Improving access to electricity and stimulation of economic growth and social upliftment.

Philip Lloyd, Bill Cowan and Nthabiseng Mohlakoana

Energy Research Centre, University of Cape Town, Rondebosch 7701

Tel +27 21 650 3230, Fax +27 21 650 2830

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Abstract

There has been spectacular progress in extending electrification to homes throughout South Africa. Between 1990 and 2001, the number of connections grew from nearly 3 million to well over 7 million. However, all such programmes must be examined from time to time to evaluate their success against a number of measures.

This paper looks at the impacts of electrification on people's lives; on whether the programme is sustainable; on whether it has impacted on levels of poverty; and whether it has contributed to social upliftment.

Electrification brings light to every home electrified; nearly 80% of the homes use it to cook; and three-quarters use it for space heating. The continued use of fuelwood and the use of electricity for cooking are strongly and inversely related, for instance. Electrification has clearly had a huge impact on people's lives.

In attempting to see whether electrification is sustainable, the three legs of sustainability, namely social, ecological and environmental, were examined. The social and ecological sustainability criteria were measured against the alternatives, and it was found that electrification was essentially sustainable by default – the alternatives were just not sustainable, and were causing significant loss of life and measurable pollution. Of course, electricity generation bears its own ecological burdens, but we were unable to identify any which had an impact on life or the ecology of the planet that had an impact even approximating the burdens presented by solid or liquid fuels in the home.

However, economic sustainability was not so clearcut. From the vantage point of the poor, it was indeed sustainable, because the Free Basic Electricity (FBE) programme gave them access to an alternative source of energy that in many areas was cheaper than any alternative. This was not true in areas that had adequate resources of free fuelwood or cheap coal, but it was true elsewhere. There are a number of limitations to FBE, however. In particular, it does not offer the basic minimum needed to fully energise a home, so that those who cannot afford much more than the FBE allowance are forced to turn to another more expensive source of energy for the balance. Moreover, the implementation of FBE is fraught with difficulties, not least of which are the various pricing and delivery limits imposed by the plethora of different distribution agencies. This latter difficulty Government is attempting to resolve by rationalisation of the distribution industry into 6 REDs, but the complexities of accomplishing this mean that it will not happen overnight. Finally, it is noted that extending electrification is testing generation and distribution to the limit, and that it is becoming urgent to increase the systems' capacities and devote capital accordingly.

Electrification has had a significant impact on poverty by any reasonable measure, not least of which because in many areas it is cheaper to use electricity than any alternative. This is true even before allowing for the external costs of the alternative fuels.

And because it has transformed many people's lives and impacted positively on poverty, we can only conclude that it is playing a significant role in social upliftment, and that it is essential to extend electricity to as many homes as possible as quickly as possible, while addressing the identifiable problems in the delivery system that prevent full uptake from occurring rapidly.

1 Introduction

The electrification programme that commenced in 1991 had electrified 2 988 243 homes by the end of 2003 [1]. In an evaluation of the programme at the end of 1999 [2] the extent of electrification was as shown in Table 1.

Table 1 Extent of electrification, 1999

	Homes		Electrified		Electrified %	
	Urban	Rural	Urban	Rural	Urban	Rural
E Cape	570407	838917	480112	268118	84.17	31.96
Free State	467683	177949	386528	107268	82.65	60.28
Gauteng	2018929	71626	1515812	38463	75.08	53.70
Kwa-Zulu Natal	928946	836749	745479	253870	80.25	30.34
Limpopo	135764	930193	116757	470213	86.00	50.55
Mpumalanga	272330	369235	182134	278255	66.88	75.36
N Cape	133262	62126	110008	46438	82.55	74.75
North West	295001	471244	252314	255320	85.53	54.18
W Cape	922858	115951	796150	75264	86.27	64.91
Totals	5745180	3873990	4585185	1793193	79.81	46.29

By any standard, this has been spectacular progress, but the questions must be posed:

- What has been the impact of this effort on the lives of people?
- Has this investment yet shown signs of ensuring sustainable growth?
- Has it impacted on the levels of poverty that seem endemic in Southern Africa?
- Is significant social upliftment in sight?

This paper is an attempt to provide some form of answer to these questions, and, where positive signs are not apparent, to identify the reasons for only qualified success.

2 What has been the impact?

For many, the arrival of electrical energy has transformed lives. One has only to look at the network of lines spreading out from a single pole to twenty or more homes to know that electrification is desired. Clean, safe energy has changed many lives, not least those of women who used to cook on antiquated appliances using liquid or solid fuels.

In a recent survey [3] in Khayelitsha, 92% of households said that they preferred electricity for cooking; only 5% preferred to use paraffin, and 3% LPGas. For space heating, about 75% preferred electricity. Most of the remainder preferred paraffin. For lighting, refrigeration,

ironing and entertainment all households said they preferred electricity. For business purposes, all surveyed households expressed a preference for electricity.

However, the use of electricity for the thermal needs of households, that is, cooking, heating water and keeping warm, has not been as widespread as had been hoped when the electrification programme was initiated. Average monthly consumption had been expected to be close to 350kWh; instead, new connections averaged 83kWh [2]. The reason for this is clear from Table 2.

