ZIMBABWE ELECTRICITY SUPPLY AUTHORITY (ZESA)

COUNTRY PERSPECTIVE ON RURAL ELECTRIFICATION

Presented at Village Power '98 : ***SCALING UP ELECTRICITY ACCESS FOR SUSTAINABLE RURAL DEVELOPMENT***: 6 – 8 October 1998 Washington DC, USA

*By Alex C.B. Makonwa – **MARKETING AND ELECTRIFICATION MANAGER (ZESA)***

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ALEX C.B. MAKOMVA – MARKETING AND ELECTRIFICATION MANAGER

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Synopsis: ***Zimbabwe's final energy consumption is in nearly equal halves commercial energy and fuelwood. Rural electrification in Zimbabwe aims at addressing the energy problems of the rural population and thereby stimulate new and diversified economic growth in rural areas, create employment and reduce rural urban migration. ZESA's mission statement states "We are committed to the total electrification of Zimbabwe at world class standards and competitive prices", and growth is a key strategic issue of the Authority's Strategic Business Plans.***

Currently only 20% of the Zimbabwean population has access to electricity and electricity accounts for only about 15% of the final energy supply. For over 80% of the urban and rural households in Zimbabwe fuelwood remains the predominant form of energy that is used for basic cooking and heating needs.

The desire to look for sustainable and environmentally friendly alternative sources of energy is the main reason for embarking on rural electrification. This paper highlights the initiative that have been taken in Zimbabwe by the Power utility in conjunction with Government and non-Governmental organisations in promoting rural electrification.

HISTORICAL APPROACH

Rural electrification was initiated in the early 80's, and by 1984, 23 rural growth centres were electrified at a total cost of Z$5,8 million. The next phase of electrification targeted 48 more centres and only 13 of these centres were electrified. Progress in the electrification programme was slow because of high costs and eventually the whole programme was suspended. A review of the programme was made and there was a need for better forward planning focusing on such issues as the correct criterion for choosing centres to electrify and the financing of the programme. The power utility was limited in financial resources coupled with the fact that some of the centres were not financially viable.

RURAL ELECTRIFICATION STRATEGY

The Rural Electrification programme in Zimbabwe is viewed in the wider context encompassing a number of initiatives not only limited to the extension of the National grid by ZESA but also other alternatives in which other organs play a role. The strategies currently being followed in the rural electrification programme are:-

⇒ *Provision of power to rural centres through the extension of the national grid (ZESA initiative)*
⇒ *Provision of power through mini hydro power stations in suitable localities.*
⇒ *Photovoltaic water pumping systems.*
⇒ *Provision of solar power to rural households through the Global Environmental Facility project (GEF initiative).*

RURAL ELECTRIFICATION MASTER-PLAN GRID EXTENSION

Following the suspension of the first rural electrification programmes a review was made by the Zimbabwe Electricity Supply Authority in consultation with Government. A policy and planning study for the electrification of rural areas was made with the assistance of an independent consultant. The study made recommendations of a policy and planning nature which included the following:-

- the selection criteria to be adopted in recommending viable centres for rural electrification. The criteria included economic, financial and other parameters in the determination of viability.
- the specific roles of the various participants involved in the rural electrification programme.
- the financing of the rural service centres that caters for both viable and non-viable centres.

  (viable centres meet the financial IRR of 16% or better)

Funding

Since the financial year 1994/95 the Zimbabwe Electricity Supply authority has been levying 1% on the customer bills and setting aside the money to finance rural electrification. ZESA carries out those RE projects that meet the financial IRR criterion. The Rural Electrification Fund is administered separately from the ZESA account. The fund produces its own set of annual accounts and ZESA has no access to the RE fund except borrowing on strict commercial terms.

The ZESA policy on tariffs is that for each customers category, tariffs should be based on long run marginal costs. With the exception of material connection fees, all customers within a particular category are charged the same tariff nationwide i.e. there are no special tariffs for rural electrification (grid electricity)

Following the approval of the policy and planning document it was necessary to carry out a more detailed technical and engineering study recommending the least cost and effective way of electrifying viable centres up to the year 2010. The study had in addition to carry out the following:-

- on the basis of the policy and planning study prepare projections, identify those centres that can viably be electrified by grid extension.
- prepare a detailed master plan upto the year 2010 showing the most efficient and least cost scenario.
- Prioritisation of viable centres to be electrified up to the year 2010.

