Residential Energy Efficient Lighting Initiative: A Case of Study of Hlomendlini, Matatiele of the Eastern Cape Province, South Africa

Nomawabo Mtshabe

Supervisor: Professor Jabavu Nkomo

A thesis is presented on the efficacy of the residential energy efficient lighting initiative, as part of the demand-side management in a rural village of Hlomendlini in the Eastern Cape. The focus of this thesis is to identify barriers of implementing CFLs in the South African context, with the aim of finding ways of removing the barriers. It attempts to understand the drivers, both in theory and in practise, of efficient lighting initiatives in South Africa and globally, as well as lessons learned. It explores the impacts of CFLs at the household level in terms of household budget and general quality of life especially to poor people. The assessment of the CFL initiative in Hlomendlini provides a unique window of how energy efficiency measures up to sustainable development in practice.

Most challenges of households in impoverished rural area in South Africa are that of inadequate access to energy services including lighting, high costs of modern energy services and the health impacts of using different energy services, most notably biomass energy. Therefore, energy efficient lighting, which attempts to address these challenges, stands a good chance of being accepted community. The findings from this study also show that success also depends on how development initiative is communicated and/or how the community participated both in the design of the programme and in its execution. With particular reference to the Bonesa initiative, this study assessed (a) how the initiative directly addresses the subjective needs of households and (b) the extent and nature of local participation in the project. The main conclusion is that if a project's aim is just about the numbers or a volume of CFLs, its sustainability is invariably compromised. This is an important lesson for energy efficiency measures in rural households in developing countries in general.

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Abbreviations

BELLE – Bombay Electric Lighting Large-scale Experience	MW – megawatts
BEST – Basic Electricity Support Tariff	NEP – National Electrification Planning
CBOs – Community Based Organisations	NER (now NERSA) National Electricity Regulator
CDM – Clean Development Mechanism	NERSA – National Energy Regulator of South Africa
CFE – Comision Federal Electricidad	N ₂ O – Nitrous Oxide
CFLs – Compact Fluorescent Lights	NO _x – Nitrogen Oxides
CO ₂ – Carbon Dioxide	NPV – Net Present Value
DEFU – Danish Electric Utility Research Institute	PBMR – Pebble Bed Modular Reactor
DME – Department of Minerals and Energy	PELP Poland Efficient Lighting Projects
DSM – Demand Side Management	R&D – Research and Development
EdF – Electricite de France	RD&D – Research and Development and Demonstration
EDI – Electricity Distribution Industry	SO ₂ – Sulphur dioxide
ELI – Efficient Lighting Initiative	SWHs – Solar Water Heaters
GEF – Global Environment Facility	SSM – Supply Side Management
GHGs – Greenhouse gases	/t CO ₂ – per ton of CO ₂ equivalent
GWH – gigawatts hours	TSI - Eskom Technical Support Unit
HH - Households	UCT – University of Cape Town
IEA – International Energy Agency	
IFC – International Finance Corporation	
IIEC – international Institute for Energy Conservation	
IPCC – Intergovernmental Panel on Climate Change	
IRP – Integrated Resource Planning	
ISEP – Integrated Strategic Electrification Planning	
ISRDP – Integrated Sustainable Rural Development Programme	
LPGas – Liquefied Petroleum Gas	

Chapter 1

INTRODUCTION

1.1 Background

Many experts caution that without effective intervention, electricity demand will exceed the generation capacity in South Africa and in other countries (e.g. Clark 1997c; Van Horen and Simmonds 1998; Gradgil and Sastry 1992). The world energy demand has been growing mainly due to development imperatives. In South Africa, energy demand, particularly electricity, has increased over the past two decades partly due to escalating population and the corresponding need for infrastructure development.¹ The implication of demand outstripping the supply is that as the population increases, the demand increases disproportionate to the supply of electricity.

South African electricity generation is currently under threat, and the demand is estimated could exceed the current capacity by 2007 (Department of Minerals and Energy (DME) 1998). South Africa's National Electrification Planning (NEP) aims to provide every household in the country with electricity by 2012 (DME 2003). While this will address the historical energy inequities within the country, it will unavoidably increase energy demand and thereby put pressure on already dwindling energy supply. The NEP is an ambitious strategy, which has more than doubled the share of electrified households in less than 10 years – from about 30% in 1994 to close to 70% in 2001 (National Electricity Regulator (NER) 2001). Despite this, there is still a huge backlog of electrification. More than 50% of rural and 20% of urban house-

¹ The 2007/2008 power supply shortages with the resultant load shedding can be seen as one of the indicators where the demand could far outstrip the supply. However, in this case, there is emerging evidence that the power outages could have been caused by technical deficiencies in the electricity supply systems. Be as it may, energy efficiency became buzzword as both Eskom and the Cape Town municipality urged residents in the Western Cape to conserve electricity (SABC News Bulletin September 2007).

holds is still without electricity. This huge backlog could imply an investment in additional electricity generation capacity.² The addition of more capacity presents at least two further dilemmas:

- It reduces government ability to pursue other macro economic objectives such as poverty alleviation, job creation, provision of housing, improved health and sanitation for the urban and rural poor, etc. and
- Such investments in electricity generation usually involve building of new power stations, which involve burning more coal with the negative environmental consequences.

A crucial empirical question therefore is how should South Africa reduce peak demand and, at the same time, minimise environmental risks caused by the generation of electricity (i.e. burning of more fossil (coal) fuels)? Evidence shows that the residential sector constitutes 75% of total national variable load (demand), and increasing due to the impact of the NEP (cf. Clark 1997a; Naude and Lane 1996), thus making this sector important for analysis. One of the crucial intervention areas is to conserve energy through a robust Demand Side Management (DSM). However, an effective DSM might be expensive in the first instance, as it requires huge capital outlays, particularly in replacing inefficient technologies. At the same time, some DSM measures worth comparatively little in monetary terms and could be implemented in the short term. The efficient lighting initiative (ELI), which was launched in the early 2000, was aimed at the residential sector as an important component of the DSM (see Section 1.2.2). The residential sector is potentially a flagship for effective DSM measures due to the following reasons:

- Although households are not the largest users of electric energy, they are most dynamic potentials of all sectors for growth in demand;

² Indeed, negotiations are at an advanced stage to build the Pebble Bed Modular Reactor (PBMR) to provide additional electric power. Some of the discussions indicate that there is a need to build regional nuclear power stations to counter the energy demand. The environmental implications of these strategies are still to be assessed (Annual report 2007, PBMR).

- In absolute terms, lighting uses little energy (it contributes less than 10% of Eskom's load profile), but contributes to peak load because it coincides with peaks for cooking, space heating and water heating.
- Newly electrified households use electricity predominantly for lighting, with few base load appliances, thereby contributing disproportionately to these peaks.
- Amongst the poor segments, the DSM programme is a service that constitutes a considerable proportion of the energy bill, which constitutes a proportion in electricity bills (Clark 1997b; Van Horen and Simmonds 1998).

It is, therefore, a policy imperative to determine the extent to which energy efficient lighting will help the residential sector to reduce its energy bills. The following hypothetical questions need to be addressed:

- Does South Africa have an environment conducive to the implement sound DSM measures?
- What have been the most recent lessons particularly in the housing sector?
- Are there important international trends from which South Africa can draw on, or can learn?

1.2 South Africa and energy efficiency initiatives: a policy context

1.2.1 Energy efficient policies and actions in support of the DME in South Africa

In response to the problem of demand exceeding generation capacity, there is a global focus on devising demand side measures to increase the efficient use of existing energy sources, rather than placing emphasis on new energy generation within the context of sustainable development.³ The measure to increase efficiency in energy

³ In this context, sustainable development simply means meeting the current generation needs without compromising the needs of the future generation.

use involves the integrated resource planning (IRP), which includes DSM. For this reason, Eskom, the South African power utility, implements an integrated strategic electricity planning (ISEP) process with two options, namely:

- *Supply side management (SSM)*: The programme involves upgrading power stations and returning mothballed power stations to services; construction of new plants (i.e. more efficient coal-fired plants, new gas fired-plants and hydro plants); importation of hydro electric power; building scaled down nuclear power station (termed Pebble Bed Modular Reactors, or the PBMR); and exploitation of renewable resources such as solar energy.
- *Demand side management (DSM)*: This is demand issue such as the lowering or smoothing of electricity consumption through load management (i.e. using power during off-peak periods) and energy efficiency (i.e. the use of energy efficient technologies) (Eskom 2001).

With funds from the Global Environment Facility (GEF), several countries are currently involved in the promotion and implementation of efficient lighting projects. These include Poland, Thailand, Mexico and Jamaica, all of which have started with the GEF-funded DSM projects, while others such as Peru, Brazil, Denmark and the United Kingdom have already completed similar DSM projects (Martinot and Borg 1998). All the projects implemented in these countries relate to the promotion of compact fluorescent lights (CFLs) for the residential customers. These examples provide important lessons for a country such as South Africa.

The South African government, through the DME, supports energy efficiency, as explicitly reflected in major policy documents (particularly the Renewable Energy White Paper (2003) and the Energy Efficiency Strategy (2005)). Attention in these documents include improvement of thermal performance of buildings, promotion of energy efficient appliances, use of solar water heaters (SWHs), appliance labelling, time-of-use tariffs and the creation of an energy efficiency agency to promote these

objectives (Van Horen and Simmonds 1998). Since evidence shows residential consumption accounts for only 10-15% of the South Africa's national electrical energy consumption, it however constitutes 75% of national variable load (Naude and Lane 1996). Energy efficient technologies could contribute to lowering of peak-load demand. The Energy White Paper (1998) commits the government also to implement the ELI for:

- Promoting the efficient use of energy in all demand sectors although the paper concentrates on residential sector;
- Promoting energy efficiency awareness in households through awareness building, and available and affordable technologies;
- Investigating the establishment of appropriate institutional infrastructure and capacity for implementing of energy efficient strategies;
- Promoting implementation through appropriate measures; and
- Promoting the introduction of a domestic labelling programme (that is, the labelling programme can assist people in their choice of appliances).

We also expect efficient lighting to bring favourable development benefits to the households, such as:

- *Economic benefits* – the reductions of peak demand eventually results in lower electricity prices and bills. Evidence shows that further investments on increasing the generation capacity especially in a form of new power station could increase the price of electricity. An investment in efficient lighting decreases the price since it is cheaper to run CFLs – since it has a longer lifespan than incandescent lights. Lower maintenance and lower replacement value of CFLs could add an economic value.

- *Social benefits* – A CFL projects could create opportunities for empowerment, as beneficiaries could be involved in its implementation, thereby providing job opportunities. The implementation of these projects could also benefit women, as they are the ones responsible for collection of paraffin and candles for lighting.
- *Environmental benefits* – the use of CFLs could reduce the impact of negative externalities, which could lead to better health, safety and quality of life to the surrounding community. Moreover, the use of CFLs could lead to minimum use of low-quality fuels such as wood and paraffin.

1.2.2 Efficient lighting as a DSM project in South Africa

In January 2000, Eskom and the World Bank (International Finance Corporation) launched a collaborative ELI with the objective of transforming the lighting market in South Africa. This resulted in the formation of Bonesa, a joint venture company between Eskom Enterprises (TSI), Africon Engineering and Umongi-Karebo to implement the ELI programme.⁴

According to Bonesa (2000), the purpose of ELI programme was to transform the South African lighting market through the promotion of compact fluorescent lamps, luminaires and other equipment in the following three broad markets:

- Emerging market (i.e. households that are being electrified at rate of 300 000 homes per year);
- Existing and new mid-to-upper income households, of which there are approximately 5 million; and
- Commercial and institutional building and industrial facilities.

⁴ Please note that Bonesa, the organisation which was tasked to implement the ELI in South Africa is no longer operational since it has been completed its contractual obligation. Bonesa's programmes have been infused as part of the DME's energy efficiency work.

This efficient lighting project was rolled out over three years. As per 1999 agreements, Eskom committed R48.8m, and the IFC, US\$2.5m. Payment of expenditures, undertaken according to the principle, Eskom (76%) and IFC (24%), was adhered to for the duration of the IFC involvement ending June 2000. Although Bonesa aimed to disseminate 18 million CFLs in South African homes by the year 2015, or 1.2 million lamps per year, this seems ambitious given that there are over 50 million incandescent lamps currently in use (Bonesa 2000).

1.3 Objective and research themes of the thesis

The focus of this thesis is to identify barriers to implement CFLs in the South African context, with the aim of finding ways of removing the barriers. The aims of the thesis are to examine the following pertinent issues:

- What are the drivers, both in theory and in practise, of efficient lighting in South Africa and globally? What are the lessons learned?
- What are the impacts of CFLs at the household level in terms of household budget and general quality of life especially to poor people?

1.4 Research methodology

The research, which informs this thesis, was conducted in conjunction with, and as part of the activities of the Bonesa project in the rural area of the Eastern Cape Province in 2002-2004. Various methods were used to collect data. These included both qualitative and quantitative approaches. Members of households, community based organisations (CBOs), Bonesa personnel and relevant Eskom departments were consulted and interviewed.

- *Literature review* - In addition to literature available such as published and unpublished papers and reports, available research works on ELI (dissertations, reports, Internet, etc) were used to collect information.
- *Primary research* - Fieldwork was conducted to obtain first-hand information on people's use of CFLs as well as to conduct interviews and

surveys. Two research techniques were employed to solicit information. These were basic structured questionnaires and more in-depth, open-ended interviews.

1.4.1 Literature review of sustainable energy development

Three types of literature reviews were conducted to give this study a theoretical edge. These were a (a) review of the theory and practice of energy efficient lighting; (b) analysis of best international practises in implementing a sustainable ELI; and (c) a review of the past and present South African examples of ELI projects.

As a way of providing a sound theoretical framework to analyse the research data, this thesis analyses theoretical discourses on linkages between energy efficiency and sustainable development. There is a plethora of writings about ELIs, especially since the late 1980s, yet a sound and well-grounded theory on the applicability of ELI to sustainable development is still lacking.

1.4.2 Quantitative research

Household energy data was collected over three days with the help of an assistant. The latter was selected from the local community and was, at the time of research, an employee of Bonesa. His assistance was crucial in the research because of his wide knowledge about the ELI project implemented by Bonesa in the area, as well as the fact that he was also a local. However, the assistant was provided with additional training in conducting research and understanding energy efficiency issues.