Table 2 Percentage of homes using electricity for various purposes

	Electricity used for			Homes
	Cooking	Heating	Lighting	Electrified
Eastern Cape	27.8%	23.4%	49.5%	53.1%
Free State	47.0%	40.5%	74.4%	76.5%
Gauteng	73.2%	70.4%	80.8%	74.3%
KwaZulu-Natal	48.3%	47.0%	61.4%	56.6%
Limpopo	25.0%	27.4%	63.8%	55.1%
Mpumalanga	40.0%	38.6%	68.3%	71.8%
Northern Cape	59.0%	54.3%	75.8%	80.1%
North West	44.6%	44.7%	70.5%	66.2%
Western Cape	78.8%	73.4%	88.0%	83.9%
Totals	51.4%	49.0%	69.7%	66.3%

The use data come from the 2001 census [4], whereas the percentage of homes electrified was assessed in 1999. In spite of this slight difference in the base date, it is clear that:

- Lighting closely follows the level of electrification – nationwide it is 105% of the electrification
- The use of electricity for cooking is generally 20-30% less than the levels of electrification – nationwide it is 77% of the level of electrification
- The use of electricity for heating is on average 3.5% lower than the use for cooking.

The recent survey[3] of Khayelitsha[i] shows that these general findings persist:

- Among households with a regular *metered* supply of electricity, 68% use an electric stove as their main cooking appliance. 53% of the households with electricity from an *extension cord* connection use an electric stove, the remainder using paraffin stoves.

[i] Approximately 40% of the households in the sample had a household income below R1200/month, which is the present poverty datum.

Among *non-electrified* households, 92% were using paraffin stoves as their main cooking appliance, and the remainder LPGas.

- Almost a quarter of the households surveyed did not report using any space-heating appliances. A further 21% said they used other means of keeping warm (e.g. blankets, or relying on some heat from their paraffin cooking stove). For the remaining households that *did* use space-heating appliances, the most common appliances were paraffin heaters (in 40% of households). The use of electric heaters was less than 12%.

Something which was not observed was the failure to use electricity when there was supply. There are indications [5], however, that in some parts of the country significant numbers of connections have been idle for over a year. The causes of this are under investigation, but are believed to be associated with the restriction of the supply to 2.5A (see below, Section 4). The reasons for a slow uptake of the thermal uses of electricity vary from one part of the country to another. They may include:

- Householders already possess appliances suited for cooking or heating with solid or liquid fuels, but not for cooking or heating with electricity.
- Householders cannot afford electrical appliances, and believe they cannot afford the running costs for cooking or heating with electricity.
- Householders presently use solid-or liquid-fuelled cookers or heaters for multiple purposes (e.g. simultaneous cooking and space- and water-heating, combustion of refuse), which are not readily achieved with electrical appliances. Instead separate electrical appliances are needed.
- Householders are familiar with 'traditional' fuels.
- Householders have access to cheap sources of energy such as fuelwood or coal, which they employ in quantities that cannot be matched by electricity.

In parts of the country where cheap fuels are readily available, lower-income electrified households may continue using these fuels for thermal purposes, saving money. Moreover, some 50% of rural households remain unelectrified, so have no option to cook with electricity.

In illustration of these issues, consider the data shown in Figure 1, which is a correlation of the census 2001 data on cooking using fuelwood and electricity. The strong inverse correlation shows that in areas where a high percentage of households cook with wood, few cook with electricity. The areas where a larger percentage of households cook with electricity are typically urban areas, where non-commercial fuels like wood are not freely available. For example, in the City of Johannesburg Metropolitan Municipality, households cooking on wood are less than 0.4% of the total, whereas in a predominantly rural area such as the Zululand District Municipality, nearly 70% cook on wood [4]. In another rural community in Kwa-Zulu Natal studied recently, fuelwood was the primary energy source for 96% of the households [6], and it cost nothing but the effort required to harvest it.

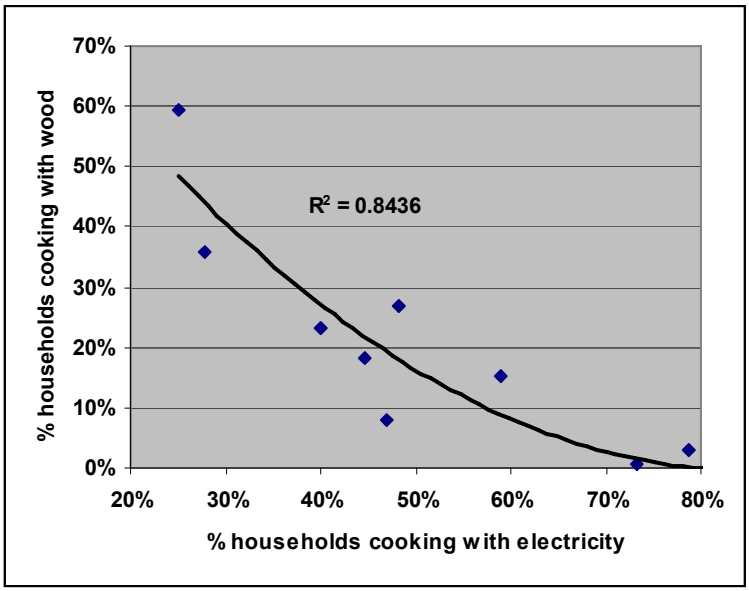

Figure 1 Comparison of households cooking with wood and electricity in South Africa, 2001

Poor households with access to 'free' (i.e. non-monetarised) fuels like self-collected fuelwood are likely to carry on using these fuels for their more energy-intensive needs, as long as the money they save through this practice can be spent on higher priorities for cash expenditures, such as food, school fees, etc. The *real* costs of using collected fuelwood (e.g. the labour expenditures and health hazards from smoke exposure) are difficult to balance for households very short of cash income, although widely recognised both by householders themselves [5] and internationally.