A summary of the financial requirements for the RE master plan are shown on Table 1. These figures are based on the 1994 projections and need revision to take into account the current exchange rate.

Table 1
RURAL ELECTRIFICATION MASTERPLAN COST PROJECTIONS

YEAR	CAPITAL EXPENDITURE COSTS Z$	INCOME R.E. LEVY Z$	CUMULATIVE Z$
1994/5	0	22 497 000	22 497 000
1995/6	0	29 385 000	51 882 000
1996/7	44 000 000	37 136 000	45 018 000
1997/8	27 200 000	40 000 000	57 818 000
1998/9	26 500 000	40 000 000	71 318 000
1999/20	30 500 000	40 000 000	80 818 000
2000/1	45 600 000	40 000 000	75 218 000
2001/2	47 000 000	40 000 000	68 218 000
2002/3	57 000 000	40 000 000	51 218 000
2003/4	60 500 000	40 000 000	30 718 000
2004/5	61 400 000	40 000 000	9 318 000
2005/6	62 500 000	40 000 000	-13 182 000
2006/7	62 800 000	40 000 000	-35 982 000
TOTAL	**525 000 000**	**489 018 000**	**-35 982 000**

Implementation of the RE masterplan commenced in 1996/97 financial year, starting with 28 centres that were selected from the masterplan. Good progress has been made so far and the energy consumption at some of the centres are pleasing and Table 2 shows the customer type and total consumption per centre.

Table 2

ITEM	CENTRE	AREA	CUSTOMER CONNECTED (Nos.)					CONSUMPTION (kwh)	
			E1	E2	E3	E4	E5	CURRENT MONTH	YEAR TO DATE
1	Chiendambuya	Northern	24	0	0	28	0	44 576	747 101
2	Sadza	Northern	65	0	0	50		83 715	889 471
3	Madamombe	Northern	4	0	0	6	0	2 906	28 586
4	Mahuhwe	Northern	4	0	0	16	0	15 886	211 820
5	Muzarabani	Northern	53	0	1	21	1	29 197	1 105 337
6	Kachuta	Northern	2	0	0	5	0	519	641
7	Makaha	Northern	Note 1						
8	Mutawatawa	Northern							
9	Bepe	Eastern							
10	Nyaruwaka	Eastern	4	0	0	10	0	8 119	112 426
11	Devedzo	Eastern	28	0	0	5	0	6 652	41 658
12	Madangombe	Eastern	5	0	0	7	0	16 051	84 322
13	Ndanga	Eastern	35	0	0	15	0	29 521	237 426
14	Buhera	Eastern	53	0	0	18	0	18 944	109 957
15	Nyatate	Eastern	17	0	0	7	0	4 927	49 155
16	Maphisa	Western	135	1	1	55	2	129 438	963 601
17	Sipepa	Western	9	0	0	6	0	5 509	36 423
18	Tsholotsho	Western	137	0	1	65	8	150 692	677 576
19	Hwali	Western	17	0	0	13	0	25 019	31 025
20	Nembudziya	Southern	35	0	0	15	0	28 410	34 271
21	Kuwirirana	Southern	6	0	0	2	0	2 947	3 426

Key E1 Domestic Customer
E2 Public Lighting
E3 Mining & Industrial Customers
E4 Commercial Customers
E5 Agricultural Customers

The demand for RE by local communities is growing and to cater for requirements outside the masterplan, a number of financial schemes have been put in place. These schemes are designed to assist and promote self help by local communities. In addition, community participation through provision of labour and in some cases material is taken into account while costing the schemes.

The Zimbabwe Electricity Supply Authority has recognised that the resources required to electrify the whole country through grid electricity are limited. To this end, ZESA acknowledges that other cheaper alternatives need to be explored and the schemes that have been encouraged are outlined below:-

PROVISION OF POWER THROUGH MINI HYDRO POWER STATIONS.

ZESA is involved in the reticulation of an isolated area that is going to be provided with energy from a mini hydro station at Manyuchi Dam in the Southern Eastern part of the country. The mini hydro plant is financed by the E7. Besides this mini hydro plant ZESA has encouraged the commissioning of other mini hydro plants mainly in the Eastern part of the country. It buys excess power from the mini hydro plants and supplies when the plant is down.

