FIGHTING ENERGY POVERTY IN CAPE TOWN

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Final Report

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EXECUTIVE SUMMERY

Energy poverty is widespread in Cape Town. Examples of energy poverty include:

- No access to electricity
- Extension cord-type of connection to electricity (unsafe, expensive and unreliable)
- Use of paraffin for cooking (highly unsafe)
- Overspending on electricity e.g. for lighting because use of traditional bulbs

The city of Cape Town uses many resources on improving the living condition of its poor citizens, e.g. by providing electricity connections to many informal settlements and through a tariff for electricity with an annual subsidy of R120 million for end-users with a low or medium electricity consumption.

This catalogue of ideas acknowledges the existing efforts to address poverty in Cape Town and attempts to add to this by listing possibilities for optimising the fight against energy poverty. Possible improvements are divided into three categories; energy efficiency, electricity tariffs and general activities:

Energy efficiency

- Create effective information campaigns in informal settlement about energy issues, such as:
  - Use alternative to paraffin for cooking (electricity, LPG or ethanol gel)
  - Use CFL's and get more light out of the electricity
  - Understand your electricity bill
  - Energy savings behaviour, such as switching off lighting during the day and when rooms are unoccupied
- Micro-financing of CFL's for low income households, e.g. 10% on the top of the electricity bill to cover CFL's purchased. This would work in the same way as low-income households pay connection fees.

Electricity tariffs

- Change the rules for Free Basic Electricity (FBE) so that it can be obtained independently of frequency of purchasing. This could be achieved by giving a daily allowance of FBE instead of a monthly allowance, in the same manner as the service charge is paid for by Domestic 1 users, which was originally a monthly charge. With the current monthly allowance system 12% lose their free electricity because they don't purchase electricity in a particular calendar month.
- Simplify the tariff so it is easier to understand and use.
  - Merge Domestic 1 and 2 into a single tariff. We give two suggestions of how this can take place. In both suggestions the service charge of Domestic 1 has been removed.

General activities

- Re-assess electrified informal settlements on a regular basis in order to assess whether new households have been established that qualify for electrification. It appears that many households in electrified settlements are not electrified due to increasing density of housing and expansion of settlements.

- Undertake information and training campaigns with the major retailers of electricity tokens such as supermarket chains. Some of these retailers wrongful demand a minimum sold value of e.g. R20. This is important in order to make electricity more competitive with paraffin in low-income households.
- Promote alternatives to paraffin in areas without electricity. Support infrastructure for alternatives and provide micro loans for initial investments in stoves, cylinders etc. Where alternatives are not possible promote the use of paraffin stoves that are SABS approved for safety.

Connecting many households to the grid and supplying free electricity has increased electricity consumption. This new consumption has created increased welfare for low-income households. Concerns have been raised as to whether this is sound policy when South Africa is low on generating capacity. Our understanding is that:

- The increase in welfare for the poor outweighs the drawbacks. The reduced use of paraffin has an especially positive impact on the standard of living
- The challenges with the high electricity demand in peak periods are mostly due to consumption outside of low-income households. More than 80% of peak demand is created outside low-income households. It will be more cost effective to target energy efficiency at the top level of consumers due to their high consumption, relatively low numbers of households and large potential for savings.
    - Energy efficiency should be widely targeted. High income households use electricity for heating water and space heating, and here time-of-use metering could help reducing consumption in peak periods. Electric heating can be disconnected for hours without major reduction of comfort. Time-of-use meters could e.g. be introduced for users with a yearly consumption above 20.000 kWh/year.

We have seen some examples of offering expensive solutions to very low income households. Solar heaters and ceilings may need a high subsidy that can be used better. The use of affordable alternatives to paraffin should be promoted in areas without electricity supply. In areas with electricity – electricity should be promoted for cooking.

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Ea Energy Analyses

Introduction

Energy poverty can be understood as highly irrational energy related behaviour (unsafe, costly) that households are forced into due to poverty. Examples can be: use of unsafe, but cheap fuels for cooking and not choosing highly profitable energy efficient equipment due of lack of money for the initial investment.

Energy poverty is a sub-set of poverty. In this project we will focus on the energy aspect, while acknowledging the broader issues of poverty, including employment, housing, education, health, migration etc.

The project is mainly based on a review of existing materials. This has been combined with information obtained through interviews with local experts from the City of Cape Town, Energy Research Centre at the University of Cape Town, Department of Electricity and the Provincial Administration. We have also visited the informal settlements of Imizamo Yethu in Hout Bay, Philippi and Samora Machel in Khayelitsha and were informed on energy consumption and life in the informal settlements.

We would like to thank all that have helped us.

The project has been carried out for the City of Cape Town with financial help from the Urban Environmental Management Programme funded by the Danish aid agency, Danida.

Poverty in South Africa and Cape Town

Western Cape and Cape Town is one of the wealthiest areas of South Africa. The housing standard in Western Cape is, with 83% formal housing, the highest in the country. The percentage of households using electricity for cooking is highest in Western Cape (89% compared to national average of 67%). The province has a high degree of households using electricity for lighting (94% compared to national average of 80%. The province has the lowest migration to other areas in the country and the second highest migration to the province (Statistics South Africa, 2007).

Cape Town's 3,3 million inhabitants in 904.000 households share very different living conditions. Poverty is widespread and the fight against poverty is only making slow progress, e.g. the national statistics show an increase in per capita income (year 2000 Rand) from R808 in 2000 to R1.051 in 2005 for the poorest 20% (Development indicators, www.gov.za).

Adequate housing for all people does not exist. In spite of housing programmes the extent of informal settlements has increased during the last 12 years. In 1993 28.300 informal houses were recorded. This number increased to 104.000 in 2006. The growth has decreased in recent years, but the number of informal settlements increased by 6% from 2005 to 2006 (City of Cape Town, 2006 & 2007).

Informal settlements (2005)	98.000
Shacks on serviced sites	28.600
Backyard dwellings	75.400
Overcrowding	59.800
Total	260.000

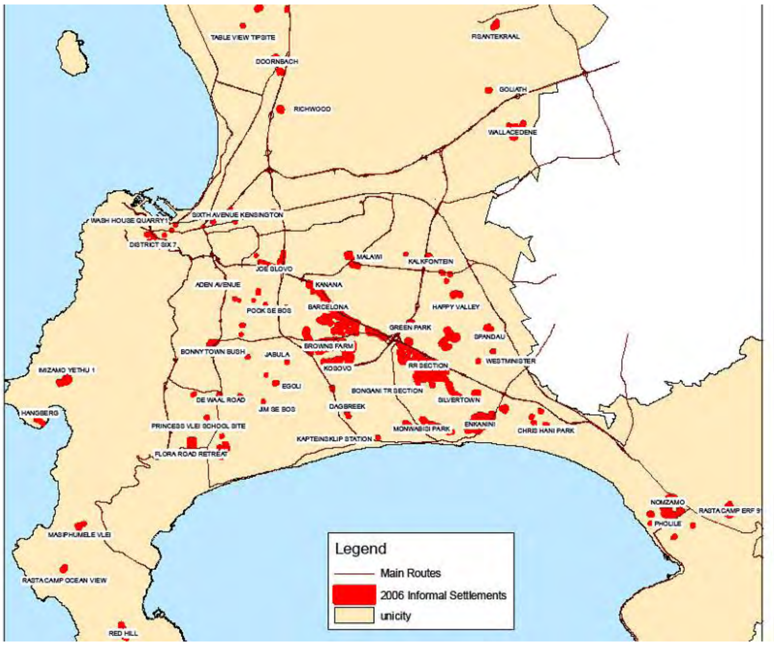
TABLE 1. BACKLOG OF DWELLINGS. (CITY OF CAPE TOWN, 2006)