In between interviews, there were breaks or debriefing meetings between the researcher and the assistant to discuss and rectify difficulties experienced, such as conveying questions clearly to the households and households' responses.

A standard questionnaire was designed for face-to-face interviews with adult household members (see questionnaire on Appendix 1). Rather than handing questionnaires to households to write responses, the researcher and assistant deciphered re-

sponses on space provided. Some questions were close-ended question where the interviewers marked the correct box, while others were open-ended questions. The interviews were conducted in a way so that they were not manipulative. Household members were not forced to answer according to what the interviewers wanted, but according to the household's real experience. In case of ambiguous or incomplete responses, the interviewees were probed for more clarity.

The aim of the questionnaire technique was to obtain socioeconomic data of the sampled households, as well as their energy consumption and expenditure patterns, knowledge and impact of energy lighting initiative implemented by Bonesa (for sample size see Section 1.6 below).

1.4.3 Qualitative research

Open-ended interviews were conducted with Bonesa officials in order to gain deeper insights into the implementation of the ELI in South Africa, and Hlomendlini in particular. As indicated by Bollens and Marshall (1973), the research process will not be complete or rounded if it is not inclusive, or if it omits a certain category that is one way or another associated with the research issues. In this context, including Bonesa officials in the study provided a different perspective, which was different to households' responses

In addition to, and complementing the interviews, participant observation was one of the methods used to gather research data. Bollens and Marshall (1973) see a researcher as an instrument that soaks up information through paying attention and watching what is going on (i.e. who is doing what, how, when and why). This research technique was used during the questionnaire and interview stages, explained above. For instance, the way household members express themselves could give positive or negative indications to certain questions or issues. The household members' behaviours, seen through observations, allowed the researchers to understand their emotions and feelings about issues being discussed.

The data was captured based on the two phases of the efficient lighting initiative in the area. These phases were as follows:

- *Pre-testing phase*, which gives information on socio economic background as well as existing consumption patterns of energy before the use of CFLs. The phase includes information of socio economic details of households, energy consumption by end users and fuel expenditure.
- *Post-implementation* phase that provides data for after the supply/installation of the CFLs. The aim is to establish and record all activities pertaining to general knowledge about CFLs, perceptions and attitudes towards the ELI, benefits of using CFLs, effects of CFL intervention on other lighting fuels and barriers inhibiting the implementation of the ELI in South Africa.

1.5 Research questions and hypotheses informing the study

1.5.1 Energy consumption patterns

Eberhard and Van Horen (1995), Davis and Ward (1995) and Afrane-Okese (1999) observe that most households use multiple fuels to meet most of their energy requirements. There are different reasons for multiple fuel use, including availability, accessibility, affordability, cultural practices, etc. This research also confirms multiple fuel use in Hlomendlini sampled households. Multiple fuel use was particularly prevalent in thermal application (i.e. cooking, heating and ironing), entertainment (i.e. radio and television), lighting and refrigeration.

The captured information gives the different types of lighting fuels used by households as well as determines how far the implementation of CFL at Hlomendlini affected the use of fuels, especially for lighting.

It was important to collect data on fuel expenditure, consumption and expenditures patterns in order to locate the lighting behaviour of Hlomendlini households into perspective. This information includes the Rand value and volumes of fuels (paraffin, LPGas, fuelwood, etc) that households use per month. This assisted in understanding the consumption patterns and expenditures on lighting fuels before the use of CFLs, to determine the potential impact of using CFLs.

1.5.2 Householders knowledge about CFLs

Since the use of CFLs is still a new in the village, it is important to determine consumer awareness on general issues concerning this technology. A critical precondition for effective use of CFLs would be a comprehensive and targeted awareness campaign or capacity building by the project implementers. In this case, the project owner was Bonesa. Also, the location of centres vis-à-vis the households, the transportation costs, the price of the lamp, the availability of CFLs and means to access it become very important issues to be investigated. The responses to these enquiries invariably indicate the extent that availability of the CFLs, access to it as well as consumer awareness affects market transformation.

1.5.3 Perceptions and attitudes towards efficient lighting initiative

Understanding how people generally react to new initiatives, such as the ELI programme, provides invaluable lessons that could inform future intervention strategies. Therefore, people's perceptions about "things" are very important points of departure, and could influence the effectiveness of any intervention. It is therefore to capture these perceptions and attitudes of households about the CFL initiative, as these provide pointers to the willingness or otherwise of households to use CFLs. In an effort to capture consumer perceptions, the household surveys included such questions as the advantages and disadvantages of using CFLs, the household's willingness to use the lamp in future, and if they can recommend the CFLs to the households who do not use it.

1.5.4 Benefits of using CFLs

The CFLs use is associated with many benefits such as long-term savings on the energy costs as well as contributing to the cleaner environment. Therefore, one of the results of this study is to ascertain whether or not, or the extent to which Hlomendlini households derived any significant and tangible benefits since the use of CFLs. A benefit of an intervention strategy is realised when it has a positive spin-off in the households' livelihoods. For example, there is a need to determine whether or not there are savings accrued from the energy expenditure as a result of the use of CFLs; whether households can afford better nutrition, education (because of access to long hours of studying); and whether there is improved security at night because of the outside lighting. It is also important to capture other benefits, such as training the Bonesa project gave to selected community members during the implementation period. One of the aims of capacity building is to benefit the wider community other than the trainees and their families.

1.5.5 Effects of CFL intervention on other lighting fuels

Literature reveals that the use of CFLs encourages the lighting usage, given that these lamps are more efficient and last longer compared to the standard incandescent bulbs (Newbold 1988, also see Chapter 2). The thesis demonstrates the changes that the introduction of the CFLs has had on the households' lighting usage patterns after the use of CFLs since.

In addition, the study looks at the extent to which the use of CFLs has influenced the usage of other fuels such as candles and paraffin. How did the use of improved lighting contribute to the use of these fuels (in terms of quantities and costs)? Largely, the impacts of CFLs on the latter determine the success or otherwise of the ELI programme.

1.5.6 Barriers inhibiting efficient lighting initiatives in South Africa

It is well documented in literature that implementing ELI programmes internationally has challenges and barriers. Some of these challenges relate to the availability of the CFLs, inadequate information, high initial cost, inadequate finance, weak incentives and absence of policy regulation and lack of institutions to gather and disseminate information, distribution of financial resources, and design and monitor the programme. Through interviewing Bonesa staff members, the specific barriers to implementing this programme in South Africa were identified. More importantly, the study analyses the solutions that were implemented as well as lessons learned from international practices.

1.6 Brief socio-economic description of the sample

Fieldwork was conducted in rural town of Matatiele in the Eastern Cape Province, in an area that was piloted by the Bonesa Programme. This area was electrified in 2000 and the load demand is still peaking. Most of Matatiele households are poor, thereby a perfect target for ELI, thus reducing the households' expenditure on electricity (cf. Clark 1997a). Hlomendlini has 308 households, all connected to grid electricity. From this size, a random sample of 50 households was selected with the aim of obtaining consistent and unbiased estimates of the population status (cf. Schofield 1996). This random selection ensured representativity and diversity of the sampled households.

The Hlomendlini area was selected for a number of reasons: the important one being that the Bonesa's ELI was concentrating on this village and, at the time, little was done by way of monitoring and evaluating the emerging impacts of ELI on household energy use patterns. The study was a perfect opportunity to interface with the initiative and ensure that lessons learned were fed back into the process of implementation.

The local economy of Hlomendlini is typical of other underdeveloped rural areas in South Africa. There is minimal local production and a heavy reliance on government pensions. There is also some dependence on fast-disappearing remittances from

workers and relatives living in major cities. With formal employment rates falling by huge margins, this source of income is fast becoming a luxury for many households, forcing them to rely very heavily on government pensions. According to Bonesa, up to 65% of locals are unemployed. A significant number of people are involved in small-scale production activities of vegetables, poultry and pig production (Bonesa 2002).

Information on household sources of income was captured and analysed in an Excel spreadsheet. This information included pensions and grants, businesses, (temporary and casual) piece-jobs, remittance, etc. This information was then analysed according to household size and gender, level of education, employment status and income distribution of household members. The captured data included brief explanation on the electrification status of the village. The strategic value of the information distinctly illustrates the social and the economic backgrounds of the Hlomendlini people, which have a bearing on their ability to afford the CFLs.

1.7 Overview of the content issues

This thesis is divided into the following chapters. The next chapter (Chapter 2) provides the detailed overview and analysis of literature reviewed. The latter reviews relevant global energy efficiency initiatives, with more focus on the CFLs initiatives.

Chapter 3 provides a context of this thesis, by outlining efficient lighting initiatives in South Africa, by (a) investigating rationale for CFLs initiatives, (b) the characteristics of the lighting markets, and (c) the potential benefits of ELI.

Chapter 4 concentrates on a study area in Matatiele. The background of the place such as the demography, income levels, status of electricity, household electricity use, local demand curve, etc are examined and discussed. The chapter also analyses the research findings possible impacts of the programme for households in Matatiele, in particular and South Africa in general.

Chapter 5 is the conclusion of the thesis. It highlights the co-benefits of energy efficiency particularly in the household market, summarises the main findings and lessons learned from Hlomendlini, as well as the recommendations for community based efficiency programmes.

Chapter 2

A REVIEW OF INTERNATIONAL BEST PRACTICES

2.1 Introduction

A cursory literature scan shows a plethora of energy efficient projects worldwide that have different objectives such as realising energy savings thereby delaying building of power stations; reduction of noxious greenhouse gases (GHGs) and reduction of peak load demand. Both the suppliers of efficient technologies and consumers receive additional benefits.

This chapter examines international best practices by analysing various efficient lighting initiatives, their successes and failures, as well as lessons learned. The chapter begins by examining literature on the efficiency rationale, the core of which is to reduce electricity demand; and then moves on to discuss issues associated with implementing CFLs projects and lessons learned. Markets are most important particularly in determining the viability of CFLs vis-à-vis competing technology. For this reason, the literature on the market barriers is examined. The final section of the chapter provides a synoptic overview of the impacts of the CFLs projects implemented in selected countries

2.2 Sustainable development and energy efficiency

2.2.1 *The rationale informing energy efficient programmes*

Most studies concede that energy efficiency such as use of CFLs offer multiple benefits (see Sastry and Gadgil 1992; IIEC 1998; Friedmann 1996; Sathaye et al 1993). Such benefits include the reduction of environmental impact in which less use of resources (such as water and coal) in power stations bring lower levels of carbon dioxide (CO₂), and reduce acid rain and emissions. Energy efficient programmes have real potential of preventing unsustainable use of non-renewable resources used in

power generation. Efficient lighting can reduce potential damages from hydroelectric dam construction in countries that have to construct dams for electricity generation (Sastry and Gadgil 1992).

A strategic reason for implementing energy efficient programmes is to clearly to reduce investments necessary for the expansion of the electric power sector, by freeing capital that would otherwise be invested in expanding utility capacity (Sathaye and Friedman 1993). The capital can then be used for purposes such as furthering significant economic development and the potential to generate higher standards of living. At the same time, efficient use of electricity helps in decreasing peak demand load that can avoid a power crisis. Because of the above benefits, several countries (i.e. Peru, Latvia, Czech Republic, Philippines, South Africa, Hungary and Argentina) are implementing efficient lighting projects with the aim of achieving the above-stated benefits (IIEC 1998).

2.2.2 Strategies for the implementation of ELI programmes

There are no readymade strategies or blueprints for implementation of CFL programmes. Many strategies can be implemented to overcome barriers of implementing efficient lights. These include rebates, leasing of technologies, innovative financing and subsidies, mass procurements, and so forth. Each strategy is discussed briefly below.

(1) REBATES

There is a growing consensus that global efficient lighting programmes describe rebates as payments offered either in a form of cash, coupon or price reduction (at a point of retail) to consumers to buy the efficient equipment or to sellers (shop owners) for them to sell the efficient equipment. This strategy enables the consumers to obtain reduction in the purchase of one or more CFL (Simmonds 1995). However, it has been discovered that although the strategy is widely used, it does not lead to very high participation rate. Furthermore, countries choose the rebate type that suits their

developmental goals. This implies that rebate schemes differ from country-to-country.

According to Acharya (2001), Martinot and Borg (1998) and Iwafune (2002), the Brazilian CFL residential lighting pilot programmes consider three different rebate levels in three different cities, ranging between 30% (Americana), 60% (Marlia) and 70% (Franca) according to city. The Brazil programme uses cash rebate and the rebate coupons are mailed directly to consumers. The coupons entitle the consumers to buy up to three lamps at a reduced price. The strategy led to 30% rebate generated sales of 5 700 lamps within the pilot period of a month, while 60% and 70% rebate levels sold the full quota of 100 00 lamps per city well before the pilot period ended. However, the success of the high rebate indicates that initial-cost is an important barrier to CFL implementation (Geller et al 1997; Martinot and Borg 1998).

The state owned utility in France, Electricite de France (EdF), with help from the environmental protection and energy management agency, send customers rebates on goods of up to 10 CFLs at a special price. This mechanism affords customers a chance to spread the payment of their CFLs over six sequential utilities bills over 18 months (Mills 1992).

The Danish utility programmes, on the other hand, use many methods, including a rebate coupon strategy, in which about one million CFLs between 1988 and 1994 were distributed (Danish Electric Utility Research Institute (DEFU) 1996; Pedersen 1997).

(II) LEASING

Many countries use a leasing scheme as a mechanism of making sure that even the poor households can afford CFLs, as it give people smaller payments with enough time to compare the bulbs i.e. incandescent and CFL. The leasing strategy allows the end-user to spread the payment of CFLs over their electric bills (Simmonds 1995).

Sastry and Gadgil (1992) pointed out that the leasing scheme in India, the Bombay Electric Lighting Large-scale Experience (BELLE), gives residents the CFLs under a four-year leasing scheme. BELLE designs the system in such a way that CFLs save consumers more in avoided energy bills, than they cost in lease payments. According to Sastry and Gadgil (1992), during the period of the project (1988-1991), the wholesale price of a CFL was \$11 but the lease to residential customers was \$0.25 per month. They predicted that over eight years the new lamps would save the Indian economy at least six times their purchase price in avoided capital investments for peak power generation.