Notable Mini hydro plants include:-

- Svinurai mini hydro (10 kW)
- Nyafaru mini hydro (20 kW) and
- Rusitu mini hydro plant

GLOBAL ENVIRONMENTAL FACILITY (GEF) :
RURAL HOUSEHOLD SOLAR LIGHTING SYSTEMS

The GEF solar project administered by the UNDP and the Government of Zimbabwe in conjunction with the Department of Energy was a pilot project expected that time to realize some 9 000 installed solar lighting systems to households in the rural areas. ZESA participated in this programme by installing 500 solar systems varying from 2 to 10 light systems. An innovative payment system was designed and became the most popular payment mode in the country. The Authority is responsible for the maintenance of the systems while the recipients pay monthly. The amount paid is determined by the size of the system installed. The current operating tariff is shown in Table 3.

Table 3

TYPE OF LIGHTS SYSTEM	MONTHLY	QUARTERLY	HALF YEARLY	YEARLY
1 and 2 lights	$70	$210	$420	$840
3 lights	$80	$240	$480	$960
4 lights	$90	$270	$540	$1080
5 lights	$105	$315	$630	$1260
6 lights	$120	$360	$720	$1440
7 lights	$135	$405	$810	$1620
8 lights	$140	$420	$840	$1680
9 lights	$145	$435	$870	$1740
10 lights	$150	$450	$900	$1800

A full project evaluation is currently being undertaken. The outcome will determine whether ZESA will offer solar installation as an option to grid electricity where the chances of grid electricity are currently remote. However, the pilot has created more demand than was anticipated particularly because of the payment system.

MARKETING RESEARCH

In 1996, the Zimbabwe Electricity Supply Authority commissioned a study, which sought to provide information for inputting into marketing decision making. This was part of the Authority's overall review of both technical and marketing aspects of services nation wide.

The marketing research was to be complementary to the rural electrification drive by providing vital information on the state of the market and the tenability of major assumption underlying current strategies. It was vital to review the current strategy in the light of low electrification rates even in the Urban Areas where electrical infrastructure is available.

The Authority postulated a number of factors that might have a direct or indirect influence on consumer choices. These had to be tested and the postulates are summarized as follows:-

- Perceived high cost of electricity. In particular household inability to meet the costs of wiring houses
- Households decision makers inability to afford cost of electrical appliances
- General public ignorance about the utility and the convenience of electricity.
- Market ignorance of the competitive costs of electricity compared to other forms of energy
- A poor corporate image of the power utility aggravated by perceptions of poor services, high cots, unreliable supply and hazards of electrocution.

The main thrust of the full project series is the establishment of a market based data base (both quantitative and qualitative) which could be used as a basis for executive decision making in three major areas.

- Establish market perceptions of ZESA with a view to developing marketing strategies that respond accordingly.
- Determine and forecast respective popularities of each form of energy and the underlying reasons for preference.
- Develop business and strategic marketing plans that respond to market size expectations
- Implement the marketing plan to optimize sales and thereby deepen sales and widen the customer base.

More specific supportive objectives to the first two above could be stated as follows:-

- ⇨ Establish the extent of awareness of and attitudes towards alternative forms of energy
- ⇨ Establish usage habits of various forms of energy and reasons for energy choice.
- ⇨ Estimate broad consumer and customer image of the Authority.
- ⇨ Assess acceptability of various possible approaches to paying for electricity – deposits, consumption. Undertake a socio-economic profiling of the market base.

A clear definition of market segments was undertaken and respondents were drawn from the following:-

- ⇒ Urban households – low and high density
- ⇒ Rural household – selected growth points
- ⇒ Commercial, industrial and mining concerns
- ⇒ Agricultural extensions