The number of people living in desperate need of a dwelling of an adequate standard is not known, but with 3,4 persons per household (as described in City of Cape Town, 2005) this could be 885.000, corresponding to 24% of city population. Immigration from rural areas and from other countries put pressure on the informal settlements. The share of households with very low income (below R1.600 per month) is

38% in Cape Town (City of Cape Town, 2007). The total backlog in housing is estimated to be 260.000 (see Table 1).

Figure 1 shows the recorded informal settlements in Cape Town. The largest informal settlements are Khayelitsha with more than 42.000 houses and Philippi with more than 15.000 houses.

In a survey of three informal settlements (City of Cape Town, 2005) it is found that average income was R1.300 per month per household and that 87% had an income below R1.900.



INFORMAL SETTLEMENT BY SUBURB	Count Dec 2005	Count Jan 2004	Count July 2003	Count Feb 2002
ATHLONE (GREATER)	145	84	145	105
ATLANTIS	1615	1580	1517	859
BELHAR	2	2	0	13
BELLVILLE NON URBAN	362	301	74	57
BLACKHEATH	506	450	436	523
BLUE DOWNS	43	25	30	30
CAPE TOWN INTERNATIONAL AIRPORT	522	526	505	510
CROSSROADS	2584	2094	2773	1901
DU NOON	752	623	696	417
GRASSY PARK	12	15	15	8
GUGULETHU	8029	8651	9034	6298
HOUT BAY	2001	1845	2609	1602
KENSINGTON/ MAITLAND	69	61	83	70
KHAYELITSHA	42170	40007	33264	30422
KUILSRIVER	206	174	146	140
LANGA/ KEWTOWN	3759	4937	5634	4749
LANSDOWNE	15	17	9	10
MACASSAR	285	245	353	271
MALMESBURY NON URBAN	99	95	94	107
MANENBERG	0	1	4	1
MELKBOSSTRAND	46	41	56	52
MFULENI	3557	2493	2960	3013
MILNERTON	1992	1948	2170	1470
MITCHELL'S PLAIN	578	375	384	359
MODDERDAM	360	296	280	258
MUIZENBERG	22	17	14	142
NOORDHOEK	831	697	594	430
NYANGA	4150	3519	3509	3984
OCEAN VIEW	18	13	12	14
OTTERY	97	98	108	101
PELIKAN PARK	11	14	17	21
PHILIPPI	15114	14335	17272	14168
RETREAT/ LAVENDER HILL	39	24	24	28
SCHAAPKRAAL	406	370	486	351
SCHOTSCHEKLOOF	21	25	17	14
SIMONSTOWN	188	126	216	88
SIR LOWRY'S PASS	394	326	345	384
SOMERSET WEST NON URBAN	344	321	314	319
SOUTHFIELD	37	15	33	20
STRAND	4559	5758	6479	6953
VISSERSHOEK	172	204	233	191
WALLACEDENE	1888	2202	3975	3221
WOODSTOCK/ ZONNEBLOEM	31	22	32	10
TOTAL	98031	94972	96951	83684

FIGURE 1. LOCATION OF INFORMAL SETTLEMENTS IN CENTRAL CAPE TOWN

Electricity supply

Although settlements may be informal, the City of Cape Town has a policy of supplying electricity to residents if possible. This practise excludes informal settlements that are on private land, on areas that have been designated for development within 5 years, areas on servitudes and settlements in national parks.

In practice six groups of electricity supply can be described as in Table 2.

	Legal	Illegal, but paying (extension cord)	Illegal, not paying
Electricity officially supplied	X	(X)	(X)
Electricity not officially supplied, but planned		X	X
Electricity not officially supplied and not planned		X	X

TABLE 2. DIFFERENT GROUPS OF ELECTRICITY SUPPLY

Illegal connections that pay for consumption are typical supplied through an extension cord. This is an unsafe and unstable supply. The fee paid to the household supplying the electricity is often overpriced.

We have not yet received information about the distribution among the different categories, but understand that in the order of 25% of the informal settlements (25.000) are situated on land where electricity will not be supplied.

Tariffs

Tariffs for electricity distributors are regulated by the National Energy Regulator of South Africa (NERSA) and are based, in principal, on the core concepts of economic efficiency and cost reflective pricing. Exceptions are allowed when implementing certain government policies with specific reference to supplying electricity to low income households. This provides flexibility for the distributor to cross-subsidise low-income groups as occurs in Cape Town at present.

In order to ensure an efficient allocation of new capacity and reduced demand correct pricing is essential. Tariffs should send the correct price signals to consumers, but remain practical for utilities and consumers. There are four criteria that should be met to achieve this;

- marginal costs are reflected in the tariff,
- recovery of total costs,
- ease of computation and transparency
- fairness (Andersen, et al, 2006)

The marginal cost of supplying electricity varies e.g. with total demand and are influenced by the availability of power plants and transmission lines. Such variance can be passed to industrial customers with interval or time-of-use meters. However for small households with a simple meter it is difficult to transmit the price signal of low and high prices off and on peak.

If the (constant) household tariff is below the marginal cost in peak periods, the price can be said to be distorted, however, the cost of improving this can be too high, e.g. costs for installing more advanced meters.

According to the Cape Town Electricity Department there is no clear idea of what a truly cost reflective tariff for households would be. (It is very difficult to define this, which is why it is important that this is defined in generation and transmission costs in order that correct price signals reach final consumers in some form.) The current tariff in Cape Town is built around previous tariffs, cross subsidies for low income groups and ease of administration. The tariff examples in this catalogue address the last two principles of a good tariff as it is assumed that total costs are recovered in the present tariff system. The determination of marginal costs being reflected in the tariff is not addressed as it is not in the scope of this report to determine this. Current regulation of the power system in South Africa suggests that marginal costs of production may not be reflected in tariffs. Pollack, M. (undated) refers to a marginal cost of production from the new diesel-fired peaking plants of R1.00. This is not reflected in tariffs in Cape Town.

One way of reducing distortion of simple tariffs is to implement DSM activities targeted at reducing demand in peak periods.