According to the IIEC (1998), the Mexican Ilumex Project, the Peruvian energy efficiency and conservation programme, the Guadeloupe and Martinique CFLs leasing programme, and a host of others, provide the leasing schemes during implementation of efficient lights to participants. In the Mexican case, the CFL purchasers have an option of paying cash up-front or a leasing arrangement under which payments will be made on their electricity bills. The implementation scheme aimed to sell as many CFLs as possible to lower tariff categories, but even a higher tariff class has the opportunity to buy the CFLs. As a result, the public company, main generator and Distributor Company called the Comision Federal de Electricidad (CFE), suffered a net loss because of that (Sathaye and Friedman 1993).

In Peru, 16 000 CFLs were purchased through leasing, with the cooperation of several utilities (IIEC 1998). The retailers in their case submit the coupons to their utility, which then bill its consumers on their monthly electricity bill to cover the cost of CFLs over one or two years.

The CFL coupons in Guadeloupe and Martinique are mailed directly to all residential consumers, providing full information and redeem for up to 10 CFLs. The IIEC reports that the programme is considered to be successful as the original stock of 100,000 CFLs was gone within 36 hours and further 258 200 lamps were subsequently purchased in exchange for coupons. The leasing programme extended to

Martinique where the number of lamps was limited to only six. A total of 346 000 lamps are distributed there (IIEC 1998)

(III) FINANCING AND SUBSIDIES

There is a consensus in the literature that financing and subsidy strategies best address the high initial barrier that many CFL projects face. Through this strategy, even poor consumers can access the lamp. Researchers define subsidies as form of direct or indirect payments to an individual or class of end-users. It gives the recipients financial incentives to purchase particular goods or service (IEA 1989). These finances are perceived to be from government, utilities, banks and international assistance such as energy conservation loan funds, which are part of national and regional development banks or private banks like the World Bank, the GEF and IFC. For instance, the World Bank and other multilateral development banks authorise loans for efficient lighting in various countries such as Peru, Latvia, Czech Republic, Philippines, South Africa, Hungary and Argentina to implement efficient lighting (Figueres and Bosi 2006).

Now and again, utilities finance projects especially if appropriate incentives are given. This is advantageous because the utilities have billing and other information on their customers, so they target specific group of customers. For example, utilities promote CFLs for residential and small businesses and for commercial buildings. They target clients with higher than average bills, unusually low power factor or demand coincident with utility peaks to reduce programme costs and increase effectiveness. Experiences elsewhere show many countries use this type of scheme either by international banks or by utilities (Dutt and Mills 1994). Peru supplies finances for lower-middle sector, as they believe that the upper-middle economic sector will purchase the product (Mills et al 1995).

Some studies see subsidies as a way of increasing the implementation of efficient lights. Some subsidies are implemented through tax rebates (Dutt and Mills 1994). The Polish efficient lighting project provides subsidies on a competitive and contrac-

tual basis to dealers and preferential prices to consumers (Martinot and Borg 1998). Manufacturers compete to provide the largest guaranteed sales at the lowest project subsidy cost and contribute additional price reductions themselves. On other hand, the project use a combination of manufacturer subsidies, which resulted in reduced price in the retail twice the level of initial wholesale price subsidy (Kazakevicius et al 1998). During 1995-1997 in two separate promotions, consumers bought 1.2 million CFLs through the project and it was considered cost efficient (Martinot and Borg 1998). There is consensus in literature that, subsidy schemes usually become less important in matured CFL markets with decreasing price than in immature market such as many non-OECD countries (see Martinot and Borg1998, Iwafune 2002).

(IV) MASS PROCUREMENT

IIEC (1998) identifies initial cost as one of the major barriers of implementing efficient lights. In overcoming this barrier, utilities and companies purchase a large number of CFLs in order to gain a price reduction from manufacturers. These companies then sell the CFLs to selected consumers with or without financing options.

In Mexico, mass procurement combines with lease financing, and this helps to reduce the first high cost of CFLs (IIEC 1998). The purchasers have the option of paying cash up-front or through leasing arrangements under which payment is made on their electricity bills. The scheme resulted in a price reduction of about US\$5-8 compared to a market price of US\$25 or more (Martinot and Borg 1998). One million and four hundred thousand CFLs were sold through the programme with an expected total number of 1.7 million by the end of the programme.

Further, the Guadeloupe and Martinique CFL leasing project uses mass procurement as a way of bringing down the unit price of CFL. Low-income consumers are particularly targeted. The project is considered successful in that the original stock of 100 000 lamps were sold within 36 hours and the Guadeloupe and Martinique is largest lighting procurement ever which is combined with a consumer discount and fi-

nancing mechanism to introduce CFLs to households (Friedmann 1996; IIEC 1998; Sathaye et al 1993; GEF 1994; Friedmann et al 1995).

(V) CFL BOXES

Some countries prepare boxes containing CFLs, which customers can borrow free of charge for few days. The idea behind is to testing the potential of CFLs and to remove psychological barriers against CFLs, such as uncertainties that the CFL means saving the lights or that they save energy but not money (Clark 1997a).

Borg et al (1995) noticed that Austria Association of Electric Utilities launched the CFL boxes scheme as hands-on lamp information. The programme prepares eight or so commercially available CFLs (ranging from 9W to 24W) to be given to customers free for testing. The Austrian programme is not explicitly concerned about environmental friendly and saving money, instead the intention is to motivate customers to compare the quality of CFLs to incandescent and to see whether CFLs fit their home environment. Borg et al (1995) see the Austrian programme as successful because there has been a remarkably high degree of acceptance of the programme, which resulted in many borrowers willingly interested in installing CFLs in their homes.

(VI) FREE GIVE AWAY AND FREE INSTALLATION

The free give away and free installation strategy is often linked to direct installation programme. The utility or third party companies offer free installation service to the end-users, thereby minimising the challenge of lack of money faced by the end-user (Simmonds 1995). Countries like Brazil, Denmark and Jamaica use door-to-door, mail, direct installation as a way to provide free installation of CFLs (Martinot and Borg 1998).

The Brazilian CFL residential lighting pilot programme attempt this in an impoverished regions, which experienced frequent blackouts. About 89 000 of 9W CFLs were distributed to 52 000 households with energy consumption below 50 KWh/month as a direct installed give-away scheme. Studies such as Jannuzzi et al

(1997), Geller and Leonelli (1997), Geller et al (1997) and Nadel (1991) and Iwafune (2002) agree that the aim of the Brazilian programme was to improve voltage and current levels in the distribution systems and thus help all customers to obtain more acceptable lighting services and lower risks of damage of appliances. However Geller et al (1997) discovered that give-away approach in an immature market like Brazil appears to do less for market evolution than in more mature markets.

Mills (1991), DEFU (1996) and Pedersen (1997) consider the Danish give-away programme as being one of the largest programmes, where 240 000 CFLs were distributed to Danish households. In 1995, the DSM demonstration project in Jamaica, gave away free CFLs to 100 homes, which were approximately 300 lamps. The reason was to enable consumers to test, establish technical criteria regarding equipment performance, customers' response and installation problems (Harris and Titus 1997; GEF 1994; Iwafune 2002).

(VII) MARKETING AND CONSUMER AWARENESS

Lack of marketing and consumer awareness of the CFLs is amongst the most important barriers that militate against their wide dissemination. Education programmes (such as appliance labelling, performance testing, information programmes and equipment demonstrations) are seen as the best way to overcome this barrier (Simmonds 1995). There is consensus in literature that consumer awareness programme enables consumers to increase their knowledge about how to identify high quality lamp, how much the savings will be, and how to use the lamp properly other than just knowing about the CFLs existence. Many countries including Poland, Peru, Guadeloupe and Martinique featured the degree of marketing and consumer awareness.

In Poland, public awareness was through participation with local NGOs. Their strategies included creation of special logos, conducted television and press advertising campaigns. The campaigns contributed significantly in raising consumer awareness of CFLs. It increased number of households with CFLs from 11.5% to

19.6%, and that 50% of first-time CFL purchasers learned about CFLs through the scheme (Granda 1997, GEF 1994 and IIEC 1998). About 80% of CFL purchasers indicated their intention to buy additional CFLs. An energy-environmental education programme in over 250 primary and secondary public schools was conducted as a way of promoting awareness. The Ministry of Education found it significant as it made students and teachers to have better insight about the use of energy and its impacts on the environment (Granda 1997, GEF 1994 and IIEC 1998). The teachers and students awareness might lead to higher purchase of CFLs since they will know the benefits, able to identify high quality CFLs and know how to use the lamp properly. The Polish programme shows that public education campaigns can leverage price concessions and other contributions from manufacturers; increase competition between products, boost consumer demand and lower prices in a sustained way (NECEL 1997; EEI 1997; IIEC 1998).

In Peru, the Ministry of Energy and Mines launched the National Energy Saving Campaign with the aim to reduce electric demand. It included public information, education, demonstration, pay-on-bill and the CFL replacement programme with out subsidies (Romani-Aguirre 1996, Iwafune 2002). The campaign led to a high degree (75%) of consumer awareness about CFLs. Three hundred and eighty thousands CFLs were sold and projected annual sales after the programme increased to 250 000 from cumulative sales of 100 000 before the programme. More than 400,000 CFLs were sold, mainly in Lima and mostly to higher income groups (Romani-Aguirre 1996; Iwafune 2002; IIEC 1998).

According to the IIEC (1998), the Guadeloupe and Martinique CFL programme specialises in media campaign through print and electronic media and the message appeals to a broad range of instincts. The campaign was able to change the islanders' perception about CFLs and the level of awareness of life cycle cost. The advertisements highlight different advantages with some financial advantages of CFLs, some environmental benefits, others technical and informative and others modern and trendy. The programme resulted to the increased use of CFLs from 1 000 to 300

000 in the space of a month. This change is not the effect of marketing and consumer awareness only but a combination of other strategies like lease and bulk procurement.

(VIII) PRODUCT LABELLING

Labelling is another way of promoting an efficient lighting initiative. The IEA (1989) sees labelling as increasing awareness about energy consumption and potential for end-use efficiency, and provides unbiased information to aid the purchasing decision. Labelling makes consumers aware of long-term savings and the environmental benefits of the appliance. It helps to overcome the barriers of misleading, absent or confusing information surrounding the product. It implies that the product has been tested for both good quality and standard. Countries like Poland and Denmark show use of logos for product labelling. As a way of promoting it, there is a need for marketing and consumer awareness to ensure that the logos used achieve a sufficient degree of public recognition. However, educational and marketing effectiveness of these programmes are more difficult to assess, and evaluations are generally limited to anecdotes.

During efficient lighting project of 1995-1997 in Poland, a public education programme with the participation of non-governmental organisation created logos to promote CFLs. The surveys illustrated that a majority of consumers felt that special labelling for environmentally friendly products play an important role in their decision-making. The whole programme resulted in the sales of more than 1.2 million CFLs, which are expected to save 725GWh electricity, avoiding more than 200,000 tons of carbon dioxide emissions (Granda 1997, IIEC 1998 and GEF_1994).

According to DEFU (1996) and Pedersen (1997), the Danish CFLs projects moved way from rebate schemes and concentrate more on quality, testing and labelling. After a lamp passes certain stringent tests, it is then placed on a utility-supported quality CFL list called the *Sparepaere* list. This list receives acknowledgement as a proof of quality even outside Denmark.

2.3 Market barriers

Most studies agree on common energy efficient barriers (see Batra et al 1993, Mills 1991, Martinot and Borg 1998; Dutt and Mills 1994; Levine et al 1992; Mills et al 1995; Parker 1991). These include the non-availability of appliances, lack of adequate information, the cost of the technology, lack of suitable financial regimes, absence of suitable incentives, lack of clear policy guidelines and institutional deficiencies. Both developing and developed countries face these problems, but in addition to that, many new problems have been experienced due to local circumstances. This explains that each country can experience different problems and the solution can be different.

2.3.1 Availability of appliances/ technology

Batra et al (1993) and Mills (1991) agree that the non-availability of appliances or technology is a major barrier in many efficient lighting initiative programmes especially in developing countries, since the latter does not usually manufacture appliances. This barrier is exacerbated by the following:

- Lack of consumer understanding of the technology and equipment available for more energy efficient lighting use;
- Lack of consumer demand, which in turn is partly determined by absence of strong environmental lobby groups;
- Lack of adequately trained individuals to train personnel in the operation and maintenance of the technology;
- Insufficient local technology capacity to develop the appliance and equipment. This is related to inadequate access to finance for research and development and demonstration (RD&D);
- Overpriced, imported technology.

Levine et al (1992) argue unavailability of appliances and technologies are caused by the lack of indigenous manufacturing. Also, it could be that the manufacturers are

not aware of the appliance or cannot obtain the right to manufacture CFLs from the government or do not perceive a market for product as individual end-users tend to purchase less expensive, less efficient products. However, countries like Denmark and France solved the problem of unavailability by producing their CFLs locally (Martinot and Borg 1998).

2.3.2 Lack of information

Lack of information about efficient lights is common to almost all the efficient lighting project. There is a consensus in literature that the majority of decision makers (including the consumers, architects, developers, manufacturers and retailers) have insufficient knowledge about the technology and its advantages (Levine et al 1992; Mills et al 1995). They are not aware of the range of energy-efficient products they can use to reduce the energy consumption and demand of their buildings. This unawareness from decision makers can result in more use of inefficient appliance that consumes and demand much energy. The information about technical and economic characteristics of CFLs is still limited and often comes from manufacturers who are not generally considered as a reliable source of information (Levine et al 1992 and Mills et al 1995).

Worldwide programmes show the lack of awareness on performance, savings and availability of appliances. This has, in some cases, resulted in wrong information and incorrect perceptions about energy efficient lighting. It made it difficult for consumer to choose between high capital cost and a low operating cost option (Parker 1991). Polish studies reveal that a group of residential consumers of energy efficient lighting had incorrect information that CFLs mean saving the lights. This resulted in customer's efforts to save energy by turning lights off more often than normal habit would entail. The customers install the lights for lesser power and thus worsening the quality of the light produced rather than replacing these lamps with more efficient light source, which allow for saving of energy without a change in lighting conditions (Okolski 1995).

In China, consumers often view efficient lights as something that saves energy but not money (Fu Min and Mills 1994). There is also evidence of the lack of understanding by government regulatory agencies about opportunities and benefits of using CFLs. This results in the reluctance to approve project investments and creation of new regulatory incentives (Fu Min et al 1997).