SUMMARY OF MAIN FINDINGS

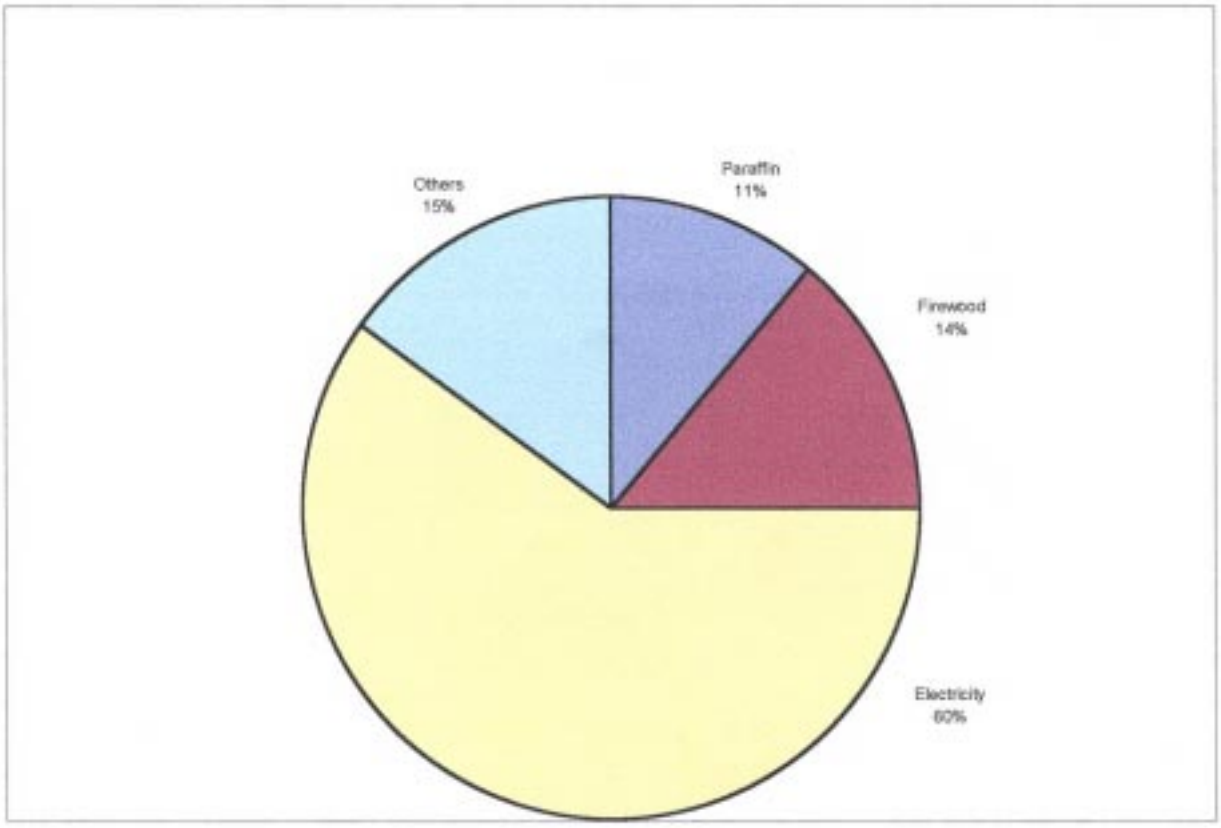
The detailed findings are contained in a separate report but for the purpose of this paper some key highlights of the findings are illustrated below. The terms used in the tables are defined as follows:-

- ➢ Absolute Awareness Index (AAI) - a measure of the level of awareness of each energy use method.
- ➢ Relative Awareness Index (RAI) - implied awareness weighting factor for various energy forms.
- ➢ Absolute Preference Index (API) - degree of preference for a particular energy method.
- ➢ Relative Preference Index (RPI) - ranked preference relative to other methods.

Heating

	RAI (%)	RPI (%)	RPI/RAI (%)
Grid Electricity	29	58	200
Firewood	29	14	50
Paraffin	21	11	50