Cape Town tariff with Free Basic Electricity

Currently two tariffs are widely used amongst households in Cape Town: 190.000 households use Domestic 1, which is for households using more than an average of 600 kWh per month, and 333.000 households uses Domestic 2, which is for households using fewer than 600 kWh per month on average. The two tariffs are illustrated in Figure 2. With a consumption of 600 kWh/month the two tariffs give the same total costs.

Domestic 2 includes 50 kWh/month of free electricity for households purchasing 400 kWh or less per month. This tariff does not have a service charge, but the variable energy charge is higher than for Domestic 1. Households may choose which tariff they wish to be charged by irrespective of their consumption. Average monthly consumption for consumers is checked annually and users are advised to change tariff if appropriate for them. Staying on Domestic 2 if consumption exceeds 600 kWh/month is more expensive for the consumer than changing to Domestic 1.

A simple Excel model has been constructed to analyse different tariff designs. The current Domestic 1 and 2 have been assessed, and alternative models have been tested and calibrated to give the same total revenue as Domestic 1 and 2 give today.

The electricity cost is calculated for 95 segments of different consumption: 0-10 kWh/month, 10-20 kWh/month, etc. the highest interval is 940-950 kWh/month

In the current version the number of users in each interval has been made to give 333.000 users on Domestic 2 (below 600 kWh/month) and 195.000 users on Domestic 1 (above 600 kWh/month). Furthermore the intervals between 0 and 400 kWh/month have been selected to reflect the information from the database provided by the Department of Electricity (see appendix 3).

	Number of users	Number of users in intervals of 10 kWh/month
0-50	13.333	2.667
50-100	17.333	3.467
100-150	20.000	4.000
150-200	24.000	4.800
200-250	26.667	5.333
250-300	26.667	5.333
300-350	26.667	5.333
350-400	26.667	5.333
400-600	151.667	7.583
600-950	190.000	5.550

TABLE 3. NUMBER OF USERS

The current tariffs have been translated into a number of variables, see table 4.

Input	Domestic 2	Domestic 1	
Energy charge	0	36,72	c/kWh
Energy charge	48,94		c/kWh
Service charge	0	2,39	R/Day
Free electricity	50		kWh/month
End free electricity	450		kWh/month
End tariff Domestic 2	600		kWh/month

TABLE 4. VARIABLES FOR THE CURRENT TARIFFS DOMESTIC 1 AND 2 (THE TWO ENERGY CHARGES FOR DOMESTIC 2 CORRESPOND TO THE TWO PARTS (E.G. BELOW AND ABOVE 50 KWH/MONTH).

The output from the model is a table (see table 5) and a graph (see figure 2).

Subsidy (0-600):	15,9	MR
Total revenue, energy	105,8	MR
Total revenue, service	14,4	MR
Total revenue	120,2	MR

TABLE 5. OUTPUT FROM MODEL

The subsidy has been calculated as the difference between Domestic 1 and 2. In this way Domestic 1 is considered as a cost reflective tariff. It should be noted that this is a (crude) assumption.

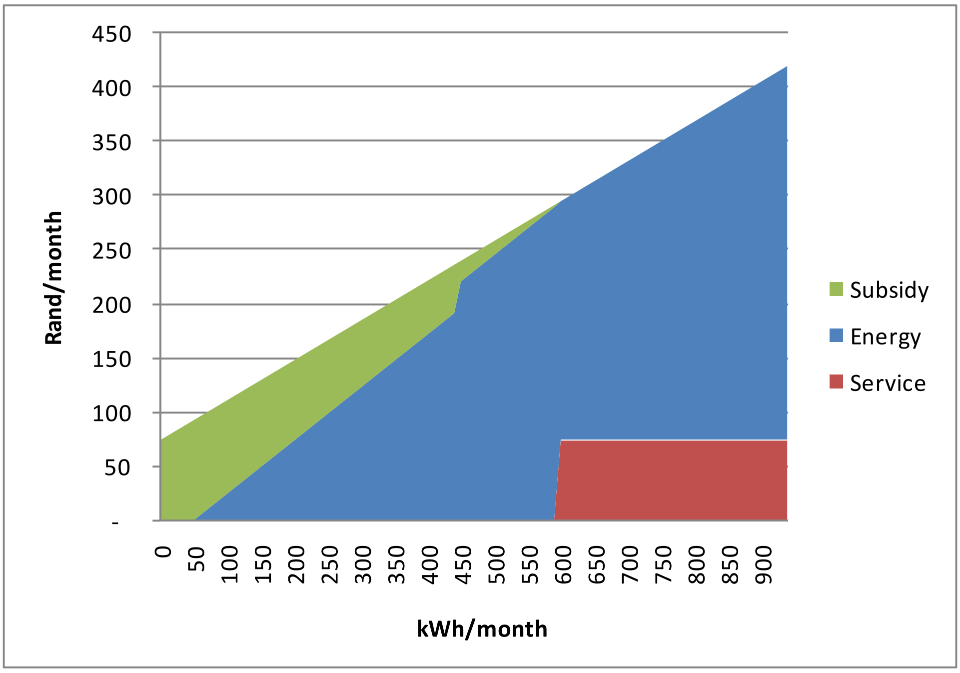


FIGURE 2. ILLUSTRATION OF THE TOTAL COST OF ELECTRICITY WITH THE CURRENT TARIFFS DOMESTIC 1 AND 2.

The two tariffs are well designed. Positive aspects are:

- Smooth costs curve
- Highest subsidy for lowest use (highest subsidy at 50 kWh/month)
- High variable cost instead of service charge in the range 50-600 kWh/month

Critical comments to the design of the tariff include:

- Zero variable cost at low interval (0-50 kWh/month): No incentive for economical behaviour
- Subsidy to quite high demand. Subsidy ends at 600 kWh/month. Many medium income households consume electricity in this range
- Jump in costs at 400 kWh/month purchased (450 consumed). One extra kWh means loss of the free 50 kWh – a value of R24.47.
- The difference between the two tariffs may be difficult to understand for end-users. The service charge may be misunderstood as costly (if not taking the reduced variable cost for Domestic 1 into account)
- Favours one person homes and small families in all income groups

As noted we generally find the tariff well designed. The jump at 400 kWh helps reducing the subsidy for high electricity users.

Alternative 1: Simple tariff

The Excel model is well suited to test an alternative definition of Domestic 2. One example could be to simplify the two tariffs into one. By removing the service charge from Domestic 1 and giving the 50 kWh free basic electricity to all, but increasing the energy cost – the total revenue can be maintained.

Input	Domestic Simplified	
Energy charge	50,48	c/kWh
Service charge	0	R/Day
Free electricity	50	kWh/month

TABLE 6. ALTERNATIVE, SIMPLE TARIFF THAT CREATES THE SAME TOTAL REVENUE.