However, in areas where most people rely on *commercial* fuels for cooking and heating, and where most households have electricity, the choice whether or not to use electricity for cooking and heating purposes depends more strongly on monetary cost comparisons. Making cost comparisons can be a complex matter, for several reasons. For example,

- The prices of different energy options (e.g. electricity, paraffin, coal, LPGas) can fluctuate over time, and vary from area to area
- Multiple uses of energy (e.g. simultaneously for cooking and space heating) affect the economics of different fuels/appliances combinations
- Appliance costs (and lifetimes) need to factored into the comparison (e.g. a good coal stove may be very expensive but last many years, a cheap paraffin stove may be affordable but only last six months)
- Low-income households have little latitude to experiment and find out for themselves whether it is cheaper to cook/heat using alternative options such as electricity, coal, paraffin, LPGas

Another important factor for lower-income households is to reduce poverty risks, by being able to manage their limited and variable budgets in a flexible manner, as circumstances demand. This can imply avoiding investments and bulk-buying, and instead choosing a more flexible hand-to-mouth approach which allows for income-saving cutbacks when required, and a greater ability to give or receive small exchanges (e.g. cupfuls of paraffin) between neighbours.

These are very real complicating factors which can make it more difficult for poorer households to choose their best energy options. But interestingly, the recent survey of energy use in Khayelitsha showed that most households in the survey were probably following a sensible course (taking account of current fuel prices in the area):

- Most electrified households (about two-thirds) were cooking mainly with electricity. Since the introduction of a Free Basic Electricity allowance – 50 kWh/month free, in Khayelitsha – it has become slightly cheaper to cook with electricity than with the lowest-cost local competitor fuel, paraffin, for low-income households.
- Few surveyed households (about 12%) used electric heaters, and 40% still used paraffin for space-heating. Paraffin heaters are likely to be slightly more economical than electric heating, at current local prices, so from this point of view the choices are rational. However, continued household use of paraffin carries familiar dangers of fires and paraffin poisoning, which are a major concern in lower-income areas of the Western Cape.
- Very few households used LPGas (less than 5%), which is not surprising when a local Energy Centre in Khayelitsha sells LPGas for R10/kg – at this price, approximately twice as expensive to use as electricity.

In this survey, the best indicator of a fairly full transition to household electricity use was the ownership of a refrigerator. 58% of the sample (67% of electrified households) owned fridges.

If the electrified households were divided into two groups – those with fridges, and those without fridges – there were a number of statistically significant differences between these two groups. The strongest difference was in the average time that the households had had electricity. Other clear differences were seen in average income levels, household size, and the number of females (but not males) in a household. Table 3 summarises these results.

Table 3 Factors associated with fridge ownership among electrified households in Khayelitsha

	Households with fridges		Households without fridges		t value	Probability
	Mean	N	**Mean**	N		
Years electrified	**8.4**	126	**4.9**	62	5.56	.000
Number of females in household	**2.5**	126	**1.5**	62	4.28	.000
Household size	**4.6**	126	**3.4**	62	4.0	.000
Household income (R/month)	**2516**	124	**1425**	61	3.7	.000

Fridge-owning households reported higher average electricity consumption levels (mean: 224 kWh/month) than other electrified households (mean: 142 kWh/month).

There are many inter-correlating factors which appear to affect the uptake of electricity. Table 4 gives the progress of electrification up till 2001. It shows that today some 5.1 million homes have had electricity for 8 years or more, out of a total of some 10.8 million homes. If the Khayelitsha findings could be extrapolated, it would show that about 46.4% of all homes

would be making full use of electricity, which is sufficiently close to the census findings shown in Table 2 to make no difference.

Table 4 Age of electrical connections to households in 2004

Year-end	Age of connection In 2004 (Years)	Total connections	Rural connections during year	Urban connections during year	Total connections during year
1990	14	2,977,765			
1991	13	3,060,235	41,474	40,996	82,470
1992	12	3,292,790	116,952	115,603	232,555
1993	11	3,624,699	166,917	164,992	331,909
1994	10	4,060,455	32,139	403,617	435,756
1995	9	4,539,222	11,982	466,785	478,767
1996	8	5,008,351	285,506	183,623	469,129
1997	7	5,507,662	257,193	242,118	499,311
1998	6	5,935,088	202,487	224,939	427,426
1999	5	6,378,378	181,025	262,265	443,290
2000	4	6,780,597	159,301	242,918	402,219
2001	3	7,118,415	142,735	195,083	337,818

Source: National Electricity Regulator [7]

Thus far we have been considering primarily grid connections. There is a growing interest in widespread non-grid development, and the National Electricity Regulator has established a number of concession areas in which concessionaires are encouraged to provide non-grid services, but the roll-out programme can best be described as halting. Many schools have been equipped with solar systems, and the theft of photovoltaics from emergency or telephony services is clear indication of the overall desirability of this type of system, but commercial uptake has thus far not made a great impact. Even with substantial capital-cost subsidies within the non-grid concessionaires programme, solar home systems have tended to reach a relative minority of higher-income households.