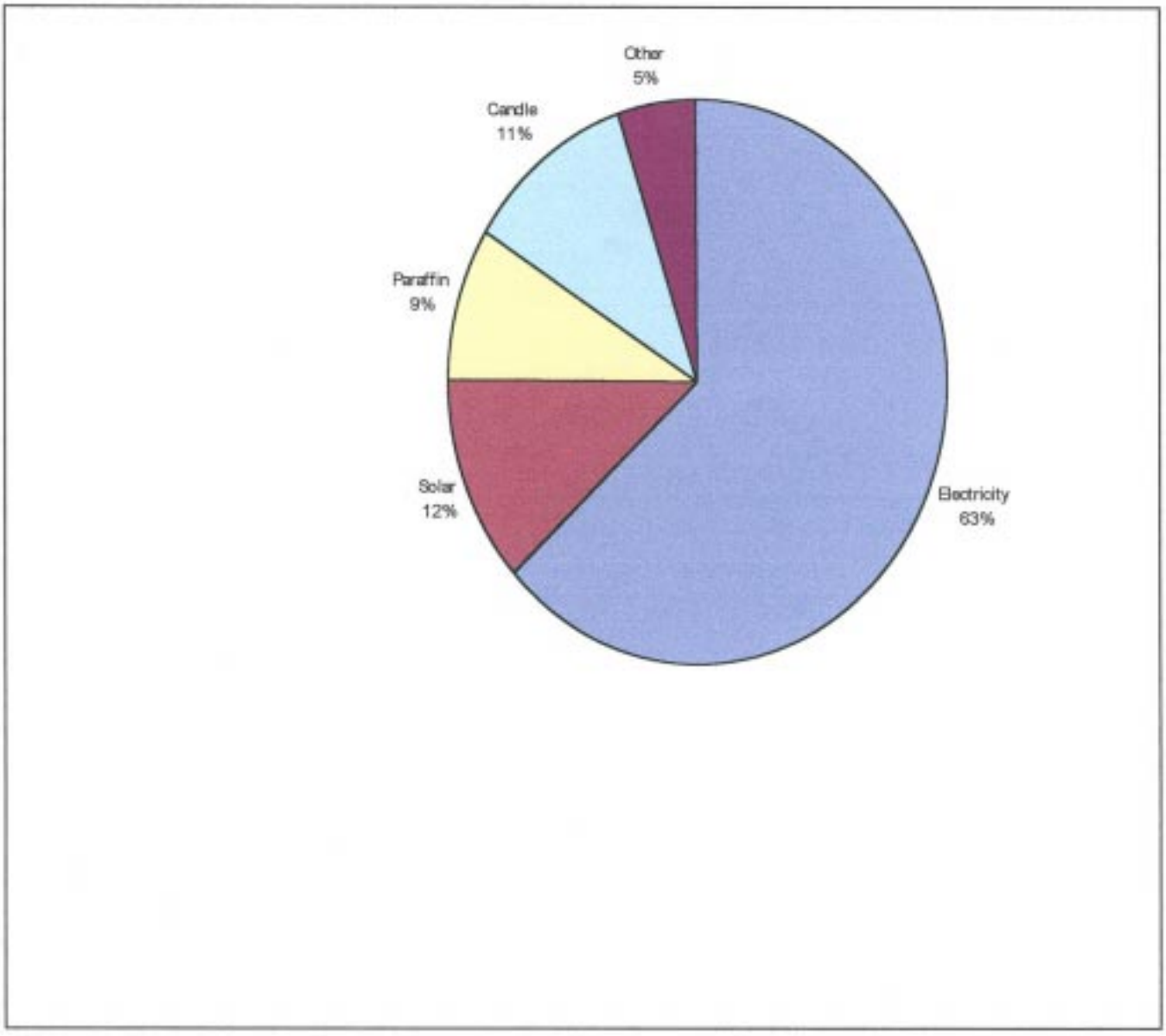
RANKED IMPORTANCE OF HEATING METHODS



Lighting

	RAI (%)	RPI (%)	RPI/RAI (%)
Grid Electricity	29	61	200
Paraffin	25	9	33
Candles	23	11	50
Solar Electricity	9	12	133