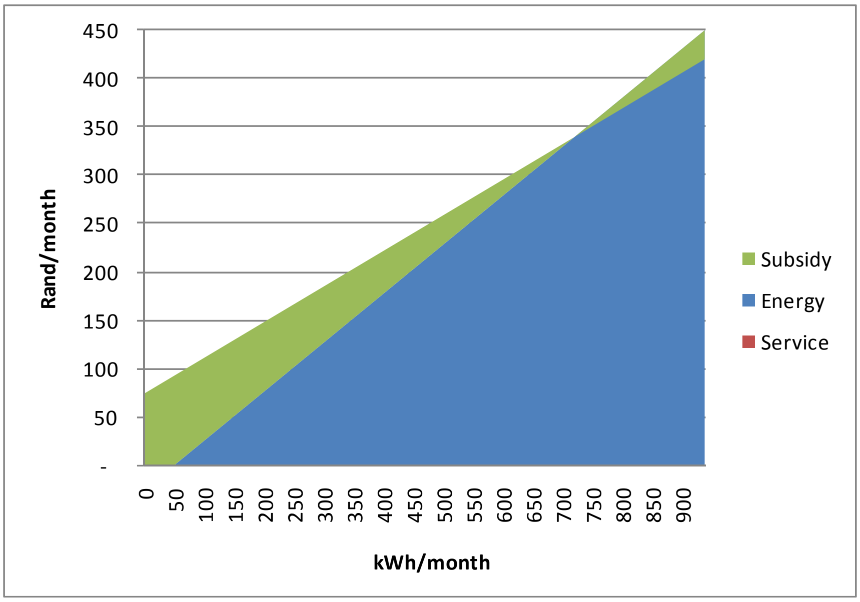


FIGURE 3. ALTERNATIVE 1, SIMPLE TARIFF. NOTE THAT THE TOTAL PAYMENT IS THE BLUE AREA UP TILL 715 KWH AND FOR HIGHER DEMAND IT IS THE UPPER LINE. THE GREEN AREAS IS A SUBSIDY (COMPARED TO THE CURRENT DOMESTIC 1 TARIFF), WHICH REDUCES THE COST BELOW 715 KWH/MONTH, AND INCREASES THE TOTAL COST ABOVE THIS VALUE.

Subsidy	15,8	MR
Total revenue, energy	120,2	MR
Total revenue, service	-	MR
Total revenue	120,2	MR

TABLE 7. OUTPUT FROM MODEL. SIMPLIFIED TARIFF

The positive factors of alternative 1 are:

- Easily understood by customers
- Easy administration
- Wider targeting ensures maximum of low income households receive benefits
- Increased marginal price (mostly for Domestic 1 users) increases incentive to save electricity

Critical comments of alternative 1 are:

- Steep increase in price after 50 kWh may result in households utilising alternative fuels
- No incentive to be economically efficient with the first 50 kWh

- Subsidy at high demand
- Favours one person homes and small families in all income groups

Alternative 2: Slow start

The current Domestic 2 has a high variable price in the range 50-600 kWh/year. The high price is in exchange for the service charge.

An alternative design would be to let the variable price increase smoothly from 0 to its final value. This could be modelled as shown in figure 4.3: An asymptotic function. To reach the same total revenue the asymptotic value is set to 55,59 c/kWh.

Demand (kWh/month)	Energy charge (c/kWh)
0	0
50	0
100	27,8
200	41,7
400	48,6
600	51,0
800	52,1

TABLE 8. EXAMPLES OF ENERGY CHARGE WITH ALTERNATIVE 2.

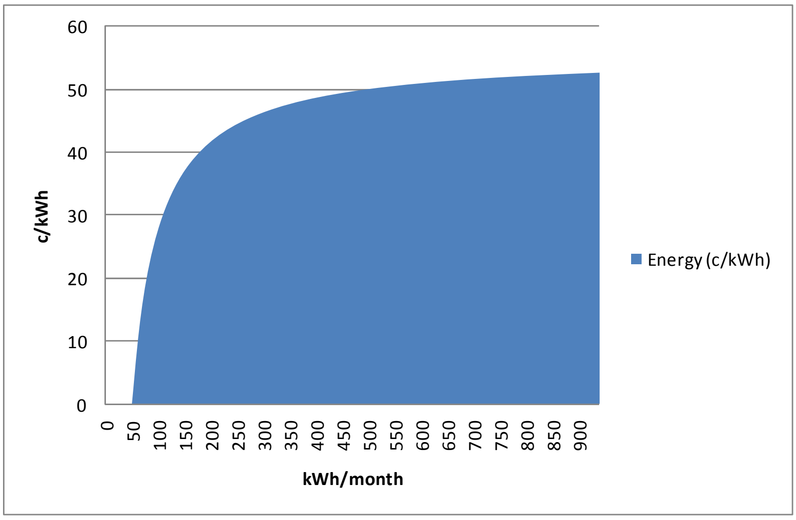


FIGURE 4. ALTERNATIVE TARIFF WITH A SLOW INCREASE IN THE VARIABLE PRICE.

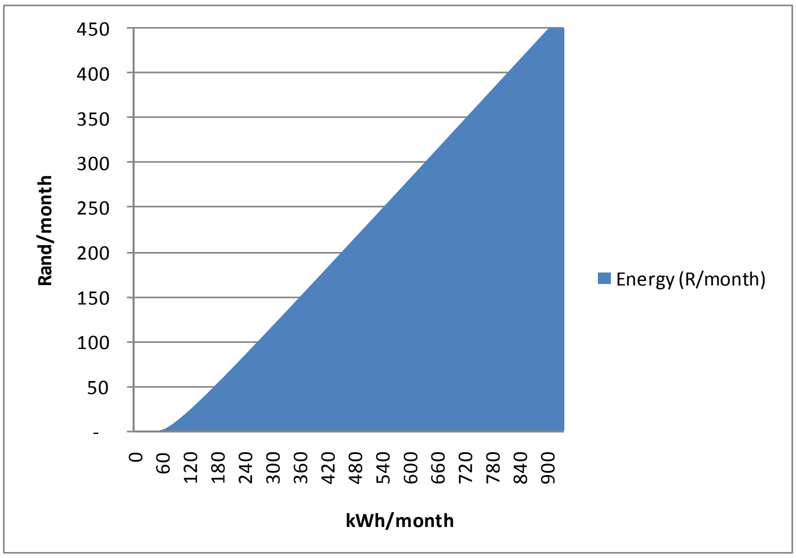


FIGURE 5. ELECTRICITY COST PER MONTH WITH TARIFF ALTERNATIVE 2.

Subsidy	15,8	MR
Total revenue, energy	120,2	MR
Total revenue, service	-	MR
Total revenue	120,2	MR

TABLE 9. OUTPUT FROM MODEL. ALTERNATIVE 2.