An obvious limitation of electrification by means of small Solar Home Systems is that they do not cater for households' thermal energy needs. In areas where subsidised solar electrification is taking place, it has therefore been the intention to ensure improved supply of other fuels for cooking at the same time. LPGas is an attractive choice for somewhat richer households able to afford it, and unable to access grid electricity. Otherwise, paraffin remains a staple fuel in rural areas where non-commercial fuels are difficult to obtain. The improved distribution of these fuels is sought through establishing local energy centres, and in some of the non-grid concession areas, 'one-stop' rural energy stores.

3 Is electrification sustainable?

The question is probably best reversed, to ask whether the alternatives to electrification are sustainable? The answer is that the majority are not, so electrification becomes sustainable by default.

Cooking or heating water or homes with solid or liquid fuels in not sustainable because it results in high health impacts. Acute respiratory infections, chronic obstructive pulmonary disease and cancer are thoroughly documented (see, for instance, [8,9]). Many of the substances in biomass smoke can damage human health. The most important are particles, carbon monoxide, nitrous oxides, sulphur oxides (principally from coal), formaldehyde, and polycyclic organic matter, including carcinogens such as benzo[a]pyrene [10]. Particles with diameters below 10 microns (PM10), and particularly those less than 2.5 microns in diameter (PM2.5), can penetrate deeply into the lungs and have great potential for damaging health [11]. A recent review concluded [12]

> "There is consistent evidence that indoor air pollution increases the risk of chronic obstructive pulmonary disease and of acute respiratory infections in childhood, the most important cause of death among children under 5 years of age in developing countries. Evidence also exists of associations with low birth weight, increased infant and perinatal mortality, pulmonary tuberculosis, nasopharyngeal and laryngeal cancer, cataract, and, specifically in respect of the use of coal, with lung cancer. Conflicting evidence exists with regard to asthma. All studies are observational and very few have measured exposure directly, while a substantial proportion have not dealt with confounding. As a result, risk estimates are poorly quantified and may be biased. Exposure to indoor air pollution may be responsible for nearly 2 million excess deaths in developing countries and for some 4% of the global burden of disease."

Even more recent evidence has shown that exposure to wood smoke has a significantly larger effect on infant birthweight than "passive smoking" of tobacco [13]. The link between coal smoke and lung cancer comes largely from China, where over two thirds of the women with lung cancer were non-smokers, and the majority had been exposed to smoky coal [14].

Locally, the use of paraffin has been associated with fires leading to the destruction of over a hundred thousand homes annually, at least 35 000 severe burns and perhaps as many as 4 000 deaths both from burns and from chemically induced pneumonia caused by children drinking paraffin.

Indeed, about the only source of energy other than electricity which does not seem to be associated with such health effects is LP gas, and that is presently too expensive to play any significant role in alleviating the plight of the poor.

Thus electricity has a significant role to play in South Africa. There are those who would point to the ash and sulphur oxides generated by coal combustion as grounds for believing our thermal power stations are unsustainable. We have been unable to find any concrete evidence of damage to either the biosphere in general or the populace in particular to substantiate these claims, and thus believe that the use of electricity is ecologically and socially sustainable by any reasonable measure. We must now turn to whether it is economically sustainable.

4 Is electricity economically sustainable?

Demand by homes sets the peak load on South Africa's electrical distribution system, so it is important to understand the determinants of the load. As noted in Section 2, monthly consumption by new connections was only 83kWh where 350kWh had been expected. The impact on the system was therefore far less than had been anticipated. Nevertheless an examination of the impact of a basic electricity support tariff [15] showed that growth in the load would give rise to overloads in a significant number of feeders, and that most of the overloads would occur in circuits electrified within the previous 6 years. The impact of a support tariff was, however, similar to the impact of overloads resulting from the natural growth in demand.

An examination of the EPRET database [16, 17] showed that in those areas of the country where there was no singularly cheap fuel readily available, the basic energy needs of households could be met with at least 1 000MJ/month. This was true in the Durban Functional Region, Pietermaritzburg, East London, Port Elizabeth, and Cape Town Metropole. In Gauteng, Kimberley and Bloemfontein, the availability of cheap coal resulted in even poorer households using as much as 4 000MJ/month. Similarly, recent studies in a rural area with adequate supplies of free fuelwood[4] showed consumption of up to 4 000MJ/month. However, these are clearly the exceptions, and the general pattern of a minimum of about 1000MJ/month seemed a good approximation.

However, these findings were before electrification had been extensive in lower-income homes, and they do not take into account the efficiency of use of the various sources of energy. Because the energy mix is changing as electrification progresses, it seemed advisable to check this effect.