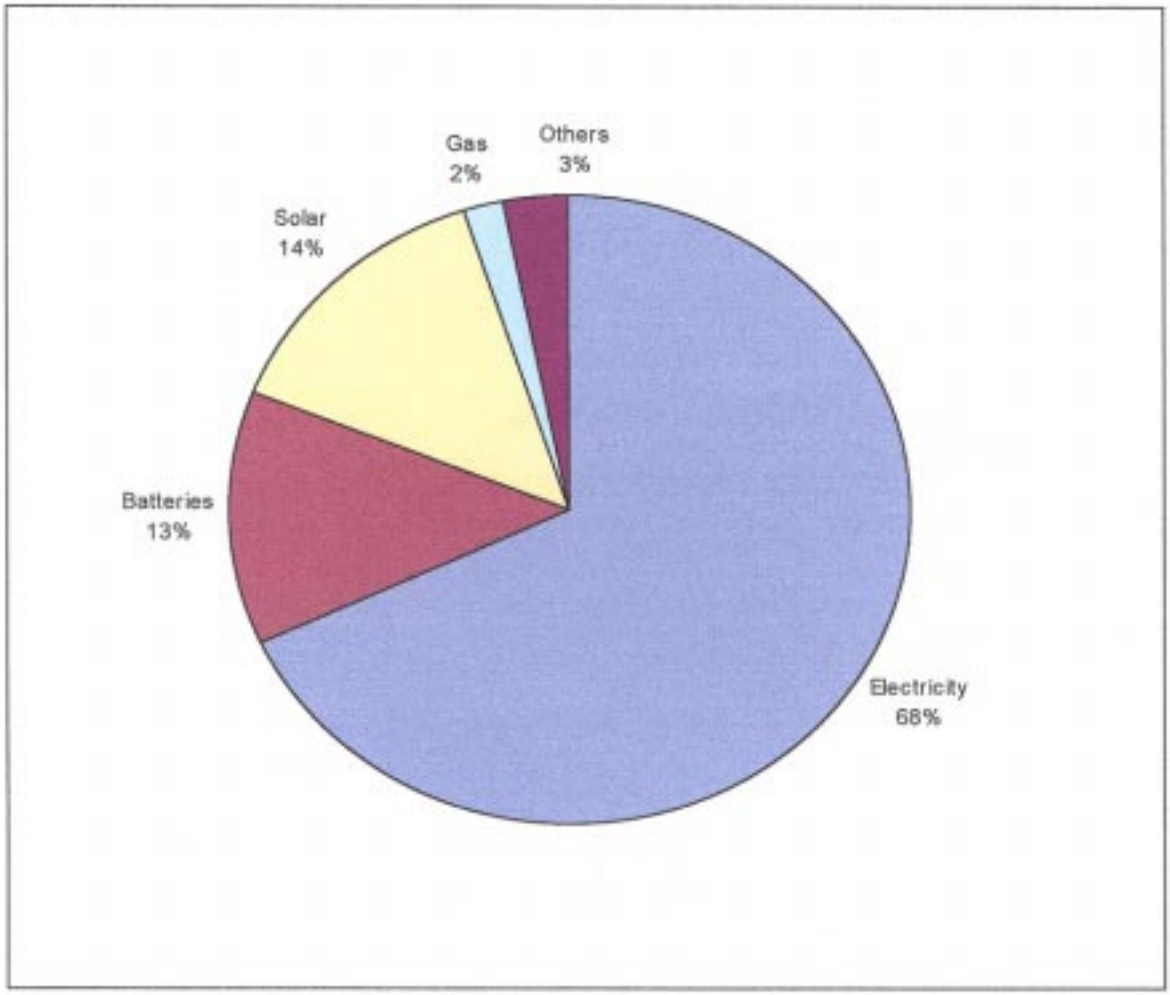
RANKED IMPORTANCE OF LIGHTING METHODS



Powering

	RAI (%)	RPI (%)	RPI/RAI (%)
Grid Electricity	37	68	180
Solar Electricity	14	14	100
Batteries - Car	14	7	44
Batteries - Dry	17	6	35

RANKED IMPORTANCE OF POWERING METHODS



One of the major objectives of the study on the energy baseline survey was to gauge the extent of off-grid electrification in Zimbabwe. The results of the baseline and the subsequent follow up for PV and gensets prove very insightful. They should provide guidance to ZESA, the Government of Zimbabwe, the World Bank and others interested in rural electrification for preparing and implementing support and development programmes in the sector.

Photovoltaics

Three general questions on use of energy were asked of respondents:

- did they use the energy source for heating?
- did they use the energy source for lighting?
- did they use the energy source for powering (e.g. TVs, radios, etc)?

Table A1.2
Respondents Using PV for Powering Appliances

Grid accessible			
Domestic	**No**	**% by category**	**% of total**
H density	8	18.6%	7.6%
L density	2	4.7%	1.9%
Rural	2	46.5%	19.0%
Employees	20	30.2%	12.4%
Sub-total	**13**	**100.0%**	**41.0%**
Other	43		
Lg scale		0.0%	0.0%
Sm scale		0.0%	0.0%
Sub-total	**0**	**0.0%**	**0.0%**
Ex-grid accessible			
Rural domestic	53	85.5%	50.5%
Sm scale		0.0%	0.0%
Lg scale	9	14.5%	8.6%
Sub-total	**62**	**100.0%**	**59.0%**
Total	**105**		**100.0%**

As Tables A1.2 and A1.3 show, 105 respondents answered they used PV for powering, while 81 answered they use PV for lighting.

This implies that there were, at a very minimum, 105 respondents, or 1,8% of the entire 6 001 respondents in the survey, who use PV. If, as should be the case, a number of the 85 respondents who said they use their PV for lighting, also use their PV for powering, then, of course, the number of interviewees using PV for both powering and lighting increases. This, then, implies that the extrapolations for general population use of PV based upon those who said they use it for power is an underestimate.