Similar results are found in Argentina, where many CFL users are not aware of the energy savings potential of efficient lighting alternatives, and do not have enough technical knowledge to choose the most appropriate options. This resulted in lack of consumer confidence on the performance of certain equipment, e.g. high efficient fluorescent tube lamps or the useful life of compact fluorescent lamps. Because of these factors, consumers tend to buy the product with the smallest first cost, which is neither the most energy efficient, nor the most cost effective considering the energy costs. Alternatively, they purchase according to brand names that they associate with high quality.⁵

The solution to the problem depends on educating decision makers. Education campaigns can involve appliance labelling, performance testing, free energy audits and government procurement link to independent and performance contracting. Countries like Poland solve the problem of wrong perceptions of their consumers about CFLs by conducting education awareness programme even at primary and secondary schools in a form of energy and environmental education programme (Martinot and Borg 1998).

2.3.3 First cost

The problem of high initial cost is one of the major barriers to the implementation of CFLs. CFLs are seen as saving money in the long run but the high up-front costs have an adverse effect on the implementation of the CFLs. As most CFLs initiatives target the poor or low-income group, this problem prevents them from using the

⁵ See (www.efficientlighting.net)

lamp, as they tend to be sensitive on high costs because of budget constraints (Sioshansi 1991; Mills 1992).

To address the first-cost barrier in the low-income sector, ELI encourages organizations that provide financial assistance (such as subsidise, rebates and leasing) to the poor to consider a CFL free giveaway programme. This approach worked very effectively in the Czech Republic's neighbour, Hungary.

2.3.4 Finance

Many CFL programmes require huge initial financial investments. Literature reveals that in many developing countries, the introduction of energy efficient technologies, policies and programmes are often limited by financial constraints (Simmonds 1995). At the household level, the cause of these constraints is low-income groups, which are incapable of meeting the high up-front costs. At the government level, it is because of lack of government funds, which result in incapability of financing the programmes. While in the private sector, the regulation results in insufficient economic incentives to implement energy efficient programmes and often discourage private utilities to pursue profit through increased sales revenues (Simmonds 1995).

The Ilumex programme, designed in cooperation with the World Bank, addresses the purchase price barrier to the use of CFLs in Mexico through high-volume procurement and an innovative financing scheme. Through the programme, consumers are able to purchase the CFLs from the utility company and pay for them over time on their electricity bill. The financing is structured so that customers see a reduction in their monthly bill, even while they are paying for the CFLs. The programme resulted in nearly two million CFLs being installed in residences in Guadalajara and Monterrey (Friedmann (1996), Sathaye J and R Friedman (1993), GEF (1994) and Friedmann et al (1995).

2.3.5 Weak incentives

Incentives mean forms of motivation for consumers to invest in efficient lighting technology. These can be in a form of financial incentives offered to different stakeholders, end-users, manufacturers and energy supply (Simmonds 1995). Geller (1991) argues that, at times, the electric power companies have little or no compelling economic incentives to invest in energy efficient lights. This creates problems especially to poor people where the cost of energy consumption represents a large proportion of their income, and where the high initial costs of CFLs are unaffordable to them. In some cases, energy represents a small fraction of total cost of owning and operating a household but this is not the case in the poor households. Sioshansi (1991) and William and Joseph (1996) declare that, sometimes, energy efficient technologies reduce sales and therefore most utility companies would lose revenue in excess of any savings derived from lower fuels and operating costs.

2.3.6 Governance policy regulation

Policies and regulations may create problems to ELI programmes. Batra et al (1993) explains that, if the cost-effective measures conflict with existing regulatory mechanisms, the implementation of these programmes would be difficult. Geller (1991) shows taxation policies, government spending, regulation policies often become disincentives to the adoption of energy efficient products but they could be in favour of production. In United state for example 90% of the federal government's R&D budget is devoted to supply options, while at state level, regulation usually makes it more profitable to promote consumption than energy conservation. This shows that sometimes government policy regulations are usually not in favour of efficient initiatives. Sometimes, the lack of government understanding about the energy efficient programmes results in the reluctance to approve investments and creating regulatory incentives.

2.3.7 Institutional deficiencies

The energy efficient initiative issues require a coordinated effort in order to ensure a high degree of integration between energy use sectors. This will facilitate the development and implementation of an integrated energy planning approach. Lack of adequate institutional capabilities prevent the use of energy efficiency appliances like CFLs. The lack of local and national institutions and agencies that produce, gather and disseminate information, distribute financial resource, design and monitor programmes, policies, and train personnel are seen as limiting the adoption of the efficient technology. Evidence demonstrates that, the lack of adequate institutional capabilities in developing countries discourage international institutions from funding small innovative technology programmes because organisations to administer and monitor the programmes are either non-existent or unable to provide the needed service (Levine et al 1992). This indicates that the lack of institutional capacity within utilities to carry out energy efficient projects and to market energy efficient technologies prevent the development of efficient programmes.

The BELLE large-scale efficient lighting experiment programme that was designed in 1990 shows influence of institution deficiencies on programme because it ended-up terminated due to number of institutional and political problems whereby bureaucrats, politicians and other parties were fighting each other (IIEC 1998; Dutt and Mills 1994).

The evidence in Peru highlights an instalment financing plan arrangement that led to an additional 50 000 CFLs sold, but it suffered from legal and institutional difficulties. The Peru project was based on the massive four-month publicity campaign, which they claim was expensive and not cost-effective as other projects that relied on subsidies (Martinot and Borg 1998). Mills et al (1995) show that even institutional weaknesses can be a problem to the implementation of efficient lights.

2.3.8 Other problems

Some projects experienced unusual different problems. In the Mexico case, the benefits from CFLs affect the utility because the utility sold less electricity, resulting in loss of revenues. The revenue loss affects finance because there were no mechanisms in place to recover the lost revenues. This implies that, the utilities can be reluctant to promote the CFL projects.

Other cases of market failure do not allow the use of efficient lighting technologies that are cost effective. Argentine consumers, as in other countries, apply high discount rates for investments in energy efficiency, that is, they *overvalue the initial cost of the product and undervalue future savings*. This is particularly the case for consumers with limited economic resources, both in the residential and in the productive sectors. A consequence is that although investments in efficient lighting are very cost effective, they are rejected.

Literature reveals a problem of split incentive. This usually occurs in situations where the owner of a building is responsible for the investments in the lighting installation but the tenant is the person who would pay the energy costs. Thus, the owner does not have an incentive to invest in making the lighting more efficient since s/he will not receive any direct economic benefit from the savings. On the other hand, the tenant has limited possibilities to modify the installation. Even when allowed to modify the installation, s/he will be reluctant to improve something that s/he does not own. A similar situation of split incentives is observed between a new building constructor and its future buyer.

2.4 The impacts of the projects

There is consensus in literature that the projects have different effects and these effects mostly depend on the reason for implementing the CFLs (see Martinot and Borg 1998). The effects can be either direct or indirect. Direct ones occur during the project implementation because of specific intervention like marketing campaigns,

subsidies, new capabilities and new pilot credit mechanisms. Impacts such as cost-effectiveness and GHG, socio-economic and peak reduction are realised.

2.4.1 Cost-effectiveness and GHG impacts

Cost effectiveness from GHG mitigation perspectives and from consumers discovered that there are many uncertainties and disputes about cost energy savings data for the programmes. Some cost effectiveness varies from low US\$5 to US\$10/ton CO₂, (for example in Poland, Thailand, Denmark and UK subsidy programme), to high i.e. US\$25 to US\$40/t CO₂ (as Mexico, Jamaica, Peru, Brazil low subsidy and UK give away programme). The high costs per ton of CO₂ abated occur in high subsidy and give away programme in Brazil. Indirect cost effectiveness of market transformation is also experienced in Thailand and below US\$5/t CO₂ appears (Dutt and Mills 1994; Martinot & Borg 1998).

The Thailand conversion from T-12 to T-8 for example saved 10% of electricity consumption and with estimated cost effectiveness of less than US\$1/t CO₂ (Martinot & Borg 1998). The PELP experience pointed out that out of 1.2 million CFLs sold, electricity generation will be reduced by 725GWh, thereby saving about US\$40 million in consumer electricity bills. Electricity savings will avoid an estimated 206 000 tons of carbon equivalent greenhouse gas emissions from their plant (Granda 1997, IIEC 1998). The benefits of reducing environmental impact from reduced power plant construction are experienced by many projects. For Ilumex in Mexico there is about 150 000 tonnes reduction of carbon missions over the life of CFLs, at a negative cost of \$0.28 per kg of carbon, since the investment is preferable in terms of energy savings alone (Dutt and Mills 1994)

2.4.2 Socio-economic impacts

The economic returns are also experienced within the programmes. In Denmark, the estimates are US\$30 per lamp consumer (net present value) NPV because of very high electricity rate and tax paid by consumers. The UK case is even estimated with higher consumer NPV due to a combination of free lamps, high electricity rates, high

lamp usage and high wattages of bulb being replaced (Martinot and Borg 1998). The Mexico Ilumex project shows that impacts differ according to society, utility and residential customers. The project indicates that, the societal benefits arise because the same amount of light will be delivered at lower overall society cost than before. The benefits include deferment of investment in new generation, transmission and distribution capability, fuel savings from avoided electricity generation, avoided purchase of incandescent bulbs and reductions in negative environmental impacts.

On the other hand, residential benefits are because of reduction of electricity bills and avoided frequent purchase of incandescent bulb (Sathaye and Friedman 1993). In addition, many people in most rural areas especially in developing countries do not have access to electricity. For lighting, they usually depend on kerosene and other sources that produce little light output. The users pay an inordinate amount since the lamps and sources are inefficient. In this case, the use of CFLs can change the living standards of many people, as they are efficient, have adequate light output and give many savings.

2.4.3 Peak reduction impact

Some studies (Polish, Brazil, Peru, Thailand, Guadeloupe and Martinique and Mexico) show that their projects implement efficient lights with the aim of reducing peak load. The Polish project demonstrates that ELI projects could cost-effectively lower peak load in electric power distribution systems and avoid or delay utility capital costs. About 7500 CFLs installed in neighbourhood reduce a peak power levels at some monitored points by about 15% (Granda 1997). Brazil's total peak load reduction is estimated at 1.8MW from almost 90 000 CFLs. In Peru (Lima), 93MW was from all measures in the energy savings campaign of which a fifth that is approximately 20MW of peak is avoided directly due to lamp replacement programme.

In Thailand, the complete conversion of the 40 to 36W lamps from 20 to 18W lamp saved an estimated 700 GWh per year compared to business-as-usual scenario and reduced peak demand by an estimated 300 MW (IIEC 1998; Martinot and Borg

1998). The Guadeloupe and Martinique CFL leasing programmes resulted in electricity savings of 63GWh per year and 14MW peak demand reduction (IIEC 1998). In Mexico Ilumex project, out of 1.7 millions CFLs introduced, reduce electricity consumption by an estimation of 169 GWh and peak reduction of about 100 MW (IIEC 1998).

2.5 Conclusion

The chapter provided a general discussion of international studies and their experience on the implementation of efficient lights. There is consensus in literature that many countries implement CFLs because of many reasons that include, the need to reduce carbon dioxide emissions in the atmosphere that come out during the production of electricity in power stations. The other reason is that, most countries have to reduce demand in peak load, which is believed that household lighting is one of cause as their lighting coincides with peaks for cooking, space heating and water heating. Some countries implement CFL programmes because it is associated with savings, for instance, of avoiding investments in the expansion of the power generation. In addition, the efficient lighting initiative can prolong exhaustion of non-renewable resources used in generating electricity. Lastly, through using efficient lights, consumers can experience some saving that can reduce their electric bills.

In order for the efficient light initiative to be successful, combinations of different schemes have to be devised. For example, international studies showed use of schemes such as rebate, leasing, CFL boxes and energy centre, free give away and free installation, marketing and consumer awareness, product labelling, financing and subsidies and mass procurement. These schemes are addressing challenges of availability of appliances or technology, lack of information, first cost, finance, weak incentives, governance policy regulation and institution deficiencies that the projects experienced. Furthermore, the efficient lighting initiative can result in both negative and positive impacts. Mention can be made of the impacts to the market transformation and technology, the CFLs effectiveness to the costs and to GHG impacts, the impacts to social and economic issues and to the peak demand. While on other

hand, other projects could not go further due to many reasons such as institutional conflicts and loss of revenue.

Chapter 3

EFFICIENT LIGHTING INITIATIVES IN SOUTH AFRICA

3.1 Introduction

Eskom generates approximately 95% of electricity in South Africa, as well as owning and operating the national transmission system (NER 2001). In the residential sector, Eskom serves 23% of customers, with the municipality distribution companies serving the rest. In terms of energy demand, the manufacturing sector consumes the most of electricity at 43.7%, followed by the household sector at 18.5% (Eskom 2006). Although the household sector is comparatively not the largest consumer of electricity, it has the most potential for growth in demand due to the ongoing electrification programme.

More than 40 GW of the nation's electricity generating capacity is primarily coal-fired with one nuclear power station, two gas turbine facilities, two conventional hydroelectric plants and two hydroelectric pumped-storage stations. There are several developments of generating electricity from natural gas (IFC/GEF 1999); however, this is still negligible. Most studies show that coal will continue to be the dominant electricity source in future at least for the next 500 years (Mutemeri and Mehlwana 2003; IFC/GEF 1999).

The aim of this chapter is to outline efficient lighting initiatives in the South African context. It investigates the rationale for the implementation of the CFLs programme in South Africa. It also analyses the characteristics of the lighting end-use focusing on electric lamp in the residential sector; and highlights the expected benefits from using CFLs.

3.2 Rationale for energy efficient lighting in South Africa

3.2.1 South African approaches in support of CFLs

The National Energy Regulator of South Africa (NERSA) commits the EDI to target 450 000 new electrification connection in South Africa annually (Clark 1997).⁶ It is anticipated that the increase in the use of electricity implies a construction of new power stations to meet the anticipated demand. As more and more households are connected to the grid, this will mean the increased use of electricity particularly on peak times (i.e. early in the morning and evenings). At the time, it was estimated that electricity demand in South Africa would exceed the current capacity by the year 2007/8 (DME 2003). This medium-term capacity constraint has prompted Eskom to examine DSM as a means to curb electricity demand at the household level. This includes the implementation of several residential DSM lighting pilot projects, mainly introducing efficient lighting awareness campaign through ElektroWise programme (Figueres and Bosi 2006). The residential sector is the target because it most susceptible to peak load demand, as its load constitutes 75% of the total national variable load (Clark 1997).

