The impacts of efficient residential lighting in Matatiela, South Africa

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Abstract
A very significant proportion of Matatiela households still rely on environmentally polluting fuels (i.e. woodfuel, candles, and paraffin) for reasons that they are easily accessible and affordable, and as a legacy of the inequalities of the past social and economic policies. Use of non-electric fuels is prevalent where unemployment and poverty are the norm, and yet, very essential for improving the quality of life. This study focuses on efficient lighting. There are strong economic, social and environmental reasons not only in favour of electric lighting, but in the use of compact fluorescent lamps (CFL) over the traditional incandescent lamps.

Keywords: energy consumption, market transformation, free give-aways, compact fluorescent lamps

Introduction

The White Paper on Energy Policy (1996) commits the government to promote energy efficiency awareness. Of particular importance, is sustainable energy security for low-income households that link growth and redistribution so that energy efficiency contributes to alleviating poverty, improves the livelihood and living standards, and contributes to employment and productivity. Most low-income households cannot afford to use electricity optimally – a factor largely attributed to past inequalities in wealth given the social and economic policies pursued – and they rely on less convenient and often unhealthy fuels. An important development was the Bonesa Efficient Lighting Initiative that aimed to implement efficient, affordable and environmentally friendly lighting to address economic and environmental problems associated with the use of electricity.

This paper examines prospects for energy efficient lighting and its contribution in improving the quality of life in Matatiela, under Bonesa's free give-away strategy. We base much of the analysis on the qualitative and quantitative survey we had in Matatiela before free CFLs were rolled out. On the whole, we interviewed about 500 of the 2300 households. We begin by taking into account the sources of energy that are accessible and affordable to the households, and that play a determining influence in consumer choice of lighting. This enables us to look at the possible impact of the free give-away strategy on these low-income households.

Background

Matatiela consist of four villages (Dengwane, Hlomendlini, Khoapa and Zwelitsha, all situated in close proximity of each other), and is geographically located in the Eastern Cape. Matatiela receives its electricity from Eskom's eastern region in KwaZulu-Natal. Each household has an average of four indoor and two outdoor fixtures. The incandescent lamps completely dominate electric household lighting.

There is large dependence on migrant labour, with men working in mines around Johannesburg, and some women working as far away as Durban and Pietermaritzburg (about 450 kilometres away). These workers remit their income to support families. But mining employment has been shrinking. As gold mines matured and their prices stagnated, mineral exports and mining has shifted to platinum but has created fewer jobs. Unemployment at Matatiela is quoted at 65 percent, and residents rely on the informal sector, mainly production of vegetables, poultry and pig for income-generation.

The communities have limited access to running water, regulated by a card system. This access is only at a central point in Khoapa, and some residents, particularly women and children travel three to four kilometres to collect tap water. For this rea-

son, a large section of the community relies on water from the river for drinking, cooking and other domestic purposes.

Energy consumption

Matatiela households use a diverse mix of fuels to meet their needs. Fuel choice depends on a number of variables such as household income levels, availability and affordability of energy resources. Higher incomes enable consumers to move to efficient commercial fuels. Primary sources of energy used for lighting by the Matatiela households are electricity, paraffin and candles, and to a lesser extent, liquid petroleum gas (LPG), and wood fuel. Of these, electricity is preferred because of its convenience, cleanliness and better light quality. The other sources of energy have high non-monetary costs.

Most houses are electrified as a result of the government's drive for electrification, and residents use pre-paid card meters. Electricity, however, does not satisfy all energy needs, and multiple fuel use is widespread, with households selecting fuels for different end-uses, as well as using more than a single fuel for the same end-use (see also Eberhard and van Horen (1995) and Davis (1998)). Electricity consumption levels are low, and poorer residents use electricity almost exclusively for lighting. Electricity is also used for entertainment (TV and radio) and, depending on the affordability of appliances, for ironing, cooking and refrigerators.

The bulk of paraffin purchased is used for cooking (using primus stoves and paraffin stoves), with much of the rest used for lighting purposes (with paraffin lamps) and for heating (using paraffin heaters). Paraffin consumption is largely attributable to accessibility and its relative low price. Although LPG is a cleaner fuel, its use (mainly for cooking) is low because of the cost of securing and refilling LPG cylinders, and the perception that it is dangerous. In fact, more households use dry cow dung to cook and warm water than LPG because dung is available almost costlessly except for collecting it. Wood is traditionally used for cooking, heating and providing light. Due to the depletion of wood resources, wood for fuel is scarce and this places a burden on women and children who travel long distances to collect it from areas of surplus, rather than using their time more productively on other more fulfilling tasks. About 20 percent of the residents usually switch off lights to save electricity and use candles. But some households mix paraffin and candles to make floor polish. This is regarded as cost-effective and is said to give a better shine than commercial polishes. Paraffin, wood and candles are also smoky, inconvenient and expensive, with health and safety risks. Access to paraffin brings greater benefit to the poor since it does not require long hours of collecting as wood.