Table A1.3
Respondents Using PV for Lighting

Grid accessible			
Domestic	**No**	**% by category**	**% of total**
H density	3	0.1%	0.1%
L density	4	0.1%	0.1%
Rural	13	0.3%	0.2%
Employees	16	0.4%	0.3%
Sub-total	**36**	**0.8%**	**0.6%**
Other			
Lg scale		0.0%	0.0%
Sm scale	2	0.6%	0.0%
Sub-total	**2**	**0.6%**	**0.0%**
Ex-grid accessible			
Rural domestic	32	2.5%	0.5%
Sm scale	2	0.2%	0.0%
Lg scale	9	0.7%	0.2%
Sub-total	**43**	**3.3%**	**0.7%**
Total	**81**		**1.4%**

In the survey, and verified in the follow up in July and August, 81 respondents, or 1.4% of the sample stated they used solar electricity for lighting.

Using the higher number of those who use PV for powering (and realizing this is an underestimate, as there are surely respondents who use it for both powering appliances and lighting), and extrapolating this to the national census, we can obtain the following estimates.

Table A1.4 and A1.5 are taken from the 1992 National Census by Central Statistics Office. The Central Statistics Office estimated population in three scenarios to the year 2007, at intervals of 1997, 2002 and 2007. The team has taken the middle estimate, which puts 1997 population at 12.338 million inhabitants. This assumes an overall growth rate of 3.45% until the year 1998 (given contemporary fertility and mortality rates), with an urban growth rate of 5.17% per annum for the period concerned, and a rural growth rate of 2.65% for the same period. Again, it should be noted that these figures are taken from the 1992 Census and the CSO's projections to the year 2007.

Table A1.4
Population Estimates from 1992 Census (1997 estimate from CSO)

1992 Census	1992	1993	1994	1995	1996	1997	1998 (est)
Rural	7.224.828	7.416.286	7.612.818	7.814.557	8.021.643	8.235.615	8.453.859
Urban	3.187.720	3.352.525	3.525.851	3.708.137	3.899.848	4.102.385	4.314.478
Total	**10.412.548**	**10.768.811**	**11.138.668**	**11.522.694**	**11.921.491**	**12.338.000**	**12.768.337**

Source: CSO

Table A.1.4 shows that the urban population in 1998 should be on the order of 4.3 million, and the rural on the order of 8.5 million. Taking CSO figures for urban and rural household sizes, Table A1.5 was prepared.

Table A1.5
Household Estimates from 1992 Census (1997 estimate from CSO)

1992 Census	1992	1993	1994	1995	1996	1997	1998 (est)
Rural	1.409.106	1.446.447	1.484.778	1.524.124	1.564.514	1.606.246	1.648.812
Urban	777.622	817.825	860.106	904.574	951.340	1.000.748	1.052.486
Total	**2.186.727**	**2.264.272**	**2.344.884**	**2.428.698**	**2.515.854**	**2.606.994**	**2.701.298**

Source: CSO

Taking these census data and applying the ZESA baseline survey and follow up analysis figures, the following tables indicate the minimum level of PV penetration today in Zimbabwe.

Table A1.6
Estimates of PV Penetration for Powering Appliances in Zimbabwe Based upon 1992 Census and 1998 ZESA Baseline Survey

Category	No	% solar sample	% sample	% national
Domestic				
Urban	23	21.9%	0.6%	5.9993
Rural	73	69.5%	5.2%	85.002
Other	9	8.6%	1.7%	
Total	**105**	**100.0%**	**1.8%**	**90.996**

Source: ZESA, Quest Data and ESMAP

This indicates that, at a minimum, there are over 90 ,000 PV systems **in use** in Zimbabwe. The emphasis is on **in use**, as the survey asked interviwees what they used at that point in time for powering appliances. This indicates operational units, not units sold but out of use. It should be noted that, as one would expect, most units are used in rural areas. However, a higher proportion, nearly 22% use PV in urban areas, as defined above (i.e. , either high density, low density, or commercial/industrial employees in urban areas). This should be of major interest to ZESA. The "other" category indicates use in rural applications on commercial farms, at mines, and other business establishments in Zimbabwe.