Given South Africa's abundant coal resources, it is likely that coal will continue to be the dominant for electricity generation well into the future. As a result, South Africa is Africa's greatest contributors to GHGs. Although South Africa's GHG is small compared to major industrialised countries, the country has a responsibility to lead by example in encouraging clean environmental practices on the continent, as this would not only reduce GHG emission, but also save the country from investing in additional generation capacity.

An effective widespread deployment of efficient lights is one of the strategies to mitigate climate change impacts as demonstrated in countries such as Poland, Mexico and Brazil. Another related serious problem for South Africa in particular, is the use

⁶ At the time of research, this institution was simply called the National Electricity Regulator (NER).

of scarce inland water for cooling purposes at coal-fired power stations. On average, each kilowatt-hour that is generated requires approximately two litres of cooling water (Bonesa 2002). The use of efficient lights could go a long way in mitigating this environmental disaster and save precious water. According to Eskom's estimates, the average annual energy savings per CFL is 1 050 kJ. This translates to an average CO₂ equivalent savings per CFL of 87 kg. Moreover, each CFL can save about 88 litres of water per year due to reduced consumption in power stations. Other environmental benefits include reduced acidic deposition and health and visibility impacts arising from local air pollution (IFC/GEF 1999).

The government introduced favourable tariffs for low-income households in April 2001. This is commonly referred to as poverty tariff or basic electricity support tariff (BEST), whereby consumers are entitled to up to 50 KWh of "free" electricity on a monthly basis. To determine the viability of this proposed alternative option (poverty tariff), Eskom and government have allocated two of the eleven nodal sites to the efficient lighting programme for piloting the BEST (Bonesa 2002)⁷. The research site, Matatiele/Hlomendlini, is one of these nodes where the BEST initiative was piloted and where each household was provided with two CFLs at no costs.

This was part of GEF's clean development mechanism (CDM) programme in South Africa to reduce GHG emission through efficient lighting initiatives.⁸ The GEF programme supports efficient lighting in order to promote the global environment agenda to mitigate:

⁷ Nodal points are areas in South Africa that have been identified and prioritised for development purposes in the Integrated Sustainable Rural Development Programme (ISRDP). The programme is designed to build socially cohesive and stable rural communities with viable institutions and sustainable economies, offering universal access to social amenities and able to attract and retain skilled and knowledgeable people who can contribute to growth and development. Currently the programme is running in the District Municipality "nodes" of Zululand, Ugu, OR Tambo, Alfred Nzo, Umzinyathi, Chris Hani, Umkhanyakude, Central Karoo, Maluti a Phofung, Kgalagadi, Sekhukhune and Bohlabela (as announced by President of South Africa, February 2001).

⁸ GEF is sponsoring the efficient lighting initiative in seven countries, which includes South Africa, and this has resulted to the formation of Bonesa.

- Biodiversity loss;
- Climate change;
- Degradation of international waters; and
- Ozone depletion.

3.2.2 Objectives of Efficient Lighting Initiative and Bonesa

Bonesa's and ELI primary role, over a three-year period, was to transform the lighting market so that the CFL becomes a lighting device of choice throughout South Africa's communities. Furthermore, specific objectives of programme were as follows:

- The lowering of household energy cost, thereby making more disposable income available, particularly to South Africa's previously disadvantaged population.
- The creation of employment and economic benefits arising from robust energy efficient lighting market.
- The conservation and preservation of environment, through the reduced demand for electricity during the peak consumption period (i.e. between 18:00 and 22:00). This would mitigate the potential adverse environmental effects, resulting from increased generation of coal-and nuclear-based electricity generation. At the same time, this reduces risks on the local environment and health resulting from use of fossil fuels.
- The improvement of indoor air quality, health, safety and quality of life for South Africa's most needy citizens.
- Reduce GHG emissions from South Africa's coal-fired electricity industry by stimulating sustainable enterprise, as well as other environmental benefits such as reducing water and coal usage.

- Increase awareness of efficient lighting by approximately 15% by the year 2005, (subject to the monitoring and evaluation requirements for this area of the programme). The programme has started since 1997 because Eskom's market research recognised low awareness about CFLs in all income segments (Acharya 2001). From the period of December 2000, ELI had eight promotional events in shopping centres across South Africa. The activities at the promotions included an exhibition stand, children's entertainment and demonstrations of CFL advantages, subsidised sales of CFLs and promotion of the national competition. The above promotions were complemented by a newspaper publication, live radio broadcasts, television adverts and national competition (Bonesa 2000-2001). However, the promotion seem to affect only urban people only and as most rural people do not have access to television, radio, newspaper and others equipments that Bonesa used.
- Achieve additional sales of CFLs and other efficient lighting technologies, and the sale of up to 466 000 additional lamps into the South African residential market, i.e. over-and-above the natural growth of lamps sales for these products. In 2000-01, Bonesa delivered 4000 modular of CFLs to the Limpopo Province pilot project. In their first six months development phase, the programme executed a joint campaign with Osram to promote the sales of CFLs. It continued networking with all manufacturers, retailers, government official, academics, marketing organisations to keep up motivation and interest in potential involvements in the future.
- *Facilitate the establishment of 2 400 new "retail" channels for CFLs.* South Africa presently depends upon high-cost CFL imports from big companies such as Osram, GE and Philips and lower-cost imports from region such as Southeast and Western Asia (Acharya 2001). This im-

plies lack of accessibility of CFLs to different income levels groups. Bonesa/ELI encourages the availability of the lamps even to retailers, so that all consumers in all income levels can access them. ELI initiated programmes with more informal retail outlets including smaller vending agents and shops providing services to rural and urban areas (Acharya 2001).

- Engage the services of a professional, independent consultant to do an annual audit of lamp sales in South Africa, by speaking to each supplier/distributor of products in the country.

While the above objectives constituted the hallmark of the Bonesa/ELI programmes, it was arguably a very ambitious target to be achieved in the specified three-year period. How and the extent to which this was achieved is the subject of this thesis. For example, even if the use of CFLs was found to have increased (as shown in Table 3.1), it is important to note that the sales were not because of the programmes.

Table 3.1: Programme sales (2000-2001) in quantities in thousands

<i>Programme</i>	<i>Q1 (2000)</i>	<i>Q2 (2000)</i>	<i>Q3 (2000)</i>	<i>Q4 (2000)</i>	<i>Q1 (2001)</i>	<i>Q2 (2001)</i>	<i>Q3 (2001)</i>
Bulk subsidies (ELI approved CFLs)	-	-	-	76	254		
⁹ Free give away (ELI approved CFLs)	50	100	200	195	85	170	400
¹⁰ Retail sales without subsidies (ELI approved CFLs)	-	-	-	-	20	20	5
¹¹ Non-ELI ap- proved sales	200	350	450	700	350	400	100
¹² Bulk purchases (Electrification RDP)	-	-	-	-	4	-	-
¹³ Natural sales growth (ELI & non-ELI ap- proved lamps)	350	520	650	200	300	400	80

Source: Bonesa 2000-2001 Review draft

Table 3.1 illustrates the number of lamps that the ELI programme distributed since 2000 as a way of meeting their target. The idea is that lamps are not only purchased through the ELI approved system, but also through non-ELI approved, or through

⁹ Free giveaways includes the distribution of CFLs at conferences, exhibitions and promotional items given to important stakeholders

¹⁰ Retail sales without subsidies relate to small quantities of CFLs that are sold to non-traditional retail outlets and which do not meet the minimum volumes required, for participation in the subsidy programme

¹¹ Non-ELI approved CFL sales relate to those products sold into market, but which either do not meet the ELI minimum technical specification and/or have not been submitted for approval by relevant manufacturer

¹² Bulk purchases (electrification -RDP) relate to the Bonesa tender for specific market segment

¹³ Natural sales growth includes those lamps sold into commercial, industrial and institutional sectors and which do not qualify for the retail subsidy

RDP electrification. These include bulk subsidized, retail sales without subsidies; free give-away, bulk purchases and natural sales growth.

3.3 Characteristics of the lighting market

The available evidence demonstrates that the South African residential lighting market is heavily dominated by incandescent lamps (IFC/GEF 1999). The use and ownership of CFLs is usually associated with household income (Granda 1997). Approximately 8% among the highest income customers use one or more CFLs. However, empirical evidence suggest that even though there is a remarkable growth rate of CFLs at the household level, the market share is still dominated by use of incandescent lamp.

Table 3.2: Annual lamp sales from 1997 to 2004 in millions

	Oct.96- Sep.97	Oct.97 Sep.98	Oct.98- Sep.99	Oct.99- Sep.00	Oct.00- Sep.01	Oct.01- Sep.02	Oct.02- Sep.03	Oct.03- Sep.04
	1997	1998	1999	2000	2001	2002	2003	2004
Incandescent	50,6	50,1	55,5	65,4	59,9	50,3	54,8	61
Tungsten Halogen*		1,3	1,4	1,6	1,8	1,8	2,1	2,5
Dichroic*		1	1,3	1,6	2,2	2,9	4,2	5,6
High Intensity Dis-charge	1,2	1,7	1,1	1,3	1	1,3	1,3	1,7
Linear Fluorescent	10	11	8,5	10,3	10,8	10	10	13,4
Compact Fluorescent	1,5	1,2	1,9	2,5	4	5	5,3	9,7
Electromagnetic Ballasts					4,5	3,8	4,2	4,1
Electronic Ballasts					0,2	0,2	0,25	0,5
PL-dedicated Luminaires					0,5	0,65	0,7	0,78

(Source: Eskom 2006)

There is a progressive increase of CFLs usage in the country since 2001. Table 3.2 shows the sales figure of CFLs, as well as the positive trend (i.e. an average growth rate of 33% compared to 19% of incandescent lamps). The increase of CFL could be attributed to the relatively successful efficient lighting initiative, which was spear-

headed by Bonesa as well as other market strategies to promote these lamps. Apart from CFLs and incandescent lights, other lamps are mostly used in sectors other than the residential. Given that this thesis focuses on the CFL initiatives at the household level, to substitution for incandescent lamps, a comparison of growth in lamp sales is therefore revealing (Table 3.2), and account for the rise in incandescent lights up to 2000. After 2001, there was a sharp decline of the use of incandescent lights as a direct result of the Bonesa initiative.

The upward trend in the use of CFLs is expected to continue. If international best practises can be implemented, the deployment of CFLs could show even better positive impacts and the lighting market could be transformed, as more and more South African households adopt the practice of using CFLs as the lighting device of choice.

3.4 Potential benefits of ELI

Since ELI-SA was still piloting the CFL implementation, the expected benefits from the projects are based on the assumptions. The Bonesa assumed the savings associated with replacing 1.2 million 75W incandescent with 15W CFL make huge savings as shown in Table 3 below. As efficient lights become a mostly use lighting device, a lot will be saved compared if the device can be a normal (incandescent) lamp. Since large amount of the country's electricity is derived from coal, it comes with huge environmental hazards (viz. SO₂, N₂O, NO_x and CO₂).

Given that South Africa makes use of scarce inland water for hydro and cooling purposes at coal-fired power stations, the use of CFLs could save gigalitres of water annually. Moreover, a much lesser coal is used when producing electricity for efficient lamps than incandescent lamps. A coal-fired power station burns 50kg of coal to power a 100W bulb over its rated 1000-hour life. In this case, of CFL, with the same light output, it would require just 10kg of coal (Bonesa 2002).

Table 3.3 also shows savings of 4.23 kilotons coal usage in 15 years to come. The indirect benefits include avoidance of air and water pollution associated with the use of coal for generating electricity, and the associated improved health, safety and quality of life of the citizens. Furthermore, the use of efficient lights reduces risks (such as fire hazards, and paraffin poisoning) associated with the use of traditional lighting sources such as paraffin, candle while at the same time improve the indoor air quality.

Table 3.3: Savings associated with replacing incandescent (75W) with CFL (15W)

<i>Resource</i>	<i>Units</i>	<i>Year 1</i>	<i>Year 5</i>	<i>Year 10</i>	<i>Year 15</i>
Electricity cost	Billion Rand	0.02	0.32	1.19	2.59
Energy use	Gigawatts/hour	72.00	1,080.00	3,960.00	8,640.00
Water usage	Gigalitres	0.09	1.31	4.79	10.45
Coal usage	Kilotons	0.04	0.530	1.94	4.23
Ash produced	Kilotons	0.09	1.40	5.48	11.23
SO ₂ emissions	Kilotons	0.570	8.59	31.48	68.69
N ₂ O	Tons	0.79	11.88	43.56	95.04
NO _x emissions	Kilotons	0.26	3.84	14.10	30.76
CO ₂ emissions	Megatons	0.06	0.92	3.34	7.34

Source: Bonesa unpublished paper

Table 3.3 shows estimates of billion Rands of electricity costs that can be saved when replacing incandescent with CFLs. The savings will affect both the consumers and supplier or utility company. For example, as CFLs are highly efficient and cheaper to run, its use implies savings from using large amount of water, coal and which explains that lesser cost will be needed for electricity generation.

The reduction of peak loads could delay the need for further investments in electricity supply. The consumers would also experience reduction in their electricity cost through reduction of their bills. At the same time, as the CFLs have a long lamp

life¹⁴, they do not have to be replaced as often, and they use less energy. Consumers therefore would experience financial savings due to lower maintenance and lower replacement costs. Bonesa (2002) assumes that by providing households with energy efficient CFLs, consumers will experience the benefits of approximately 75% free/saved electricity on their lighting load. This would then contribute positively to the peak demand and resulting in a beneficial situation for both the customers and the utility. In this case, the utility benefits include reduced capital investments required to meet the increasing demand, from generation and distribution capacity point of view, and the less wastage in the system will most likely translate at some point, into a greater availability of supply to more households.

Other energy savings benefits could be realised. After 15 years, about 8 640 GW/h savings could be realised but with same light output (see Table 3). These savings lead to longer lighting hours, as consumers know that CFLs use less energy than incandescent lights do. This is significant in low-income households as their livelihoods would be greatly enhanced (i.e. money saved and longer lighting hours to facilitate evening education).