Advantages of alternative 2 are:

- Gradual increase in price per kWh. Smooth start at 50 kWh/month and no jump 450 kWh/month
- Reduces incentive for using alternative fuels
- Encourages energy efficiency

Critical points of alternative 2:

- More complicated tariff system for customers to understand
- Increased cross subsidisation in system

Comparison

Three different sets of tariffs have be analysed here: The current tariffs (Domestic 1 and 2), and a simplified tariff and a tariff with "a slow start".

All three models have the same electricity sales. All three have 50 kWh/month free electricity. All three have the same total revenue[1].

[1] The recovery of total costs in the current tariff system is assumed in the current tariff system, which is why the income from the alternatives is set to be the same.

	Current tariffs Domestic 1 and 2	Alternative 1: Simplified tariff	Alternative 2: Slow start
Ease of computation	Yes	Yes	Yes
Easy to understand	Shift between two tariffs, and jump at 450 kWh/month is somewhat complicated	Yes	Variable price requires a table or a graph
Fairness	Yes	Yes	Yes
Highest energy charge	50-600 kWh/month	Same charge (above 50 kWh/month)	Increasing asymptotic to highest value
Jump in payments?	Yes at 450 kWh/month	No	No
Subsidy (compared to current Domestic 1)	Yes, until 600 kWh/month, highest below 450 kWh/month	Yes, until 700 kWh/month, and (marginally) extra cost for users above 700 kWh/month	Yes, until 680 kWh/month, and (marginally) extra cost for users above 680 kWh/month
Service charge	Yes above 600 kWh/month	No	No
Legally acceptable?	Yes	Yes	Yes
Low energy charge for low income households – where use of paraffin is an option?	No	No	Yes

TABLE 10. COMPARING THE THREE TARIFFS

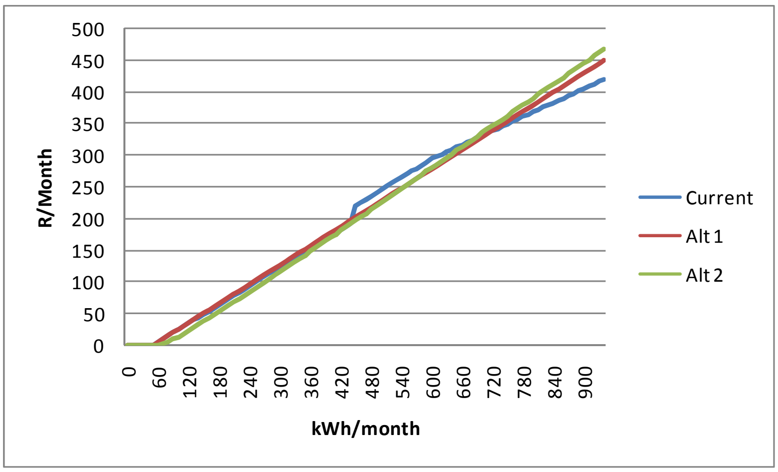


FIGURE 6. COMPARISON OF THE THREE TARIFFS

Comparing the three tariffs (in figure 6) shows that the differences in total costs are moderate. For users with a high demand some difference can be seen.

Energy use in low income households

Electricity use in informal settlements varies a lot. In some houses electricity is only used for lighting, radio and ironing. Electricity for these purposes can be supplied within 10 kWh per month if CFL's are used for lighting. Other end-uses such as cooking, refrigeration and TV each requires in the order of 50 kWh per month (with medium to low efficient equipment). Space heating can be up to 25 kWh *per day* in winter in an uninsulated shack.

Electricity is a very efficient energy type for most end-uses. For lighting, a traditional light bulb is much more efficient than a paraffin lamp. For the same amount of light the incandescent bulb only requires a fraction of the energy. A CFL is five times more efficient than the tradition bulb. Although the CFL is more costly to buy the total cost are much lower.

Electricity is more efficient for cooking than alternative fuels (70-80% compared to 40-60%).

For space heating the energy use by alternative fuels is similar to that of electricity. Burning fuel requires some ventilation, which adds to the energy consumption.

In summary, electricity is superior for lighting, refrigeration, media and other appliances. In energy terms electricity is moderately better for cooking, while for space heating the difference is even smaller.

Many low income households with access to electricity still use paraffin for cooking. Some say that it is because it is cheaper; however this seems not to be true (see table 11). It can be difficult for households to compare prices for two energy types with different units (kWh and litres) and with different efficiencies.

Table 11 also illustrate that the current tariff, Domestic 2 where the service charge is exchanged with a higher variable price, makes electricity more expensive.

Energy type	Per traded unit	Unit	Per kWh	Efficiency when cooking	Per kWh in food	Compared to Domestic 2
Electricity, Domestic 2	0,4894	R/kWh	0,49	71%	0,69	100%
Electricity, Domestic 1 *	0,3672	R/kWh	0,37	71%	0,52	75%
Paraffin	6,00	R/Litre	0,51	40%	1,28	186%
LPG	16,66[2]	R/kg	1,30	63%	2,07	300%
Ethanol gel	6,00	R/Litre	0,86	45%	1,90	276%
			R/kWh		R/kWh	

TABLE 11. ENERGY COSTS FOR COOKING. EFFICIENCIES FROM COWAN (2006). LPG PRICE FROM POLLACK.
*** SERVICE CHARGE NOT INCLUDED**

In table 11 actual end-user prices are used. Howells et al. (2005) and Pollack (undated) point out that the electricity tariffs may not be truly cost reflective. If electricity mainly is used during peak periods and the electricity system has a tight capacity balance, then the tariff may severely underestimate the cost of supplying electricity. They find that use of LPG is more economical, when including the cost of new electricity capacity or generation of electricity on the most expensive plants. Howells and Pollack both quote peak generation prices in the order of R1/kWh, but were written before the large price increases in LPG

[2] Price on 14 June 2007 from retailer, (Cape Argus)

caused by increasing oil prices and increased demand. This along with the unfortunate planning involved in Eskom's role out of LPG for low-income households should be considered before recommending LPG for use by poor families.

Paraffin has been exempted from VAT since 2001. With the high security risk related to paraffin, this practise can be questioned. If LPG or ethanol gel was broadly available as viable alternatives this subsidy should end.

Energy use

In Table results of a survey in an informal settlement show that many different appliances are present. In Table the energy type for cooking, lighting and heating is described for three informal settlements.

Electric lights	82%
Iron	75%
Electric kettle	70%
Electric stove	65%
TV	63%
Fridge	58%
Paraffin stove	57%
Radio	54%
Cell phone	50%
Paraffin heater	40%
Music system	39%
Paraffin lamps	33%
Video	15%
Telephone	14%
Microwave	13%
Washing machine	12%
Electric heater	12%
Gas stove	12%
Fan	8%
Imbhawula (brasier)	4%

TABLE 12. TYPES OF APPLIANCES IN USE IN KHAYELITSHA (LLOYD AND COWAN, 2005)

Note that a number of these energy uses are only possible with electricity: TV, fridge, radio, cell phone, music system, video, microwave, washing machine and fan. TV, radio and music systems can be powered by car batteries.