There are compelling reasons that explain reliance on paraffin despite preference for electricity. According to Simmonds and Mammon (1996), and Mehlwana and Qase (1996, 1998), the sharing of paraffin with neighbours, when the need arises, is part of poor peoples social relations and a survival strategy in most low-income households. Also important are factors like familiarity with paraffin, and the offer of credit terms (Mehlwana and Qase, 1996, 1998). Erratic incomes and the ability to buy paraffin in small quantities and the lack of knowledge on using other fuels, inhibit ascension on an 'energy ladder' from paraffin to electricity (Simmonds and Mammon, 1996)). This behaviour is even prevalent to some low-income households in Matatiela who, although connected to the grid, do not utilise electricity lighting for the whole month for affordability reasons.

Although we expect fuel switching in favour of electricity for cooking, lighting and other household purposes to increase as income levels rise and distribution improves, evidence elsewhere suggests that complete displacement occurs in a minority of homes (Davis, 1998)). Electricity is typically considered an additional fuel in low-income households, and it does not always replace other fuels, but rather adds to the fuels used. Afrane-Okese (1999) and Davis and Ward (1995) also find that most electrified households in rural areas use a combination of three fuels to satisfy their needs (wood, paraffin and electricity). Undoubtedly, electric lighting is more efficient and of a better quality than that provided by other fuels, but poverty limits the uses of this clean energy.

Energy efficient lighting and market transformation

Efficient lighting involves choice between the incandescent lamps, that totally dominate the household lighting market, and compact fluorescent lamps (CFL), which are seen as a new 'phenomenon' in the market. Literature points out that the major drawbacks of incandescent lamps are that they are inefficient, do not last long, and are environmentally unfriendly. During its lifetime, a CFL, when used in place of an equivalent incandescent bulb, uses 75 to 80 percent less electricity and lasts on average 10 times longer. Thus, there are good economic, social and environmental reasons favouring the choice of CFLs over the traditional incandescent lamps. But for the CFL to invade the market dominated by incandescent lamps, it becomes imperative to have a clear strategy targeted at the low-income consumers of Matatiela.

One such strategy has been the Bonesa Efficient Lighting Initiative free give-away strategy, designed to accelerate the penetration of energy-efficient lighting technologies and transform the market. By positively influencing individual behaviour and changing consumer purchase preferences to favour

energy-efficient lighting choices, the primary goal of the programme was to transform the residential lighting market. Its objectives were to:

- lower household costs and more disposable income available;
- create employment and economic benefits from the energy efficient lighting market; and
- improve indoor air quality, health, safety and quality of life.

A free give-away strategy

To promote market penetration to low-income households, Bonesa embarked on a free distribution of CFL fixtures in 2002, where 1800 households were each given a pin-based 15W and a non-pin based 11W CFLs. The broad targeting of households implies more beneficiaries and decreases the risk of inclusion and exclusion. However, it benefits more the rich than the poor households and creates even more inequality in consumption and disposable income. This free distribution strategy was augmented by other activities such as providing information about CFLS to the households, and providing information (brochures and posters) and cash rebates to local retailers as an incentive to stock and sell the lamps.

There are some important basic features about CFLs to consider. Unlike screw-based or bionet-based types that allow a CFL lamp to fit into the same type of socket a standard incandescent lamp uses, pin-based CFLs have a separate ballast (non pin–based CFLs have a built in ballast). The intended effect is to reduce the likelihood of the households reverting back to incandescent lamps. The ballast lasts three times as long, can be retained, and is not part of the bulb. This does not only reduce the price of the lamp when the bulb is replaced, but it also results in less sold waste generated since the ballast is not discarded when each lamp fails. The lamp performs like the screw-based types in terms of energy saving. Furthermore, pin-based CFLs require a three to five meter lead between the plug and luminaire, giving flexibility on where the lamp is placed, whether hung from the ceiling, roof or standing on a table.

The overall strategy is to convince the Matatiela households that CFLs are an excellent investment on the grounds that they are energy saving, have a low maintenance cost, provide an excellent light distribution, and consequently influence their lighting choices in favour of CFLs. Benefits of the free give-away programme are:

- Low-income residences would not install efficient light fittings without such a subsidy given their limited disposable income.
- Provision of low-cost lighting services is central to South Africa's development strategy.

There are some barriers to be addressed that may inhibit widespread investment in energy-efficient lighting. First, is their affordability. Households may have information about the economic benefits of efficient lighting, such as the expected energy savings and reductions in energy bills, and yet find the purchase price prohibitive. Second, is the question of access. Unless CFLs are available in shopping outlets, incandescent lamps will always have a competitive advantage. After all, households prefer using a technology to which they are accustomed. Third, is the issue of risk aversion, which may lead to low penetration levels of CFLs if households perceive themselves to be the only purchasers of the product.

These market barriers have important implications for the feasibility of the project. A mix of strategies such as public education, quality control (to enhance consumer confidence and to reduce the element of risk), subsidisation, a penetration pricing strategy to entice consumers, which should enhance and lead to a sustained market penetration of CFLs. The resulting economies of scale should reduce costs in the long run. The effect on accessibility of additional measures, like incentives on bulk purchases by retail chains, hypermarkets and supermarkets become important in promoting penetration levels.