Van Horen and Simmonds (1998) and Bonesa (2002) demonstrate that consumers benefit from a high quality light source, together with free electricity associated with approximately 75% of savings achieved without decreasing light output. Bonesa (2000) assumes that these savings could literally enable a household to accomplish other needs such as adding to the list of electrical appliance that are not available (e.g. hot plate stove). The households could also use their appliance for an entire month (additional two weeks in a month), before needing to replenish the prepayment voucher that normally would have only lasted two weeks in the month. The implementation of CFLs also involves economic activities in the form of job creation, by training and empowering targeted communities in order to market assemble and distribute the luminaries (Bonesa 2002).

¹⁴ Long lamp life of CFL is about ten times as long as that of an incandescent

3.5 Conclusion

Similarities can be drawn between international and South African efficient lighting initiatives. Primarily, there has to be an important driver of efficient lighting. While in some countries, the environment plays a major part, in South Africa this also holds true, but there is additional driver to preserve dwindling electricity supplies. Therefore, as in the case of South Africa, the environmental and economic drivers are the most important determinants.

Furthermore, it is demonstrated that the efficacy of efficient lighting lamps deployment depends on robust and innovative strategies. Up to 2001, South Africa sold the CFLs through various scheme such as bulk subsidies, free give always, bulk purchases and natural sales, which are either ELI approved or non-ELI approved.

If an efficient lighting programme is to be sustainable, impacts have to be realised. In the South African case, various benefits are assumed to accompany the use of CFLs. According to lessons from international programmes, not all projects accomplish their aims.

As far as South Africa is concerned, as the next Chapter will demonstrate, we should not assume that the ELI would immediately bring positive results. It is important that other additional and related activities be given priority. These would include effective public awareness in both urban and rural areas, and the provision of innovative financial schemes. These will collectively provide people with opportunity to use the lamps. Chapter 4 investigates how these issues were handled in Hlomendlini.

Chapter 4

LIGHTING PRACTISES WITHIN THE CONTEXT OF ENERGY USE IN HLOMENDLINI, MATATIELA

4.1 Introduction

This chapter elucidates the socioeconomic data of households, and provides the energy use patterns, which in turn contextualises the lighting patterns in the sampled households. It is significant for the study to understand the general background and status of the Hlomendlini. The understanding of the socioeconomic status of households will give a better understanding of whether they could afford, or willing to use, CFLs. It is also important to source as much information as possible on households' general knowledge of CFLs, their understanding and awareness of the implementation programme.

The data presented here includes such information as household size, gender issues affecting decision-making in households, educational status of householders, employment details and income distribution. Focus is also on a brief analysis of electrification status as well as energy usage patterns in the area, which includes lighting, thermal application, media use, cooling lighting and lighting fuel expenditure. The community awareness about CFLs initiative is discussed for understanding whether the community was informed about where these bulbs were sold. In addition, this enquiry determined the reasons the CFL initiative was undertaken in this area. The analysis also includes the community benefits of using CFLs, which focuses on economic, social and environmental spin offs of using CFLs as well as the impacts on household fuel consumption patterns such as paraffin and candles.

This will enable to:

- Examine the perception, reactions and attitudes of Hlomendlini households on the efficient lighting initiative.
- Discuss the benefits that people observed and experienced since the use of CFLs and these will include economic, social, environment and any other benefits that they have noticed.
- Look at the effects of CFL initiative on the consumption of lighting fuel and their usage patterns.

Hlomendlini has 308 households, all connected to grid electricity. From this size, a random sample of 43 households was selected with the aim of obtaining consistent and unbiased estimates of the population status (cf. Schofield 1996). This random selection ensured representativity and diversity of the sampled households.

4.2 Socioeconomic Profile of Hlomendlini

4.2.1 The engendered nature of households

The household survey revealed that household sizes varied from two to eight people per household, with an average of about five people per household. Women headed about 54% of the households while men accounted for 46%.

Given that women are generally responsible for the acquisition of energy sources, and their utilisation for a range of services such as cooking, heating water and ironing (Eberhard and Van Horen 1995), there was an expectation of high chances of acceptance of the CFL initiative in the area. A high acceptance rate could probably promote the use of cleaner lighting fuels i.e. more use of CFLs compared to candles and paraffin lamps.

4.2.2 Education and employment

Table 4.1 illustrates the educational attainments of heads of households (HHs). It reveals that women are more educated than men HHs. Female HHs went up to tertiary levels compared to male that went up to high schools levels. Nevertheless, this does not signify better education overall, as only 9% have reached tertiary level while a large number went up to secondary level. The outcomes of this standard of education might be poor and resulted to lack job opportunities for the HHs.

Table 4.1: Education levels of household heads

	<i>Female</i>	<i>Male</i>	<i>Total</i>	<i>% Female</i>	<i>% Male</i>	<i>% Total</i>
Tertiary	4	0	4	21%	0%	9%
Secondary	12	14	26	63%	59%	61%
Primary	1	9	10	5%	38%	23%
No Education	2	1	3	11%	4%	7%
TOTAL	19	24	43	100%	100%	100%

Given that most HHs (Table 4.1) did not possess a good standard of education, this correlated with information in Table 4.2, which showed high unemployment rate of 65% amongst the HHs. This could signify that HHs heads were financially not supporting their households, since Table 4.5 shows that most of them were not employed. Informants mentioned that factors such as the high rate of retrenchments, companies that closed down, bad health conditions and other problems were contributing factors towards high unemployment rates. Only 23% of the HHs was in skilled employment. These included those in the teaching and nursing professions and those working at the local shops in Matatiele.

Table 4.2: Working status of household heads

	Fe- male	Male	Total	Female	Male	Total
Formal skilled	6	4	10	32%	17%	23%
Unskilled Employment	1	4	5	5%	17%	11%
Unemployed	12	16	28	63%	67%	65%
TOTAL	19	24	43	100%	100%	100%

From the survey results, people in unskilled jobs such as vending, gardening, fencing and building headed only 11% and skilled at 23% with total unemployment rate of 65%. The situation is further aggravated because Hlomendlini does not offer any real opportunities for employment. There is lack of skills to undertake to support small-scale economic activities largely because of the non-existence of economic sectors such as mining, manufacturing or agriculture. According to the survey findings, most household heads received support in the form of remittances from family members working in bigger towns. This demonstrates that the unemployment status of HHs did not necessarily imply that they cannot afford, or will not use the CFLs.

4.2.3 Income distribution

Having collected income data, our next task was to choose the number of classes into which this data could be grouped. Although the choice of the groupings (or classes) is arbitrary, we determined the number of appropriate classes and the class interval using the Sturges' Rule¹⁵.

¹⁵ The calculations of the income groupings are according to formula by Sturges' Rule which is as follows: $C = 1 + 3.322 \log_{10}(n)$

Where

C = number of classes

n = (number of items) sample size

Class Width = Range / $C_{un} = (H - L) / C_{un}$

C_{un} = unrounded number of classes

H = highest observation in the sample

L = the lowest observation in the sample

Table 4.3: Income grouping of the households

Classes (Rand)	Frequency	Total (%)
0 – 517	13	30%
518 – 1035	13	30%
1036 – 1553	11	26%
1534 – 2071	3	7%
2072 – 2589	1	2%
2590 – 3107	1	2%
3108 – 3625	1	2%
Total	43	100%

Table 4.3 shows that 30% of the HHs surveyed had an income of between R0 and R517 per month and that around 60% lived with or less than R1 035 per month. These figures, however, did not include remittances or earnings by other members of the households. The information presented here corroborates the high rate of unemployment and dominance of low paid jobs such as unskilled jobs, vending and self-employment. Table 4.3 also implies that households have access to other financial support, because 90% have access to income every month, given the unemployment rate of 65%.

The general relationship between the rate of unemployment and the level of income is that, if the employment rate is high in the area the level of income will be low. The comparison of the results in Tables 4.3 and 4.4 shows that although rates of unemployment are high in Hlomendlini, the levels of income in the households are high, relative to the rate of employment. This implies that there are ways of receiving income in these surveyed households without necessarily being employed, in which the survey revealed this as in a form of financial support mechanisms such as pensions or grants (namely old-age pensions, child-support grant and sick grant). Some households received support or allowances from family members working in other parts of the country.

4.3 Electrification status and energy use patterns in Hlomendlini

4.3.1 Electrified houses in Hlomendlini

The Hlomendlini village was connected to the grid in 2001 from Eskom's Eastern Region in KwaZulu Natal (Bonesa 2002). Based on the survey results, 49% households had outside lamps; and all surveyed households had inside lights, whereas, only a few households owned other electric appliances such as stoves, irons and heaters.

Table 4.4: Number of bulbs per household

No. of lights	No of people (Bulbs inside)	% with bulbs inside	No of people (Bulbs outside)	%with bulbs outside
1	13	30%	8	38%
2	10	23%	9	43%
3	8	19%	2	10%
4	6	14%	1	5%
5	2	5%	0	0%
6	2	5%	0	0%
7	2	5%	1	5%
Total	43	100%	21	100%

Based on the survey's findings, all the 43 houses buy incandescent bulbs for the inside usage while only 21 houses buy incandescent bulb for outside usage. The highest number of bulbs that the households buy every month was seven, and of the 43 households; only two have bought seven incandescent bulbs in a month. In addition, as Table 4.4 confirms, households mostly bought one inside bulb with 30% of the households buying one bulb every month, compared to only two that purchased seven bulbs. The table reflects that generally, the households buy bulbs for inside usage than the outside.

The time that the households used their inside room electric lights was between 19:00 and 21:00, and for outside lights was between 20:00 and 21:00. Only 16% households left their incandescent lights on throughout the night, and security was cited as the main reasons for this behaviour.

Although the village is connected to the national grid, the survey revealed that not all households used electricity for lighting, cooking, space heating and other needs. This was mainly due to a number of reasons, such as:

1. Not affording because of financial problems,
2. About to extend their houses, so with time they will have the lamps,
3. Do not like the outside lights (even for security purposes) and
4. Saving on electricity by having as few lights as possible

There appeared to have been a general use of electricity for mostly lighting (even though some households will utilise as few lights as possible for the reasons mentioned above).

4.3.2 Thermal applications

The survey revealed that Hlomendlini households satisfied their cooking needs by using a combination of electricity, gas, paraffin, woodfuel and coal (see Table 4.5). The households most preferred cooking fuel was paraffin since it was perceived to be the most widely available fuel and efficient on time and cost compared to wood, coal and electricity is thought to be expensive for cooking. For space heating, electricity, paraffin, wood and coal are used and with paraffin and wood (when available) as the most preferred fuels. A mixture of electricity, gas, paraffin, wood and coal were used for ironing.

Table 4.5: Comparative fuel use for thermal applications

	Cooking	Space heating	Ironing
Electricity	10	03	17
Gas	12		04
Paraffin	40	30	33
Wood	32	33	16
Coal	06	06	03
Total	100	72	73

4.3.3 Media use (radio and television)

Table 4.6 reveals that for households who owned media appliances such as radios and televisions, electricity (and in few cases, car and dry batteries) were used for these services. People alternate the use of these fuels depending on the availability, i.e. when electricity is available, it will be used and when not available other sources like dry cells and car batteries will be used. This means that there is no extra cost demonstrated because of media use however, there is cost towards the spare battery when necessary. They buy and charge their batteries in the small town of Matatiele, which cost an additional R14 for transport.

Table 4.6: Media use

	Entertainment / Media	%
Electricity	21	9%
Others (dry cells batteries, car batteries)	10	4%
Total	31	13%

4.3.4 Cooling

For refrigeration, the results illustrate electricity (7%) as the source of energy that is commonly used while other few households use gas (2%). Only 20 households out

42 survey owned refrigerators. Refrigerator is not the priority in most households except for those that own small businesses. Households alternate the use of fuel between electricity and gas depending on the availability.

Table 4.7: Cooling

	Cooling	%
Electricity	15	7%
Gas	05	2%
Total	20	9%

4.3.5 Lighting

The survey analysis confirms that electricity demand for lighting purposes was higher than other purposes such as cooking, space heating, ironing, entertainment, etc. Almost 81% of the surveyed households used electricity extensively for lighting. Even households, which were not utilising electricity due to financial constraints, wished they could afford to use it for lighting purposes. Accordingly, paraffin lamps and candles were used as substitution when there was no electricity. Bad weather (mainly caused by thunderstorms and lightning) and a fire outbursts (in a few instances) were mentioned as the reasons for power failure. The great demand for electricity for lighting purposes indicated good prospects for the acceptance of CFLs by the community. The prospects might have been great if households could be enabled to change for more efficient and fuel-saving appliance for lighting such as CFLs.

4.3.6 Lighting fuels expenditure

The survey shows that 81% of households purchased electricity coupons every month and only 19% used electricity only since the Bonesa initiative provided free coupons in order to test the use and acceptance of the CFLs. The reasons put forward for not purchasing electricity again revolved around affordability issues. Households complained about high costs of getting their electricity cards, as they have to

collect them at a bigger town in Kokstad, some 128km from Hlomendlini. These households spent, on average, R40 per month on transportation and R5 to R100 (or a household average of R40) per month on electricity. The monthly expenditure explained households' limited use of electricity to a few applications like lighting, which have a low fuel consumption rate.

Almost all households bought the incandescent bulb except a few (19%) which had not yet collected their cards since the connection period. The survey revealed the average two bulbs per household were bought since the village was connected in 2001. This was because the Bonesa programme encouraged the substitution of incandescent with CFLs. In addition, households had never bought incandescent bulbs since the launch of the CFLs initiative.

The survey revealed households use an average of 17 litres of paraffin each month or an average monthly expenditure of R52. A maximum amount of 62 litres of paraffin is what houses used in a month, and with one litre as the minimum amount. In terms of candle use, the survey reveals that households bought them at least once a month, or the average of 11 candles per households. In the process, each household spent about R7 every month to purchase candles.

The survey reflects that there was a strong correlation between fuel expenditure per household and availability of disposable income i.e. the higher the income, the more expenditure on fuels or the more use of electricity for all household needs. However, as indicated above, even if households were financially unstable, it did not mean that they would not use electricity for lighting. This is also demonstrated in Eberhard and Van Horen (1995) study, which found out that households with lowest incomes tend to spend a higher proportion of income on energy. The survey also attested to the fact that energy expenditure occupies a prominent place in poor households' economies and usually accounts for large proportion of monthly expenditure.

According to survey results, Hlomendlini people use a mixture of fuel for various end uses. This is dominant feature of energy use patterns in poor urban and rural households (Eberhard and Van Horen 1995). Many reasons trigger the multiple fuel use, and some of them are discussed in Eberhard and Van Horen (1995) as availability and access to fuel cost, income levels, availability of labour for collection of fuel (e.g. wood fuel), social relationship and convenience in terms of service which is efficient and better quality e.g. electricity for lighting.