	Paraffin	Electricity
Light	32%	68%
Cooking	56%	44%
Warmth	79%	21%

TABLE 13. TYPES OF ENERGY USED FOR BASIS FUNCTIONS (CITY OF CAPE TOWN, 2005)

Safety

Energy and safety is highly related.

Electricity can be lethal if not managed properly. The extension cord style of electricity connection which is often used in informal settlements does not fulfil standard electricity safety requirements. Households without electricity may be tempted to connect to other installations, e.g. traffic light or street light. Such activities can be highly dangerous and do cost lives.

However, the use of paraffin is without doubt the most serious safety concern for low income households. The Paraffin Safety Association of South Africa does not give exact numbers on the people killed or injured by paraffin, but say "the number is unacceptably high and runs into many thousands of incidents every year". The injuries include poisoning of children, respiratory diseases and burns.

Paraffin stoves have been proven to be highly unsafe and many have been withdrawn from the marked due to new standards. Paraffin stoves that do not meet SANS 1908 have been banned since January 2007, and those that do not meet SANS 1243 will probably be banned from January 2008.

For households living in shacks the threat of fire is very real. Shacks are often made of wood and are placed so closely that fire quickly spreads through an area.

In the report about basis electricity support tariffs (University of Cape Town, 2002 and 2003) the health impact of using paraffin is analysed as well as the economic costs of paraffin for South Africa. Hospital treatment costs related to paraffin is estimated at R330 million per year. Although uncertain, analyses indicate that more electricity for cooking can reduce this in the order of R70 million though fewer Lower Respiratory Infections (LRI) caused by paraffin smoke.

Ethanol gel is an alternative to paraffin. Gel is a safe fuel is the way that fires is unlikely to happen. Concerning indoor climate some concern still exists (Lloyd, 2007). Burning gel is not as clean as burning LPG.

Energy efficiency activities in Cape Town

Awareness of the importance of energy efficiency has increased in recent years in South Africa due to the capacity problems the country is experiencing. Despite this there is little regulatory leeway for distributors to implement energy efficiency activities.

In low income households it is seldom economically efficient to introduce highly technical solutions, such as solar water heaters, as consumption is invariably to low to justify this and because the pressure low income households put on the system in peak periods is much lower than larger customers. In Cape Town low income households contribute less than 10% of total peak demand, which indicates that it is not in this group of consumers that the most economic savings are to be found. Energy efficiency in low income households is, however, not only about saving kWh's. Increased efficiency in this consumer group can result in improved quality of life due to receiving improved energy services for the same amount of money, thereby reducing energy poverty and making funds available for other necessities.

Low tech solutions and behavioural programmes should be implemented in low income areas. These could include a continuation of the CFL programme, education on how electricity functions, how meters work, how to read and understand electricity bills, knowledge of which appliances consume more electricity and the real price of electricity in relation to other fuels. Behavioural programmes that encourage consumers to switch of light bulbs during the day and when no one is in the room could form an important part of an energy efficiency drive.

Consumer needs and wishes must be taken into account in these programmes. Though very limited in statistical accuracy, it appears that many low income households may have discarded their CFL as the light output of the 15W CFL is significantly less than that of the 100W incandescent, which is therefore preferred. The same light output is achieved through a 20W CFL. There have been reports that the quality of the CFLs distributed under some DSM campaigns has been low, which resulted in many CFLs failing. This undermines the effectiveness of the DSM campaign as savings are not realised. Failures of distributed CFLs due to low quality can have a serious influence on consumer confidence in the product and result in reluctance to purchase CFLs in the future.

Smart meters and more technical solutions should be implemented in higher income groups with a large demand e.g. over 20,000 kWh annually. Behavioural patterns may also have a marked effect in this group. A simple example of this is that swimming pool pumps are responsible for 1% of peak demand (Eskom, 2007). This load is easily shifted and would have an effect similar to saving 10% of low incomes total peak consumption.

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FIGHTING ENERGY POVERTY IN CAPE TOWN

Appendices

Appendix 1: Energy situation

There have been numerous interruptions, both planned and unplanned, in power supply in South Africa over the past few years. These interruptions have two main causes; a lack of generation capacity in peak periods and problems at distribution level due to aging infrastructure and theft of pylons and lines.

In Cape Town there were major interruptions in 2005/6 due to the failure of a generator at Koeberg Power Plant, which resulted in widespread load shedding in the area over a period of six months. Since then Cape Town has not been badly affected by load shedding with the only planned interruptions occurring in January 2007 as shown in figure 1.1 below. If there have been other interruptions in power supply in Cape Town they have not been due to brownouts.

There have, however, been wide scale brownouts in other regions in South Africa due to a lack of generating capacity at peak periods. Load shedding occurs both in summer and winter periods, which indicates that the problem is acute and that minor fall outs in the power system lead to power interruptions. A DSM programme is in place that attempts to address the need for generating capacity, but the targets are modest considering the seriousness of the capacity crisis in South Africa. The annual DSM target is 152 MW, or 0,4% of peak demand. There is a target over 20 years to implement 4.255 MW of DSM, or 12% of current peak demand.

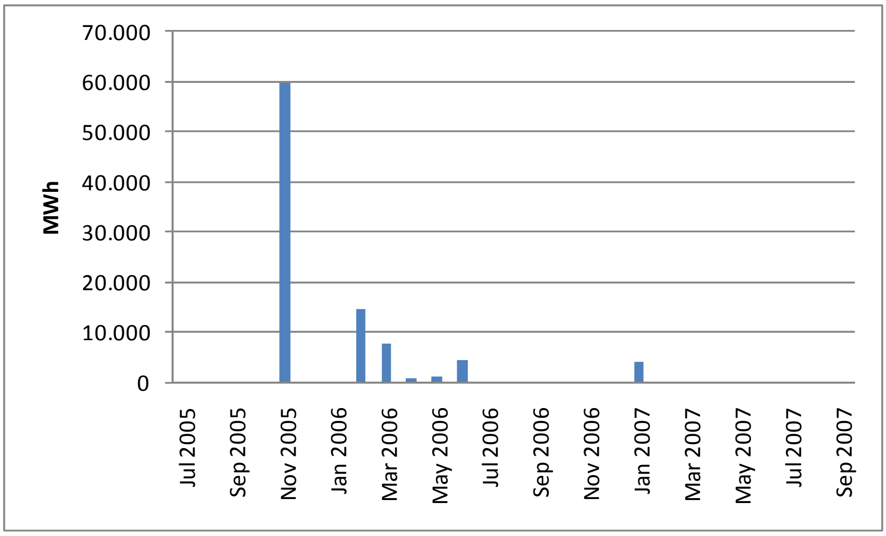


FIGURE 1.1. LOAD SHEDDING IN THE CAPE TOWN AREA

The daily load curve for Cape Town is shown in figure 1.2 below. The interesting points to note on the load curve are that the curve is relatively flat during the day with consumption in the middle of the morning only marginally lower than the absolute peak in the evening and that the winter peak is only 20% higher than the summer peak.