We have recently determined the efficiency of a number of sources of energy[18], and, for instance, paraffin when burned in stoves typical of those used in lower-income homes had a cooking efficiency of 36%, whereas an electrical 2-plate cooker had an efficiency of 68%. This would reduce the minimum energy requirement for a fully electrified home to about 550MJ/month, or about 150kWh/month.

The survey of electrified homes in Khayelitsha[3] showed:

- The poorest, unserviced homes in Monwabisi electrified via extension cords used an estimated 100kWh/month (median) (N=36)
- Serviced shacks in Site C used a median of 170kWh/ month (N=50)
- In Kuyasa, an RDP housing are, the median consumption was 150kWh/month (N=50)
- In Makhaya, a "core housing" area of generally higher income, the median consumption was 250kWh/month (N=51)

Thus it appears as if the estimate of about 150kWh/month, obtained from looking at all forms of energy supplies to lower income homes, is a reasonable approximation to what users consume in practice.

The current FBE policy envisages an allowance of 50 kWh free electricity per month, for poor households. Clearly, this would not be enough to *cover* a monthly consumption of 150 kWh, but it would bring the average unit cost of electricity down by a third, at this consumption level, generally making electricity a more affordable and more attractive household energy choice, compared with other commercial fuels such as paraffin and LPGas. In areas where cheap coal is available, the use of coal for combined cooking and heating would

(unfortunately) still compete against electricity, bringing its attendant problems of high local pollution levels and health hazards.

The benefits of switching to electricity use are well known, and include greater versatility, improved safety and less indoor pollution. On the other hand, there is little evidence that household electrification 'creates jobs'. Many other factors act as constraints on job creation and income generating activities.

The implementation of FBE poses many challenges. At present, local governments have the constitutional responsibility to ensure the provision of basic services, and the funding stream for FBE accordingly passes to local governments, via the Department of Provincial and Local Government. Municipalities are expected to identify poorer households, in order to target the FBE subsidies. This in itself can be a challenge, in some areas. Secondly, municipalities presently have discretion over how the funds allocated for FBE are actually used. Subsidising electricity may not always be regarded as the most important priority, and a municipality might decide to use the funds for other purposes.

The uniformity of FBE provision is further jeopardised by the continuing disparities (e.g. in electricity tariffs, service levels, delivery capacity) among different municipal distributors in the country, pending rationalisation of electricity distribution in Regional Electricity Distributors. However, in areas where FBE has been successfully implemented, the effects are appreciated. In the Khayelitsha survey, for example, approximately half the electrified households reported that they have been using more electricity, and using electricity for more purposes, since the recent introduction of FBE.

Of course, FBE cannot directly benefit households without access to electricity. In urban areas, where electrification rates are relatively high (e.g. 80%), there are still likely to be significant numbers of low-income households without a regular electricity service, for example because they are settled in areas which have not been approved for settlement and services by a municipality. This is a key problem, closely associated with the wider challenges of housing backlogs, provision of services, and urban in-migration. In rural areas, as mentioned before, some 50% of households are not connected with grid electricity, and would therefore not benefit currently from FBE provisions. (There was a tentative replication of an FBE allowance for households with solar home systems in the non-grid concession areas, in the form of an operational subsidy of R40/month, but the onward transmission of such a subsidy by local government proved uncertain, and this approach may be discontinued.)

A further complication is that the present policy on electrification is to provide a 2.5A supply unless the householder pays a connection fee, in which case a 20A supply is provided. 2.5A will provide a total of 550W, which is enough to power lights and a few low-power devices such as a radio, but not enough for a kettle, single-plate stove or one-bar heater. About half of all recent new connections have been 2.5A [5], and many of "idle connections" are of this kind. It therefore appears as if one hindrance to the extension of the use of electricity is this policy, which does not provide the users with adequate benefits. The analysis of the Electricity Basic Support Supply Tariff [15] recommended a minimum of 10A supply, but this would have meant that those who already had 20A connections would have objected. For this political reason, therefore, the proposal was not supported.

Yet a further complication is local policy of the level at which FBE can be claimed. Some distribution authorities set the maximum monthly use at 150kWh. Above that, the benefit of FBE falls away. As we have seen, 150kWh is the *minimum* necessary to energise a home, so

users are fearful of adopting full electrification because this would mean loss of the FBE benefit.

Recognising that FBE benefits will not reach the unelectrified, and that unelectrified households include some of the poorest and most in need, the Department of Minerals and Energy has drafted proposals for a wider approach, to cover "free basic energy", not just electricity. However, given the complex and varied distribution routes for non-electric fuels, this could be even more challenging to implement.

It is of interest to review possible electricity support options. A range of such options is illustrated in Figure 3 [14].