4.4 Community Awareness about the CFLs initiative

4.4.1 “Where are these lights sold”?

Most community members were aware of the efficient lighting initiative that was piloted in their area. They were aware of the role-players behind the distribution of “free lights”. When asked about the rationale of the initiative, they presented that Bonesa and Eskom were seeking to generate awareness and support for the product. Others said the aim was to enable consumers to sample the benefits of the product and to promote the Eskom and Bonesa business. They even said that Eskom is as merely fulfilling what should have been done during the electrification process.

While many households had a better knowledge about the implementation of CFLs, some had insufficient knowledge about the place around their area that sold the lights. Only 2% knew where to get the lamps and the majority were not certain of the place of purchase. Questioning them on how to get the lamp when the Bonesa lamp burnt out, most households came with the following answers:

Table 4.8: Community response: awareness of CFLs

<i>Community Responses</i>	<i>Percentages</i>
▪ Do not know	13%
▪ Ask from other people who already bought the CFL	3%
▪ Ask from people trained by Bonesa	2%
▪ Buy at Kokstad	2%
▪ Phone Eskom	3%
▪ Wait for Bonesa to tell us	5%
▪ Buy incandescent bulb	7%

Their answers revealed confusion and lack of awareness and, as evident in their answers, there was a high possibility that households would revert to incandescent lamps when they replaced the CFLs. The lack of awareness, especially of places that sell CFLs as well as the income factor, would militate against full and sustained conversion to efficient lighting. Overall, there was a lack of awareness about the areas where CFLs were sold, as most households never saw CFLs in their surrounding areas. There was still a challenge of making lamps available and accessible everywhere, as it was exposed during survey that the CFLs were not available and accessible to these people.

4.4.2 “Eskom and government care for the poor people like us”

At first glance, the survey results clearly showed a positive impact on the households in terms of reactions, receptions and perceptions. A large number of people (65%) had positive reactions on the effects of the CFLs. They mentioned that since they started using the lamps the following advantages were immediately experienced:

Table 4.9: Community response: benefits of CFLs

<i>Community Responses</i>	<i>Percentages</i>
▪ Better illumination	10%
▪ Saves electricity	10%
▪ Saves money	7%
▪ Stays longer than normal bulb	15%
▪ Not easy to break	3%
▪ Does not affect eyes, the light is good	12%
▪ Looks attractive and smart	8%

The comfort that people received from using the CFLs might be a good indicator for prolonging the use of CFLs in the area. Some households mentioned that they are very appreciative to the government and feel that government is very helpful to poor people like them. While some felt that Eskom cares for the people's need and they care about the needs of the old and poor. These statements substantiate the fact that households were happy to have the opportunity to use the lamps, which save electricity and reduce their monthly normal electricity bill.

In addition, 93% of the households were willing to continue using the CFLs even if the lamps are not freely available. Their willingness to use the lamps was determined by what they have discovered and noticed since using the lamp. At the same time, 95% of the houses were prepared to recommend and encourage the use of the lamp to people who were not aware of and did not use the lamp.

Only 35% of the households pointed out some disadvantages with CFL. These include:

Table 4.10: Community response: disadvantages of CFLs

Community Responses	Percentages
▪ The CFL takes time to give light when switching it on	6%
▪ Do not know where to get them or not easy to get CFLs	7%
▪ Cannot afford to buy more of CFL	5%
▪ They failed to work	2%

Nevertheless, with the mentioned disadvantages, generally the households expressed their enthusiasm and willingness of using CFLs. Because, even those that noticed disadvantages are willing to use the lamp in future.

4.5 Community Benefits of Using CFLs

4.5.1 “We are saving more money on electricity”: the perceived economic benefits of CFLs

Eighty four percent of households mentioned that CFLs save electricity and, as a result, saves money. Households also noticed that their electricity meters were not clicking or “running faster” as before the implementation of CFLs. Some mentioned that the coupon that would last for a month was then lasting for two months. Others claimed that they even buy their electricity coupons with less money. Since the inception of the CFLs initiative, some households leave their lights on (both inside and outside lamps) throughout the night, as they know that the CFLs save electricity. In leaving the lights on at night, one important security benefit was realised. It was perceived that an illuminated night is a deterrent to crime.

In terms of savings on fuel expenditure, about half of the surveyed households expressed the money they save on electricity was used on other basic needs such as buying more food. Some even said they were saving money towards improving their living standards by, for instance, building better dwellings. Eight percent of the households wanted to buy more electricity and open small business that will help to generate additional income for the households.

While the majority of households attested to the economic benefits, there was also a significant (though a minority) number of households (16%) that did not notice any significant savings on their fuel expenditure. Accordingly, they observed that, they:

1. Used same money as before and there was not change in electricity bills
2. Did not use CFLs frequently, or long enough to notice savings
3. Had never considered observing the extent of savings

4.5.2 Training and employment opportunities

Only two community members in the pilot received training to assemble, distribute and supervise during the project. The training and the experience received would help them in future to get jobs. Better knowledge and understanding about the CFLs might be of help to the trained members because they can open their own business whereby they would help community members with the problems that might come across.

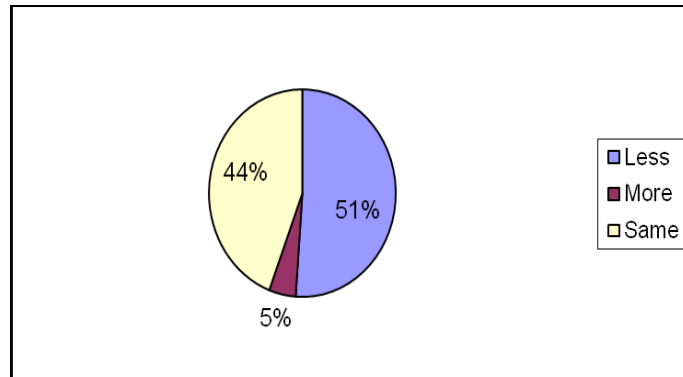
4.5.4 Cleaner air and less indoor pollution: the environmental spin-offs of using CFLs

Although people did not mention any environmental benefits per se, the survey findings indicated a slight change in the use of other lighting fuels (such as candles and paraffin lamps). This is a significant environmental benefit as it means cleaner air and less indoor air pollution and likelihood of residential fires. The minimal use of candles reduces burns and fire normally associated with the use of candles. In addition, the use of CFLs may reduce poisoning accidents that are experienced through use of paraffin.

4.6 Impacts of CFLs on Fuel Consumption Patterns

Even after changing from the use of incandescent bulb to CFLs, sixteen percent of households still burn their lamps from 19:00 until 21:00, with few exceptions, where the outside lamps burn through the night or at times the inside lamp burning longer when pupils are studying.

Figure 4.1: Change in consumption of paraffin after the use of CFLs



As indicated in Figure 4.1, almost half of the households were buying less paraffin since they used CFLs. Some of the reasons for this change of behaviour are illustrated in the following table (and these are correlated with the few households who had not observed any marked changes).

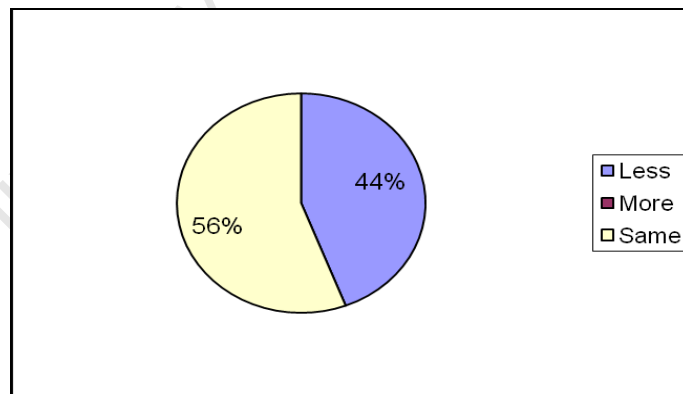
As CFLs burn longer, and at less cost, schoolchildren took advantages of this to study for longer hours than before. A significant number of households mentioned that CFLs helped their children because they can study for longer hours compared before as the lamp saves electricity and money. They even mentioned that the situation was not affecting their lighting fuels budget instead their electricity budget is less than before.

Table 4.11: Comparative analysis of perceived changes brought by CFLs

Positive changes (51% of households)	No changes (44% of households)
<ul style="list-style-type: none"> ▪ There is no need to buy more paraffin as before since CFL saves electricity ▪ They do not use paraffin the same way they use to before the use of CFL ▪ They do not use much of paraffin for lighting, except when there is emergence 	<ul style="list-style-type: none"> ▪ They do not have money to buy electricity ▪ They use paraffin for other purposes like cooking, space heating and ironing ▪ It is not easy to notice change because cost of paraffin is going up while litres are still the same so even if litres are lesser because of CFL use but the cost was similar same and sometimes more.

Figure 4.2 indicates that most (56%) of households used the same number of candles as before. They mentioned that they do not have money to buy electricity. The households also point out that they buy same quantity of candles for times of emergencies.

Figure 4.2: Change in consumption of candles after the use of CFLs



On other hand, 44% use fewer candles and they pointed out the following reasons:

- Since CFL saves electricity there is no need to buy many candles as before
- Use candles for emergencies only, like when there is power failure.

4.7 Conclusion

The results show that the sampled Hlomendlini households could be generally rated under the normal village with generic characteristics: high rate of unemployment; low education levels; and the majority live below subsistence levels. As a result, the use of electricity in the area is generally limited to lighting while other available source of energy such as paraffin and wood are still used for cooking and space heating.

Hlomendlini is similar to other rural villages in terms of multiple fuel use to meet different end uses such as lighting, cooking and space heating. In addition, their fuel expenditure is low. It appeared, at least on the surface, that more and more households had better awareness of efficient lighting initiatives. However, consumer awareness also needs to be accelerated, as there was crucial information which the consumers lacked (viz, for instance, places where these lamps could be purchased).

There was an evident acceptance of the initiative because of the advantages of saving on energy cost, which could be realised in a short space of time. They were even willing to recommend the lamp to the people that are unaware of it.

It was noticeable that although there was a general acceptance of and willingness to use CFLs, there were households who were not realising the benefits. Although these were minority households, their plight needed to be addressed in terms of availability, affordability and awareness of these initiatives.

Chapter 5

CONCLUSIONS AND RECOMMENDATIONS FROM THE HLOMENDLINI CASE

Sustainable development seems to be something like motherhood and apple pie – everyone finds it a good thing, there is almost universal appreciation. At first sight, this is highly positive, as this could signal the entering of a holistic and responsible thinking into the world of politics and society. But as it often happens with other catch phrases that suddenly come into vogue, like ‘empowerment’ and ‘participation’, it might not be more than a rhetoric which fails to translate into practice, this all the more so because sustainable development can be given several different interpretations (World Commission on Environment and Development 1987: 8).

5.1 The co-benefits of energy efficiency in the housing sector

The International Panel on Climate Change (Levine and Urge-Vorsatz et al 2007) argues that energy efficiency in residential and commercial buildings is the low-hanging fruit in terms of mitigating against GHGs. Chapter 3 of this report states that the buildings are the fastest growing sector (after transport) in terms of energy consumption. The cost of energy efficiency technologies in the building sector is relatively less than in any other sector. In mitigating the harmful impacts of GHGs, the residential sector is seen as the so-called “low-hanging fruit”. Lighting constitutes one of the important energy end-use and requires least resources to transform to energy efficiency.

Arguably, therefore, there are obvious environmental benefits in promoting energy efficiency in households through initiatives such as ELI. This thesis has assessed some of the international trends of implementing energy efficiency through CFLs as well as the benefit thereof. Of critical importance for a developing country like South Africa, are some key lessons, which include: (a) the environmental benefits of energy efficiency programme; (b) ensure the sustainability of programmes designs to disseminate CFLs; and (c) the implementation of CFL programme in conjunction with

other energy efficiency programmes. For instance, CFLs should be part of a dwellings' thermal envelope.

The above assessment was tested in Hlomendlini in terms of its applicability.

5.2 Summary of the main findings

A key government policy, as promulgated in the White Paper (DME 1998), is based on three interlinking tenets. These are:

- All South Africans have equitable access to energy resources and services;
- Energy plays a major role in the economic development of all citizens;
- Generation, transportation, distribution and consumption of energy are done in an environmental sustainable manner

The findings in Chapter 4, in particular, demonstrate that some rural households in South Africa, like Hlomendlini, are one of the lowest net consumers of modern energy (like electricity). It shows that access to CFLs also facilitated for the improved access to modern electrical services. However, it was not clear how energy saved from lighting in Hlomendlini households had an impact on local energy balance.

The justification for the ELI in Hlomendlini is based on the premise that it will save power and enable households to use the saved income on other development needs. This study has found very little evidence of this, because energy saved is too small to make a difference or for households to notice savings

Most challenges of households in Hlomendlini households, like any impoverished rural area in South Africa, are that of inadequate access to energy services including lighting, high costs of modern energy services and the health impacts of using different energy services, most notably biomass energy. Therefore, energy efficient light-

ing, which attempts to address these challenges, stands a good chance of being accepted by the community. The findings from this study also show that success also depends on how development initiative is communicated and/or how the community participated both in the design of the programme and in its execution. With particular reference to the Bonesa initiative, this study assessed (a) how the initiative directly addresses the subjective needs of households in Hlomendlini and (b) the extent and nature of local participation in the project. The main conclusion is that if a project's aim is just about the numbers or a volume of CFLs, its sustainability is invariably compromised, as demonstrated in Chapter 4. This is an important lesson for energy efficiency measures in rural households in developing countries in general.

The assessment of the CFL initiative in Hlomendlini provides a unique window of how energy efficiency measures up to sustainable development in practice. Below are some of the lessons gleaned from the Hlomendlini analysis that inform the policy aimed at energy conservation or improved access to energy services in underdeveloped areas of South Africa.