These load patterns indicate that there is a large constant consumption outside of cooking in the domestic sector and that energy efficiency initiatives may have equal economic value in cooking as in other areas. This could indicate that promoting alternatives to electricity for cooking in low-income households has no greater economic value than reducing consumption in water geysers and pool pumps in peak periods.

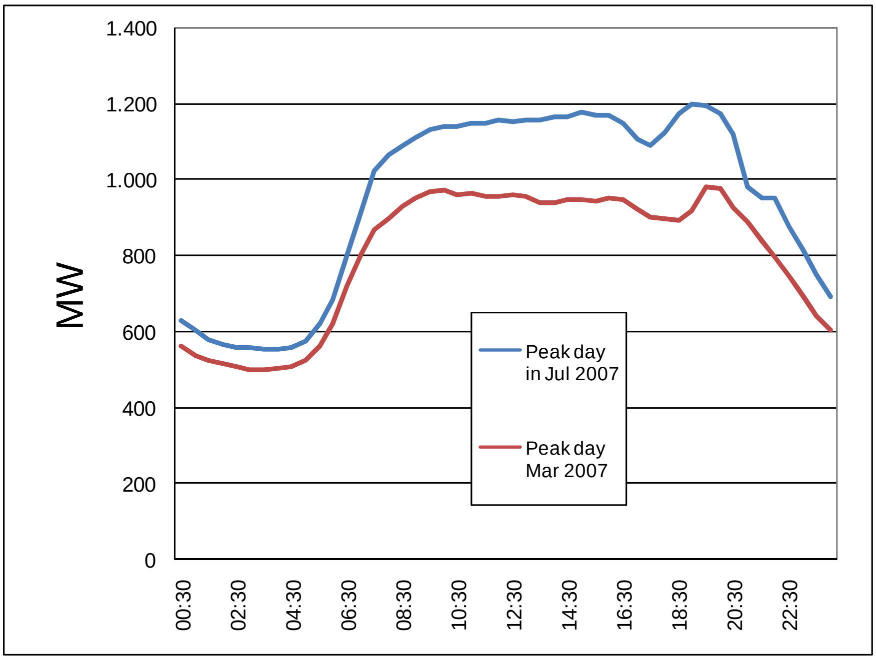


FIGURE 1.1. LOAD CURVE FOR CAPE TOWN METRO. UP SCALED TO COVER THE COMPLETE SUPPLY AREA.

Appendix 2: Regulation for electricity tariffs in South Africa

Electricity pricing in South Africa is averaged over the entire system at TOU rather than utilising marginal costs at TOU (NER, 2006). This practice distorts the true cost of production by reducing the apparent costs of new generation, which results in the demand price for electricity in peak periods being lower than the cost of generation. This practice is a generation-orientated solution to capacity problems, the result of which can be costly and lead to too much generation capacity and too little energy efficiency. In the long-term increased consumption will be encouraged in order to utilise overinvestment in generation capacity. This has been experienced in South Africa before in the 1970's, '80's and '90's. It appears that history may well repeat itself if this form for regulation continues.

This system reflects a "tragedy of the commons" scenario as no single distributor receives benefits for implementing energy efficiency initiatives as a bulk consumer. Instead increased sales leads to increased income for distributors whilst the additional system costs are divided between all participants whether they have contributed to the increase or not. The only acknowledgement of cost differentials is in transmission charges, which are divided into three tariffs dependent on the distance from Johannesburg.

It is most likely that Cape Town benefits from this averaging of prices due to its geographical positioning compared to the major generation plants. Despite this it is in Cape Town's interest to make consumption as efficient as possible. Generating capacity in the Cape Town area functions as an anchor for the electricity system in the region. Disturbances in this generating capacity may lead to large swings in voltage and power flows that can damage sensitive equipment and ultimately lead to blackouts in Cape Town and surrounds. This was highlighted by the electricity crisis in 2006. This situation could be reflected through the domestic electricity tariff and in DSM activities.

In domestic tariff structures it is more acceptable to use average pricing for smaller consumers in order that tariffs are understandable for the average consumer and that a level of fairness is maintained in the tariff structure as supplying very small consumers is more expensive than supplying larger consumers. This practice provides a level of protection against high prices for low income households. It should, however, be considered that larger consumers put a greater pressure on the electricity system during peak periods, which necessitates greater peaking capacity. This should be reflected in domestic tariffs for large domestic consumers in a system with limited capacity.

In practice the regulator utilises historical tariffs and benchmarks in assessing tariff proposals from distributors based on the guidelines mentioned above (NERSA, 2007). The variable cost of bulk electricity purchased by distributors is averaged out by being considered as a single, bulk expense rather than a variable. This could be a case of the regulator removing necessary price signals to distributors as there is no incentive for distributors to carry out DSM activities or streamline operations as revenue will be reduced accordingly. This does not necessarily reflect the current capacity crisis in South Africa and represents a generation orientated regulatory practice.

Appendix 3: Analyses of electricity purchase with free basis tariff

Department of Electricity have provided us with a database about purchase of electricity for users on Domestic 2 that have received the 50 kWh free electricity. This is mainly uses with consumption below 400 kWh per month. In some case a higher purchase take place. The possibility to receive the free electricity exists for users that for 12 month have an average consumption below 400 kWh/month (equal to a yearly purchase below 4.800 kWh).

The database includes the monthly purchase of electricity for 192.468 users from October 2006 to October 2007. We have used information for November 2006 to October 2007 (the newest 12 month period). Meters still in stock is included in the database, also meters that have been lost, e.g. in shack fires are still in the database. We have deleted all meters without any electricity purchase in the studied period. The active database consists of 163.624 users.

Only a part of Cape Town is covered by this database. The area has approximate 75% of all users receiving free basis electricity in Cape Town.

	In database	In Cape Town
Domestic 2, receiving free basis electricity	163.624 (75%)	217.104 (100%)
Domestic 2, not receiving free basis electricity		116.000
Domestic 1		190.000

TABLE 3.1. OBSERVATION IN DATABASE AND TOTAL USERS IN CAPE TOWN

It can be observed in table 3.2. that 15% of the users are purchasing more than 400 kWh/month (the limit for receiving free electricity). This is possible due to the way in which free electricity is provided. Free Basic Electricity is given to all households on pre-paid meters with an average monthly consumption of 400kWh or less. When a new connection is made it is automatically given Free Basic Electricity in order to ensure that all eligible households receive the subsidy. Consumption for all consumers is checked in June each year and those whose average monthly consumption exceeds 400 kWh lose Free Basic Electricity. However the period included in the database is different from the period where checking takes place (June to June) so some households with an average consumption over 4,800 kWh annually are included.