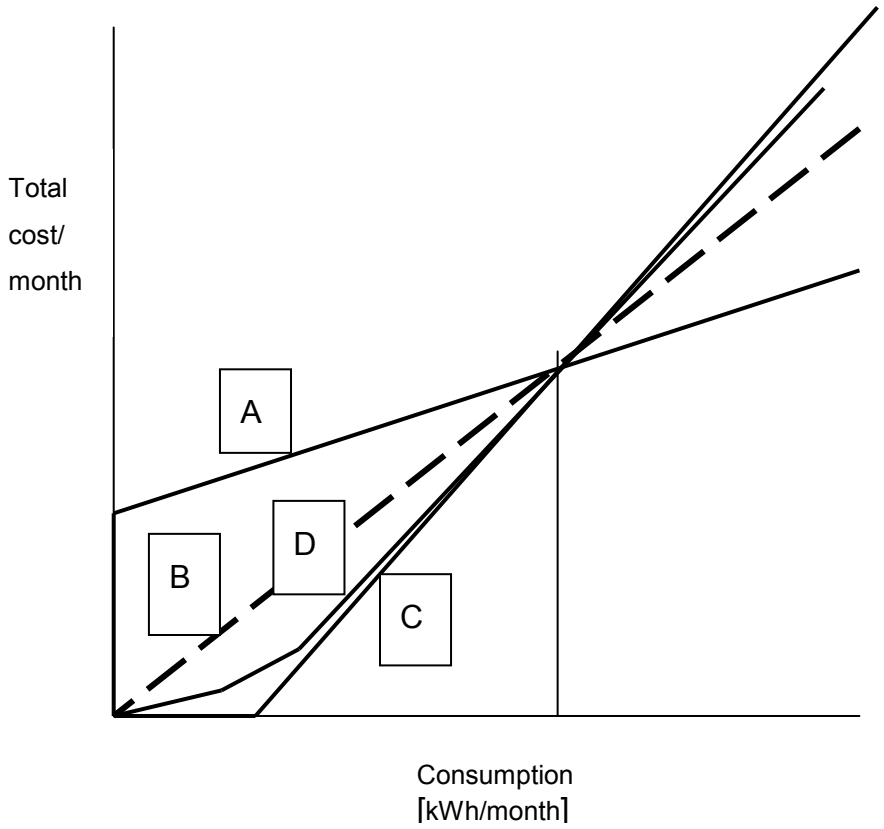

Figure 2 Possible electricity support tariff structures

Tariff	Description	Characteristics
A	Two part tariff with fixed monthly (basic) charge and an energy charge	Cost reflective of fixed costs associated with distribution, such as capital, operations and maintenance
B	Simple energy rate tariff	Simple to meter and administer. Subsidy for small consumers recovered from large consumers.
C	Two part increasing block rate energy tariff with first block free	Free energy for the smallest consumers, subsidised by larger consumers. Magnitude of subsidy and recovery is higher than tariff B.
D	Increasing block rate tariff with three blocks, first block may be free or low cost.	Energy becomes progressively more expensive with greater consumption. Subsidises small consumers and encourages energy efficiency. Requires complex metering.

The general anticipation is that there will be 50kWh of free electricity per month, and that thereafter customers will be billed at a rate somewhat higher than a simple energy rate tariff, that is, a two-part tariff such as C in Figure 3. This was the preliminary scheme announced in January 2001. However, while some cities have implemented such a scheme, the Department of Minerals and Energy is still investigating the best methods for implementing a basic electricity supply support tariff [19]. There was a pilot scheme involving 8 000 grid-connected households. These households received R20/month in direct subsidy, which is close to 50kWh/month under many tariff structures, but by no means all. The scheme also tested the benefits of a R48/month subsidy for non-grid-connected households. The test was not an unqualified success because the delivery of the subsidy was at less than optimal efficiency.

The level of 50kWh/month of basic electricity was motivated on the following basis: [18]

- 56% of households in South Africa connected to the national grid (in Eskom's licensed areas) consumed on average less than 50kWh of electricity per month. This was more than the last two quintiles of the population that can be classified as poor;
- 50kWh per month was considered adequate electrical energy to meet the needs for lighting, media access and limited water heating and basic ironing (or basic cooking) for a poor household;
- The level of 50kWh had been spoken of generally at national level and has been accepted as a norm in respect of free basic electricity. This quantity had achieved widespread political and community acceptance and expectation.
- Energy efficient lighting and other energy saving initiatives could increase the utility of this 50kWh.

However, the assumption that 50kWh was adequate to meet basic needs was clearly flawed, and indeed the Department provided [20] a Table that indicated this:

Table 5 Tabulation by DME of basic household needs

Item	Watts	Hours used per day	Days used used/month	kWh	Quantity	Total kWh
Energy Saver Light	11	5	30	1.7	1	1.7
Light	60	5	30	9	3	27
Light	100	5	30	15	1	15
TV (b&w)	35	6	30	7	1	7
Iron	1000	4	6	24	1	24
Kettle	1000	0.5	30	15	1	15
Hotplate	1000	1	25	25	1	25
Fridge (small)	250	6.5	30	49	1	49

In the referenced document, the final column, which was headed "Cumulative", was blank! Clearly there was recognition that 50kWh was insufficient for basic needs, even without consideration of whether an hour a day was sufficient to cook meals for a household.