5.3 Specific lessons learned from the Hlomendlini case study

A broad consensus is that the provision of adequate and sustainable energy options is central to, and a catalyst for, development, particularly the eradication of poverty in rural or developing contexts. It is seen as an integral component of social equity, economic growth and environmental sustainability. The introduction of specific energy technologies, such as the CFLs, arguably increases the services for the poor by providing opportunities for employment and contributing to a sustainable environment. These are two sustainability indicators: (micro) economic growth and environment protection are the hallmark of the South African government development policies. To a limited extent, a few jobs were created in Hlomendlini, particularly related to the installation of the lamps. The manufacture of these remains outside the community, and fitting a bulb may not, in the great scheme of things, be considered as a significant employment creation. The case study of Hlomendlini attests this. In

reviewing whether this initiative was a success or not, critical issues, many of which are methodological needs to be borne in mind, as illustrated below.

5.3.1 The meaning of development: the practicalities of the rhetoric

Sustainable development rhetoric assumes that the basic needs of the present generation are met without compromising the needs of the future generation. Secondly, it also implies that the natural environment is not finite, nor is it always renewable as was previously conceived. Therefore, environmental concerns should be considered in the production and consumption of natural resources. Thirdly, it means empowering the local population to take lead in its own development. This means a decentralised development planning as to ensure a proper participation in the planning and implementation of initiatives. The latter point is critical as it played itself out in Hlo-mendlini. The case study demonstrated that the process by which these needs are met is as important as the end-result itself. The process should address equity issues in the development, while at the same time, promoting self-reliance. Popular participation and local control of the process are the panaceas for success of rural development.

Unfortunately, development initiatives, such as the Bonesa programme, are often more supply orientated than demand driven. The overall concern of Bonesa as stated in its objectives was to ensure that as many as possible CFLs are used in rural areas. Indeed, the major key performance of the programme was the volumes of CFLs distributed in households. In the process of disseminating these modern technologies, community interests were aroused by officials pointing to the benefits of switching to CFLs as opposed to the normal lighting practises. This is a normal marketing strategy in any context – selling items and pointing out the benefits – and there is nothing untoward about it. However, in the context of sustainable development, such strategies may not work in rural areas because they are usually top-down with little feedback from the community.

Communities need to be part of the solution and not merely “informed” about the product. Like many initiatives, the Bonesa programme paid more attention to technical and less on organisational (institutional) hurdles. Barriers to sustained use of an energy technology may have less to do with technical efficacy that: (a) the inadequate rural income to pay for the use of the new technologies; (b) inadequate knowledge of user needs; (c) uniqueness of each rural situation; and (d) inadequate participation of rural people in energy projects. It is important to mention that ‘portraying renewable energy as a universal solution to rural energy development is not correct’. Participatory development is not rhetoric but an essential in rural development efforts.

At the outset, the thesis’s objectives were to explore the drivers of efficient lighting initiatives in South Africa as well as the international experience. In addition, the case study of Hlomendlini was meant to demonstrate the impacts of CFLs in terms of improving people’s lifestyles both in qualitative and quantitative sense. However, the CFL initiative to achieve the latter, it should be embraced within the communities and households. The following are broad conclusion that can be learnt from this thesis.

5.3.2 Do not isolate lighting patterns from broader energy uses

Integrated energy planning is important to realise energy efficiency in households. This simply means that lighting should not be seen in isolation from other household energy patterns. Chapter 4 has shown that the first thing to understand before one devise intervention strategies aimed at energy efficiency is to understand the household energy end-uses. This also refers to the in-depth understanding of household energy needs and priorities. Therefore, it is important to establish beforehand whether energy efficient lighting is the major concern or priorities of the households. In addition, the benefits of households from energy savings should demonstrable or quantified, and these benefits need to be communicated in the language they can understand.

Thus, the results from Chapters 3 and 4 suggest that the Bonesa initiative may not achieve the intended benefits of facilitating for massive deployment of energy efficient bulbs. The reasons for this vary. They include the fact that lighting is seen as not a major end use in households. Most households, despite having access to electricity still used other non-electric fuels, such as biomass, kerosene, etc. In addition, households view thermal applications (i.e. cooking and heating) as the most important end-uses. This is demonstrated by the expressed views by many householders in the sample that they were not seeing the difference, let alone realising the benefits efficient lighting on their budgets. This could also be the result of many villagers not aware of where to look for in terms of benefits.

5.3.3 The users' perceptions and attitudes need to be assessed

Human nature predicts that not all people react positively to changes, especially the change that will revolutionise their way of doing things. People will often form opinions and views about a new initiative. Such perceptions are governed by what they know or shaped by their existing information. In many ways, some initiatives collapse because of negative perceptions that users have. These perceptions are often shaped by “imperfect” knowledge. It was demonstrated in this thesis that many households were not fully informed about the Bonesa initiative, as some viewed it as “free bulbs” without an understanding of the aims of the CFLs or Bonesa initiative. This is disastrous, because as soon as the programme/initiative ends, people often revert to inefficient energy types or back to the incandescent bulbs.

It is clear from this study that villagers will revert to normal “cheaper” bulbs once the projects finishes, than adopting a new behaviour of energy efficiency. This is because they do not fully understand the reasons for change of behaviour (from using “normal” incandescent lighting to CFLs). The process by which one initiates development is as important as the new technology or behaviour one is promoting. Community or consumer sophisticated understanding and ownership should be cultivated to ensure that the new way of doing things is embedded. Community ownership starts at problem identification up to the choice of technology that is proposed.

If the Bonesa programme should be reviewed in the future (as it has long ceased to be operational), hard questions need to be posed to guide the initiative, as this study has done. These questions are:

- Are people aware of the nature of benefits that CFLs provide?
- Was there a pre- and post capacity building exercise to provide a comparative analysis of the pros and cons of switching to CFLs?
- Which agency did the awareness programme?
- What language was it conducted?
- Was experiential and participatory learning utilised?
- Did the community view lighting as their main priority in the broader scheme of things?

5.3.4 People want to see obvious benefits

Often (although less obviously stated), the objectives of project implementers and project beneficiaries are diametrically opposed to one another. Bonesa was one of the Eskom's initiatives or, at least, was an initiative, which had the blessings of the power utility. Partly as the result of the fastest growing demand in the country, which is outstripping the supply, the objective of Eskom is to conserve as much energy as possible. Thus, the parastatal will support any efforts that will lead to reduced energy demand, irrespective of the size of the project.

On the opposing spectrum, rural households are more concerned with *lack* of access to basic services, such as energy services amongst many essential services. Even with full electrification, households were observed to still use the traditional and transitional fuels (in the form of cow-dung, wood, candles and kerosene). One of the main reasons they continue to use these non-electric fuel is that these fuels present obvious benefits at less costs. A paraffin stove or heater provides both cooking and heating simultaneously. A biomass stove (or brazier) provides a household with multiple end uses such as cooking, heating, lighting, and in many instances, acts as an insect

repellent. What are other important uses of electric lighting other than providing better illumination as compared to other fuels?

Therefore, as stated above, beneficiaries would not adopt a technology until benefits are so obvious for everyone to see. The Bonesa officials tried to communicate the benefits of switchover, but many households remain unconvinced. The reluctance may, as stated in many instances in this thesis, the benefits are very miniscule to warrant any changeover; or lighting is not a key priority in households.

5.4 Recommendations

Rural areas in South Africa are in dire need of development. Initiatives like Bonesa to introduce better type of lighting should be commended and encouraged. However, it is important that when these strategies are implemented, critical attention have to be paid on how the initiative is conceived and executed to avoid the negative unintended consequences. Strategies to increase access to better energy services for the rural poor should be implemented within a rural development framework. Therefore, what the study recommends is that initiatives like energy efficient programme should be located within the rural development paradigm, and not be perceived as isolated events that purely “sell” technology to communities.

In addition, the no simple, purely technical solutions to address rural energy, and effective solutions can take place in other parts of the system. Firstly, energy problems cannot be treated in isolation from the problems of rural poverty. Secondly, the supply of new hardware, such as the CFLs, is not sufficient condition for the reduction of energy poverty. It must be introduced in a basket of development initiatives such as schooling, better nutrition, adequate housing and other rural infrastructure, and so on. Thirdly, most energy solutions are designed outside rural areas and face problems of functional adaptation. Therefore, in implementing sustainable energy solutions, it is important to execute these within an integrated energy-planning framework, as well as to encourage proper community participation. Lastly, for energy efficiency solu-

tions to succeed in developing countries, they have to address energy poverty rather than shortage of supply.

In its simplest form, integrated energy planning implies an approach, which addresses demand-side management such as conservation and efficiency, environmental issues and social equity in energy provision. It sees energy as a crosscutting sector, which underpins almost all economic sectors. Therefore, in order to ensure maximum development impacts, energy policy and implementation strategies have to be integrated with other related sectors. Development does not need energy per se, but the services that it can supply. Energy is only one aspect of development, and all other factors evolve concurrently. The goals for integrated energy planning are to (a) increase local employment; (b) stimulate small-scale industry; (c) increase agricultural production; and (d) to benefit all the rural populations especially the women.

A successful integrated energy planning is done through proper community participation in the decision-making processes. Rural development is 'multi-faceted' and requires a range of interventions. Therefore, the success of the initiative will depend on proper consultation and genuine participation by the local population. Therefore, the process through which development is delivered takes a centre stage than the actual product of development.

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Appendix A

Questionnaire: Energy efficient lighting initiative in Eastern Cape Province -Matatiele village, Hlomendlini

1. HOUSEHOLD INFORMATION

a. Members of households and their contribution

Name	Gender	What is his/her relation to the household head	What is the highest level of education completed	What is her/his employment status	Where does he/she live most of the time	How often does she/he come home to this house (if living elsewhere)	How much is he/she contributing to the household
Give the name of household head and people living in the house	Male or Female	e.g. Daughter, son	e.g. Std 10, university, college	Vendor or formal employment (like teacher, nurse)	e.g. in the house, somewhere else	e.g. once a week once a month once a year other-specify	
a.							
b.							
c.							
d.							

b. Pensions and grants

Do any member of the household receive a pension (old age, disability), a pension from work or a child support grant from government Yes No

If yes, fill their names in the table

Name	What sort of pension r grant	How much does he/she gets per month	How often does he/she contributes money to your household (e.g. every month)	How much does he/she contributes to your household each time
a.				
b.				

c. People with their own (either registered or unregistered) business (Self employed)

Do any member of the household have their own business (either through selling) Yes No

If yes, fill in the below table

Name of the people with own business	What does he/she do to earn money	How much does he/she earn per month	How often does he/she contribute money to your household	How much does he/she contribute to your household each month
a.				
b.				

d. Piece jobs (temporary and casual employment)

Do any member of your household earn money by doing work for other people informally (piece job)				
		Yes	No	
If yes, fill the table				
Name of member doing that	What kind of job does he/she do	How often do he/she get the piece job	About how much does he/she earn each time	About how much of this money does he/she contribute to he household
a.				
b.				
c.				

e. Other money received by household members

Do members of the household receive any other money				
		Yes	No	
If yes, fill the table below				
Name of member	Where does this money come from	How much money is received each time	How much of this money contributed to the household	How often is the contribute
a.				
b.				

Notes: Remittance: from any member not staying with the family

Maintenance: from child's father contribution maintenance or because of divorce or separation

2. Energy consumption

a. End-uses of fuels.

What is the main fuel that you use for the following end-uses? Please mark fuel/s for each end-use with tick.

	Electricity	Gas	Paraffin	Wood	Coal	Candles	Other specify
Lighting							
Cooking							
Space heating							
Entertainment							
Ironing							
Refrigeration							
Any other (Specify)							

b. Lighting fuel use and expenditure

Give details about the expenditure on the lighting fuel use by answering the below questions

Fuel type	Number of times buying per month	Person responsible for getting	Transport cost per trip	Distance to the place	Amount of fuel bought (e.g. in units, litres, packets)	Cost of fuel
Electricity						
I. Coupon						
II. bulb						
Paraffin						
Candles						
Any other (specify)						

c. Use of electric lights

In which room do you regularly use electric lights in the evening	At what time do you switch on your lights in the room	At what time do you switch off the electric lights
a.		
b.		
c.		
d.		

Do you have outside lamp Yes No

If no, why you do not have it

If yes, how many do you have

At what time do you switch them on

At what time do you switch them off

Do you leave any lights on throughout the night Yes No

If yes, how many outside lights do you leave on

- At what time do you switch on the lights
- At what time do you switch off the lights

How many inside lights do you leave on

- In which room is this light
- At what time do you switch on
- At what time do switch off

Do you ever stay without any electricity in the house

If yes, how many days in a month does this happen

What is the cause of that

When this happens, what do you usually use for lighting

How much you use and spend on these when you are out of electricity in the house

	How much do you use	How much do you spend
Candle		
Paraffin		
Other (specify)		

d. General Knowledge about CFL

Is there any place around selling the CFL Yes No

If yes, give the name of the place

How far is it from where you live

How much do you pay to go to the place (return)

How much is the lamp

If no, where are you going to get the CFL if it runs out

How far is it from where you live

How much do you pay (return)

How much is the CFL

Are you satisfied with the price	Yes	No
If no, what can be done to solve the problem		
If yes, give reasons		

e. Reactions, receptions and perceptions of efficient lights or CFLS

From your experience, can you point out some advantages of using CFL		
What can you say are some disadvantages of CFL		
Are you going to continue using the CFL	Yes	No
Why		
Can you recommend someone to use the CFL	Yes	No
Why		

b. Lighting

Now that you use CFL, do you use lights more than before	Yes	No
If YES, why		
For what purpose do you use the lights for		
Does this have effect on household budget		

c. Training

Anyone in the house that was trained (e.g. to assemble, distribute and supervise the activities within the community) during the implementation of CFLs	Yes	No
If so, what kind of job was he / she doing		
Was he/she paid for that	Yes	No
If yes, who was paying him/her		
How much was he/she paid		
Do you think the training he/she received will be useful in future	Yes	No
If yes, explain why		

If no, explain why

Do you know anyone in the community who was trained (e.g. to assemble, distribute and supervise the activities within the community for anything) during the CFL supply Yes
No

What was he/she trained for

Do you think the training will help them in future Yes No

If yes, in what ways will the training help him/her

If no, explain why

Presently, are they using the training they received Yes No

Give reasons for the answer

d. Effect of CFL Intervention on other Lighting Fuels

Now that you are using CFL

What amount of paraffin are you using (in Rands)?

What amount of paraffin are you using (Quantity)?

Is it less or more than before?

Why is that?

What about the amount of candles

What amount of candles are you using (in Rands)?

What amount of candles are you using (in Quantity)?

Is it less or more than before?

Give reasons for the answer