Additionally, as Table A1.7 indicates, a further 81 interviewees stated they used PV systems for lighting. The data are being analyzed to determine the number of users who use their systems for both powering and lighting, as this number will be greater than 105, and will imply a higher national extrapolation for those using PV.

Table A1.6
Estimates of PV Penetration for Powering Appliances in Zimbabwe Based upon 1992 Census and 1998 ZESA Baseline Survey

Category	No	% solar sample	% sample	% national
Domestic				
Urban	23	21.9%	0.6%	5.9993
Rural	73	69.5%	5.2%	85.002
Other	9	8.6%	1.7%	
Total	**105**	**100.0%**	**1.8%**	**90.996**

Source: ZESA, Quest Data and ESMAP

Car Batteries

Another objective of the survey was to get a good idea of the number of car batteries in use in the country for providing off-grid electricity. Table A1.7 shows that 540 respondents stated they use car batteries for powering appliances (generally TVs, radios, radio cassettes and similar devices). No respondents stated they used car batteries for lighting.

Table A1.7
Respondents Using Car Batteries for Powering Appliances

Grid accessible			
Domestic	**No**	**% by category**	**% of total**
H density	203	4.6%	3.4%
L density	10	0.2%	0.2%
Rural	45	1.0%	0.8%
Employees	85	1.9%	1.4%
Sub-total	**343**	**7.8%**	**5.7%**
Other			
Lg scale		0.0%	0.0%
Sm scale	6	1.9%	0.1%
Sub-total	**6**	**1.9%**	**0.1%**
Ex-grid accessible			
Rural domestic	152	11.8%	2.5%
Sm scale	20	1.5%	0.3%
Lg scale	19	1.5%	0.3%
Sub-total	**191**	**14.8%**	**3.2%**
Total	**540**		**90.%**

One of the interesting features of both Table A1.7, above, and Table A1.8, below, is the high proportion of "urban" users of car batteries. In fact, a higher number of "urban" respondents state they use car batteries than rural. There are two explanations for this.

First, most of the urban respondents are in high density areas where there are many homes without grid connections. Many employees in the survey in the grid-accessible areas do not have electricity connections, so use batteries for their appliances. Secondly, many households have old appliances that are DC-driven, including classic stereo phonographs that are driven by lead acid batteries. This is borne out by market supply surveys that show these types of heavy batteries are widely available in urban retail outlets. It is believed that for many of these households, the costs of purchasing a new entertainment unit is prohibitive, relative to continued use of batteries.

Table A1.8
Estimates of Car Battery Penetration for Powering Appliances in Zimbabwe Based upon 1992 Census and 1998 ZESA Baseline Survey

Category	No	% battery sample	% sample	% national
Domestic				
Urban	298	55.2%	8.0%	84.722
Rural	197	36.5%	13.9%	229.390
Other	45	8.3%	8.3%	
Total	**540**	**100.0%**	**9.0%**	**314.112**

Source: ZESA, Quest Data and ESMAP

Taking the baseline and follow up surveys and extrapolating them to the overall population, it can be seen that, **at a minimum**, over 314,000 car batteries are in use in Zimbabwe, with at least 230,000 of these in rural areas. The "other" category, which includes small rural and urban businesses, cannot be currently estimated for extrapolation as there is no census or other national data available from which to extrapolate. However, given the importance in the survey group (8.3% of businesses), this probably accounts for thousands of batteries, thereby making the estimates in Table A1.8 underestimates.

OBSERVATIONS, CONCLUSIONS AND RECOMMENDATIONS

1. The Grid Rural Electrification programme in Zimbabwe is structured and implemented according to a master-plan. The master-plan consists of RE centres that have met selection criteria of economic and financial viability. The funding is through an RE levy which is independent of ZESA finances.

2. Other modes of rural electrification mainly renewable technologies are also being implemented by Government, non-Governmental Organisations and individuals. ZESA has implemented successfully the GEF project and a lot of experience has been gained from the project.

3. The marketing research conducted by ZESA and subsequently altered to suit ESMAP needs has identified the enormous rural demand for energy services. The research findings should assist ZESA, Government of Zimbabwe and all other stakeholders.

4. The RE programme in Zimbabwe is in our view adequately structured and the demand for Rural electricity has been amply demonstrated. This demand is in the Rural Areas where there is potential for development and thereby alleviating poverty and contributing to environmental protection. However, the programme needs better resources than is the current case. The international community is therefore called upon to support this worthy cause.