As a final dimension to this problem, let us develop the thought introduced earlier – "R20/month in direct subsidy is close to 50kWh/month under many tariff structures, but by no

means all." The Electricity Distribution Industry (EDI) in South Africa is very fragmented, and it is present policy to bring coherence by the establishment of 6 Regional Electricity Distributors. The rationale underlying this were spelt out in 2001: [21]

> "The current arrangements in the EDI are the result of the historic development of the sector and form no coherent pattern. As a result, consumers face significantly different levels of tariffs, standards of supply reliability and service across the country. The result is widespread inequity among consumers. This is inconsistent with government objectives of promoting economic and social development throughout the country. In particular:
>
> - Wide disparities exist in the **tariff structures** caused by the high level of fragmentation of the industry (domestic tariffs supplied by municipalities range from 16 – 60 c/kWh). These tariff differences bear little or no relationship to the quality of service provided, the costs of supply or consumers' ability to pay;
> - Reliability of supply and the ability of distributors to offer a basic and secure supply to **low income households** differs markedly across the country;
> - **Unfair discrepancies** exist between Eskom Distribution and Municipal Distribution purchasing tariffs from Eskom Transmission – to the benefit of some large customers, but the detriment of the majority of domestic and low-income consumers;
> - **Electrification** needs are not evenly distributed across regions, with some of the poorer regions having the greatest need. Under the current EDI structure, the burden of financial support to newly connected rural and low income urban customers will fall randomly on some consumers and not others in an entirely unplanned and uncontrolled manner; and
> - The threat of financial collapse is most acute for a number of municipal distributors in certain **low income rural, urban and industrialised areas** in South Africa."

This makes it clear that the provision of 50kWh/month or R20/month FBE is not simple or clearcut. It impacts adversely on some municipalities and other distributors, and cannot readily be implemented nationally until such time as the Regional Electricity Distributors are in place – which seems unlikely to happen overnight.

Therefore let us summarise the position:

- The least electricity needed to run a household is about 150kWh/month.
- At 150kWh/month, the direct costs of electricity are less than the costs of alternative fuels, while the alternative energy sources have large indirect health and social costs. This means that **150kWh is affordable by most households**.
- Urban households are increasingly obtaining access to electricity, and there is a shift in the national demographics such that the rural population is decreasing. Moreover, some of the more populous rural areas still have access to adequate supplies of wood or affordable coal. As many as 70% of all households in those areas are able to use as much as 4000 MJ/month, equivalent to over 500kWh of electricity/month when efficiency is taken into account, so for such households electrification is not affordable except for the low-power uses such as lighting and entertainment.
- In these circumstances focus on the urban areas will yield the greatest benefit to the greatest number of people in the least time.

- While the *purpose* of FBE is the alleviation of poverty, it is not achieving this because the problem is not the unaffordability of electricity but the lack of access to electricity.
- Moreover, FBE is not achieving its objective because of disparities in local distribution policies that are unlikely to be resolved overnight.
- Finally, it is becoming increasingly obvious that the capacity of the generation and distribution systems is approaching limits that will require significant capital, and until such time as decisions are taken to increase their capacity, this limitation will hinder wider access to electricity and the benefits it can confer.
- There are already signs that increasing electrification is increasing the demand [22].

In this connection it is of interest to see the mix of appliances shown in the Khayelitsha survey.

Table 6 Cooking appliances in use in Khayelitsha homes, 2003

	Type of electricity supply		
Main cooking appliance	Pre-payment meter	Extension cord	No electricity
Electric stove / oven	68%	53%	
Gas stove	8%		8%
Paraffin stove	24%	47%	92%
Totals per group	100%	100%	100%
N (households per group):	151	36	37

Of the 122 owners of electric stoves, 2% were single-plate, 59% two-plate, 30% four-plate and 9% had full stove/oven combinations. There was a strong correlation between household income and appliance used for cooking, with those relying on paraffin stoves having a median household income of only R1010/month, whereas those possessing a four-plate stove or stove/oven combination had a household income in excess of R2000/month.

Overall appliance ownership in the 226 households surveyed is given in Table 7. These figures provide a picture of modernisation and "energy transition" dynamics in a low-income urban community that has been provided with good electricity services. The least common appliance in the sample is the traditional/makeshift *imbhawula* (used by only 4% of the households) and the most common appliances are electric lights (82%). Clearly some of the households do not yet have access to electricity, so cannot use electric appliances. Even so, an important indicator is that almost two-thirds of the entire sample (65%) own and use an electric stove. Not all of them use an electric stove as the *main* cooking appliance, but among households with a normal metered electricity supply, most of them do.

Table 7 Appliances in use in Khayelitsha, 2003

Rank	Appliance	% ownership	Rank	Appliance	% ownership
1	Electric lights	82%	11	Music system	39%
2	Iron	75%	12	Paraffin lamps	33%
3	Electric kettle	70%	13	Video	15%
4	Electric stove	65%	14	Telephone (landline)	14%
5	Television	63%	15	Microwave	13%
6	Fridge	58%	16	Washing machine	12%
7	Paraffin stove	57%	17	Electric heater	12%
8	Radio	54%	18	Gas stove	12%
9	Cellphone	50%	19	Fan	8%

10	Paraffin heater	40%	20	Imbhawula	4%

To conclude this section, which has necessarily been somewhat discursive:

- There are aspects of the current electrification programme that do *not* appear to be economically sustainable.
- Specifically, it appears as if the provision of free basic electricity is *not* achieving its objective because makes less of a contribution to poverty alleviation than the provision of electricity at a common cost to more people. Greater electrification would provide cheaper household energisation than the alternative sources of energy, particularly when the external costs of those alternatives are taken into account.
- However, recognition that FBE is not achieving its objectives suggests that accent on rectifying the identifiable problems in implementing the programme are as important as extending electricity services.