The potential impact of free give-aways

To determine the potential benefits that accrue to households per month, we calculate expected savings, per bulb substitution, using the formula below:

$$\text{Savings (in rands)} = \{(Inc_W * Inc_{OHM}) - (CFL_W * CFL_{OHM}) * C_M\}$$

Where:

Inc_W = Incandescent lamp wattage (power)
$Inc_{OH\,M}$ = Incandescent lamp operating hours per month
CFL_W = CFL wattage (power)
CFL_{OHM} = CFL operating hours per month
C_M = Electricity unit cost per month

We assume that the 15W and 11W CFL lamps replace 60W incandescent bulbs, and that the average days in a month are 30. A much better light quality results where we adopt a three-to-one ratio between a CFL and an incandescent bulb. Since CFLs are sensitive to frequent switching, we also assume that the CFL bulbs replace the incandescent where they are left on the longest per day. Our survey results show that 90 percent of the respondents switch on inside lights for an average of 4 hours a day. About 40 percent of the sample did not have outside lights. For those with outside lights, 50 percent switch them on and off almost at the same time as inside lights. Household preference is to install lamps in the kitchen, bedroom and living rooms on

the grounds that much time is spent in these rooms.

Two possible options with the free giveaways are either to have both CFLs indoor, or to have one indoor and another outdoor, both switched on and off at the same times, at 4 hours a day (Option 1) or to have one indoor left on for four hours, and the other outside left on for 12 hours (Option 2). At a cost of 40 cents per unit, electricity savings amount to R4.51 (Option 1), and range from R8.83 to R9.22 (Option 2) per household per month (see Table 1).

Table 1: Impact of substituting incandescent bulbs with CFL lamps

Option	*Household savings (monthly)*
1: two CFL (15W and 11W), one in the house and one outside or both in the house	R4.51
2: one CFL in the house, one outside	
(a) 15W inside and 11W outside	R 9.22
(b) 11W outside and 15W inside	R8.83

Even though we may argue that savings to households increases households average propensity to consume, as these funds can then be spread to other household purchases, some households may not even observe the extent of savings on the electric bill. Where savings are noticeable, substitution of incandescents with CFLs may lead to two effects: encouraging a snapback or rebound effect where some households increase their usage by taking back some of their energy savings in other benefits, and the purchase of more CFLs resulting from cost savings of efficient lighting. It is also possible that the savings may also promote purchase of other fuels.

The developmental goals associated with the free give-away project are, in some ways, in harmony with the country's macro-economic objectives. For example:

- The prime objective is to keep the cost of electricity low. Adopted on a wide scale, efficient lighting provides an opportunity to release resources, previously tied to the expensive use of incandescent bulbs, to meet economic needs to improve access to basic services, to replace more costly energy (paraffin and incandescent bulbs), and to invest more on energy saving lamps. Even though the initial cost of the CFL is higher than that of the incandescent, the savings to the average household are expected to be significant in the long run.
- There are benefits from good quality lighting. First, good quality lighting provides opportunity to children to study longer at night leading to improved educational results. Second, because reading is easier with electricity than with paraffin and candles, improved lighting encourages more reading, and contributes to improved literacy rates. Third, by enabling use of more light, improved lighting lengthens the time for domestic chores and leisure, and offers opportunity for more time on entertainment, communication or socialising. Fourth, lamps burning outdoors at night deter crime and enhance a feeling of security among households. The trade-offs in these benefits depends on household choices. To optimise on these benefits, one would expect pupils to spend more time on studying than on other social benefits (for example, entertainment), and that the extension of women's working day is not too excessive to lead to inadequate sleep with an effect on their health.
- Efficient lighting leads to a reduction of emissions and resource use associated with the use of electricity. On the other hand, a reduction in dependence on traditional sources of energy has the potential of reducing the risk of smoke inhalation, burns that are commonly associated with paraffin and candle use, reduced risk of paraffin poisoning, and improved indoor air quality.

While these goals appear valid, the crucial tests will be whether the Matatiela households lighting usage increased or decreased after the free-give away programme, and whether there is sustained consumer demand in CFLs. But fostering that demand requires more attention to the useful roles of education, marketing and advertising. Fortunately, product prices have been falling in real terms.

Conclusion

Free give-aways contribute in mitigating the negative impact of electricity use on the environment and reduces electricity costs. The economic savings from burning a CFL not only ensure that more electric light is used, but also that residents use better quality lighting for the whole month. The savings potential has an immediate benefit of offering households choice to extend their households purchases to satisfy their wants.

A significant benefit also accrues to those low-income households who, although with electricity connections, could not utilise this resource to its optimum for affordability reasons. The use of CFLs not only allows households to experience benefits, but also the use of more efficient and less expensive electricity and its associated benefits. Overall, we conclude that increased use and accessibility of efficient lighting to households would play a role in improving their economic, social, and environmental well-being, and contribute to the reconstruction and development of impoverished areas. But for

this to happen, the CFLs will have to be made available, be affordable and promoted on wide scale.

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