	Number of users	
1-2.400 kWh/year (-200 kWh/month) 2.400-4.800 kWh/year (200-400 kWh/month) 4.800-7.200 kWh/year (400-600 kWh/month) 7.200 kWh/year or more (600- kWh/month)	21.842 117.542 23.297 943	13,3% 71,8% 14,2% 0,6%
Total	163.624	100%

TABLE 3.2. USERS DIVIDED IN GROUPS ACCORDING TO CONSUMPTION

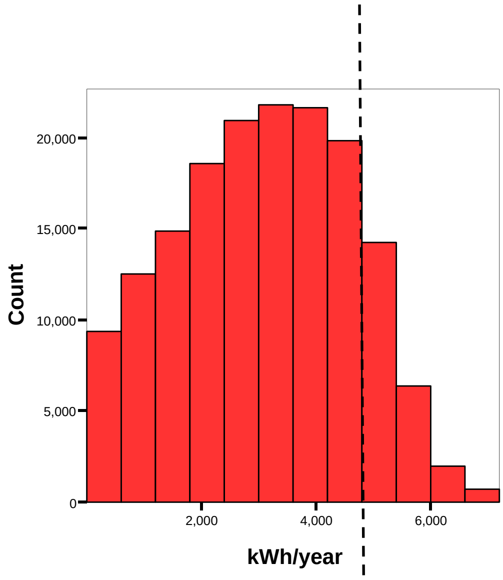
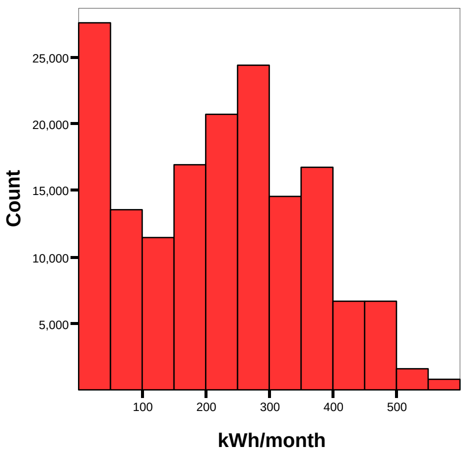


FIGURE 3.1. HISTOGRAM FOR THE YEARLY ELECTRICITY PURCHASE. THE 0,6% OF THE USERS WITH CONSUMPTION ABOVE 7.200 KWH/YEAR ARE NOT INCLUDED IN THE FIGURE. X-AXIS IS YEARLY PURCHASE (IN 600 KWH INTERVALS). Y-AXIS IS NUMBER OF USERS. THE DASHED LINE INDICATE THE PURCHASE OF 4.800 KWH/YEAR (400 KWH/MONTH), CORRESPONDING TO USERS THAN CAN CONTINUE TO RECEIVE THE FREE ELECTRICITY.



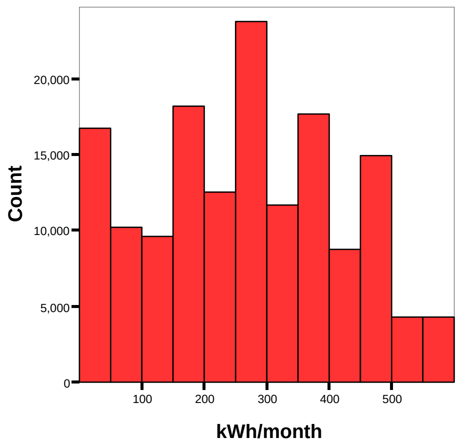


TABLE 3.2. HISTOGRAM FOR THE ELECTRICITY PURCHASE IN JANUARY 2007 (LEFT) AND JULY 2007 (RIGHT). USERS WITH CONSUMPTION ABOVE 600 KWH/YEAR ARE NOT INCLUDED IN THE FIGURE. X-AXIS IS YEARLY PURCHASE (IN 50 KWH INTERVALS). Y-AXIS IS NUMBER OF USERS.

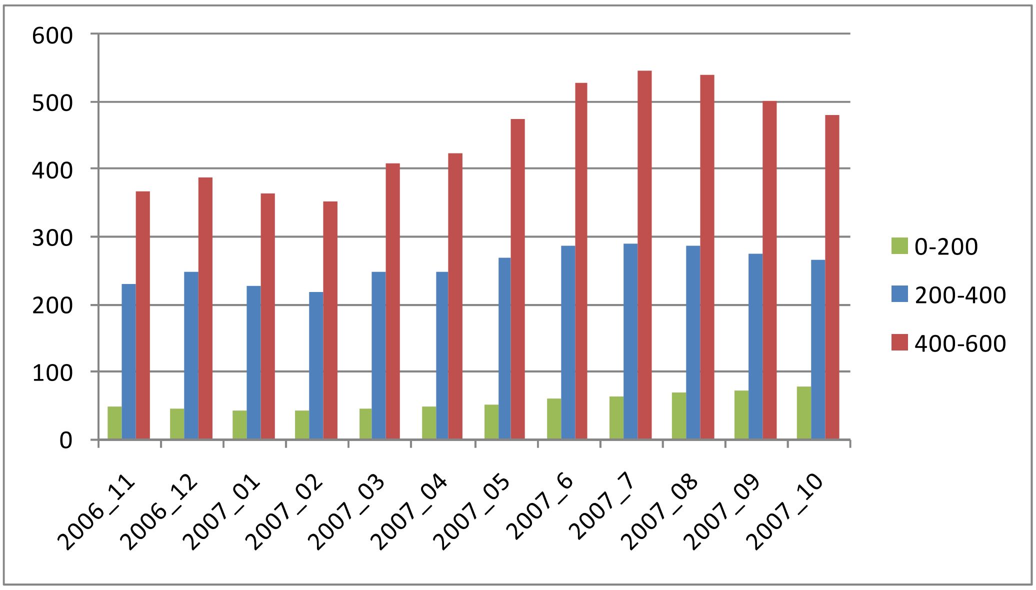


Figure 3.3. Monthly purchase for three groups of users (average consumption 0-200 kWh/month, 200-400 kWh/month and 400-600 kWh/month[3]). Y-axis is kWh/month.

If the users do not buy electricity in a calendar month, they lose the free electricity. They need to purchase some amount each month to obtain the free electricity. In average 12% of the users do not but electricity in a given month. The share is highest in summer, when consumption is lowest. The value of the not required free electricity is in the order of R5,7 million per year, or R35 per average user.

There is a correlation between yearly purchase and the number of month without any purchase: Every time the yearly purchase is increased with 1.250 kWh, the average number of month without any purchase decreases with 1.

[3] These households are included in the database as when a new connection is made it is automatically given Free Basic Electricity in order to ensure that all eligible households receive the subsidy. Consumption for all consumers is checked in June each year and those whose average monthly consumption exceeds 400 kWh lose Free Basic Electricity. However the period included in the database is different from the period where checking takes place (June to June) so some households with an average consumption over 4,800 kWh annually are included.

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