5 Has electrification impacted on poverty?

The answer to this question must be *Yes*. Consider the data from the survey of Khayelitsha [3] shown in Table 8 below. At 1 June 2004, the cheapest available paraffin was R2.90/litre, and electricity cost 50c/kWh less 50kWh free. The household cost was R96,40/month for a household cooking mainly on electricity, against R99,20/month for a household cooking mainly on paraffin. If the cost of fires and health impacts of paraffin use are factored in, then this small difference becomes hugely magnified.

Moreover, people are aware of this difference. The increasing access to electricity (except for in-migrating households establishing informal homes on areas of land which are not approved for settlement, and hence ineligible for municipal service provision), and the increasing affordability of electricity are likely to lead to a growing number of households in Khayelitsha switching away from paraffin and towards full electricity use instead. Backing this up are community perceptions of the dangers of using paraffin in a context like Khayelitsha. In the survey, 78% of households said that paraffin was "dangerous" or "very dangerous", while only 8% said the same about electricity.

Table 8 Median use of paraffin and electricity in Khayelitsha homes.

		Paraffin, litres/month	**Electricity, kWh/month** [a]
	N	Median	Median
Households cooking mainly with electricity	124	6 litres	210 kWh
Households not cooking mainly with electricity	102	18 litres	150 kWh

[a] When householders were asked how much they pay for electricity each month, common answers were "50 rand" (which buys 150 kWh of electricity) or "100 rand" (which buys 250 kWh). This point is a caution about the accuracy of the data.

So not only does electricity provide a cheaper option for household energisation, it also reduces some of the impacts of poverty related to health, wellbeing and safety.

However, only about 40% of the population of Khayelitsha that we have been studying have been truly poor as generally recognised today, i.e. with a household income below about R1200/month. As noted in the previous section, those still using paraffin for cooking have a median household income of only R1010/month. It is a moot question as to whether the

continuing use of paraffin arises from the lack of access to electricity, or from sheer poverty. So some consideration of the final question is necessary.

6 Is significant social upliftment in sight?

What is abundantly clear is that there is a correlation between the household income and degree of use of electricity. However, it also appears that housing affordable to the lowest income levels is often the most recently occupied and equally often unserviced. So the driver of the correlation could be the lack of access to electricity rather than poverty per se. In the poorest part of Khayelitsha studied, there was extensive use of extension cords to supply households with the little electricity available. The demand was estimated at about 100kWh/month per household, which is below the minimum level necessary for full electrical energisation, and which meant in turn that the households had to turn to other, more expensive forms of energy to meet their needs.

In contrast the areas serviced with electricity were showing a significant demand in excess of the minimum needed to energise their homes. It is thus clear that they are taking advantage of the benefits offered. They are spending more on electricity than they strictly need to, which can only be a sign of the alleviation of their poverty. Levels of paying for service are high, which means that they can afford the service.

One of the hopes for electrification which does *not* seem to be borne out is use being made of electrical supplies for home industries. There was very little direct evidence from the survey of Khayelitsha[3] that electricity contributed to local income-generation, although all the survey respondents agreed that electricity was the preferred energy option for supporting business activities. It is clear from the widespread use of extension cords that onselling of electricity must provide some local income, but it has to be asked whether is the type of economic activity normally considered as a "home industry."

7 Conclusions

In this paper, we first reviewed the extent of electrification, and concluded that, yy any standard, there has been spectacular progress. However, we posed four questions:

- What has been the impact of this effort on the lives of people?
- Has this investment yet shown signs of ensuring sustainable growth?
- Has it impacted on the levels of poverty that seem endemic in Southern Africa?
- Is significant social upliftment in sight?

The answer to the first was affirmative. For many, the arrival of electrical energy has transformed lives. Homes are clean and well lit. Cooking, washing and ironing are simplified. There is a much-reduced risk of fire. There are previously undreamt-off opportunities for learning, communicating and for home entertainment. The uptake of a wide range of electrical appliances is a clear indication of the benefits electrification brings. Extension cords taking electricity to the unelectrified are yet another sign that its benefits are desired.

Electrification seems fully sustainable on the social and ecological levels. The health hazards presented by solid and liquid fuels are increasingly being quantified, and identified with significant lost years of life. At the lowest level electrification is clearly economically sustainable also, as it permits the household to receive the basic minimum energy services cheaper than any alternative. At higher levels, however, the sustainability must be questioned. The reasons for this have been explored, and we conclude that the restructuring of the distribution sector will probably go a long way towards making it more sustainable. However, it is increasingly clear that significant capital expenditure in both generation and distribution are essential and urgent if electrification is to deliver on its promise in a truly sustainable way.

Electrification has clearly impacted on poverty, if only because it provides an alternative to solid and liquid fuels that costs less than those fuels and has far less external costs. For these reasons, it is starting to play a significant role in social upliftment. However, the hopes that it will offer a range of income-generating activities to the poorer homes do not appear to be borne out in practice.

Because electrification has transformed many people's lives and impacted positively on poverty, we can only conclude that it is playing a significant role in social upliftment, and that it is essential to extend electricity to as many homes as possible as quickly as possible, while addressing the identifiable problems in the delivery system that prevent full uptake from occurring rapidly.

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