Implementation of Renewable Energy Technologies – Opportunities and Barriers

Zimbabwe Country Study

Southern Centre for Energy and Environment
Zimbabwe

SOUTHERN CENTRE FOR ENERGY AND ENVIRONMENT

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UNEP Collaborating Centre on Energy and Environment
Risø National Laboratory
P.O. Box 49
DK 4000 Roskilde
Denmark
Phone: +45 46 32 22 88
Fax: +45 46 32 19 99

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ACRONYMS

CDM	- Clean Development Mechanism
BUN	- Biomas Users Network
DBSA	- Development Bank of Southern Africa
DoE	- Zimbabwe's Department Of Energy
GEF	- Global Environment Facility
JICA	- Japan International Co-opertion Agency
NGO	- Non-Governmental Organisation
NRSE	- New and Renewable Sources of Energy
O&M	- Operation and Maintenance
RETS	- Renewable Energy Technologies
R&D	- Research and development
UNIDO	- United Nations Industrial Development Organization
UNDP	-United Nations Development Programme
SADC	- Southern Africa Development Community
SCEE	- Southern Centre for Energy and Environment
SIRDC	- Scientific and Industrial Research Development Centre
UCCEE	- UNEP Collaborating Centre for Energy and Environment
UNEP	- United Nations Environment Program
ZESA	- Zimbabwe Electricity Supply Authority

Report by
R.S. Maya – Executive Chairman (SCEE)
A. P. Mhlanga - Researcher (SCEE)
N. Nziramasanga – Director (SCEE)
M. Mutyasira – Information (SCEE)

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EXECUTIVE SUMMARY

Renewable Energy Technologies (RETS) have over the years become an integral part of the energy supply chain in most developed countries. Recent projections show that 13.5% of the world's primary energy supply comes from renewable and this figure has an aggregated annual growth rate of 16%. Wind has the highest annual growth rate of 22% while the least annual growth rate of 2% is for hydropower. The main push for renewable like wind in the OECD countries are environmental concerns and the business aspect in power generation. The situation is however completely different in Africa, where the thrust for RETs is developmental based. Although the continent has abundant renewable energy resources like solar, biomass, wind and hydro potential, they have remained largely unexploited. Several efforts have been made to help African countries like Zimbabwe to exploit such resources.

The main objectives of this country study included review of Zimbabwe's development of past RETs, establish barriers related lessons learnt from such projects and currently running RETs projects, identify barriers experienced by other projects and then select a few barrier removal projects and then develop them with the help of all stakeholders in the country.

The methodology of this study involved a review of past RETs projects to establish barriers faced and barriers related lessons learnt. An examination of the policy instruments related to RETs was done to establish how they promote the dissemination of the technologies as well as their adequacy. A survey of all possible RETs projects in the country was carried out and in this survey the end-users were visited and interviewed by the research team. An initial workshop, which was attended by all stakeholders, was held in November 1999. An Advisory committee on RETs in Zimbabwe was then set up comprising of various stakeholders from government, the private sector, research institutions, interviewed end-users and the NGO community. The committee was tasked with the responsibility of coming up with recommendations to barrier removal and promotion of RETs. After interested stakeholders had presented their candidate projects proposals, the committee started the process of identifying barriers to the projects and selecting feasible projects. A final workshop was then held in August 2000 where the findings of the whole process were presented to all stakeholders for discussion and analysis.

The problem of barriers was found to be very complex. A good number of RETs projects in the country were successfully implemented. The success of such projects was underpinned by the following factors, addressing the immediate and basic needs of the people, participatory approach, awareness creation and enabling income generation activities. Some projects were also not very successful as they faced a lot of barriers like poor institutional framework, limited financial resources, lack of appreciation of associated benefits and technology failure. A close analysis of barriers revealed that there are two classes of barrier namely primary barriers and secondary barriers. Primary barriers are the real barriers while secondary barriers are more of the effects of primary barriers. One example of a common secondary barrier is lack of funding which has a corresponding primary barrier that people are not able to develop and present bankable RETs projects to banks and other financial institutions for funding. So the barriers addressing task has to consider the barriers at both levels. Experiences in some barriers removal projects showed that barriers removal initiatives might end up creating new and different barriers. A case in point is the 1993-1998 UNDP-GEF PV project, which during its implementation created a lot of companies installing PV systems. The companies however could only survive under this project that once the project ended they could not survive. Companies that survived are those companies where RETs are not their core business like

battery manufacturers. Several barrier removal actions were also recommended at the final workshop. The action concentrated on directed and concerted efforts to disseminate RETS. DoE and industry were encouraged to meet often and have a working relationship, lobbying the government for policy reform on RETs and information exchange among stakeholders.

Government policy was also examined to establish its effectiveness and adequacy. It was realized the policy on RETs was largely inadequate and a lot of contradictions between the policy and the reality existed. An example is the low pricing of fossil fuels, which has put RETS on permanent disadvantage. It was also realized that most policy contradiction existed because of government's social obligation of making energy affordable to the general populace that is poor. The change of the mandate of DoE from policy implementation to formulation was a welcome move as the department has limited financial resources and they can now be more effective. It was also realized that the government was very keen to introduce RETs for basically three reasons namely developing rural and remote areas, environmental concerns, and promotion of economic growth. This keenness has however been largely hampered by lack of resources. To this end DoE is willing to form partnerships with developmental organisation to help it meet its mandate. The local utility has scored a first by allowing IPPs to generate electricity and feed into the national grid demonstrated by the Rusitu Power plant. This reflects a general shift from monopolistic tendencies to an open market system. The move is hoped to trigger other IPPs to generate power as well.

Eight barriers removal projects were selected and developed. The projects are aimed and capacity building, national RETs policy formulation, technical research and critical information generation. Although some of the barriers that will be addressed by the projects are specific to the projects a good number of the barriers are general barriers like building the capacity to develop and present bankable RETs projects. Entrepreneurial skill development also transcends all RETs although one technology will be used as a model. On a national scale, RETs have the capacity to become an integral part of the energy supply chain if the barrier removal projects recommended here are implemented.

CHAPTER 1 : ZIMBABWE'S ENERGY SITUATION

1.1 Energy overview

The energy sector in Zimbabwe accounts for about 15% of GDP and public revenue mainly from exercise duties on liquid fuels but it contributes only 1% to formal employment. This sector, however, has a more significant share in aggregate investment, foreign borrowing and debt. The country's primary energy base consists of coal, thermal and hydropower, biomass and solar energy. Coal bed methane exploitation is still in the planning stages.

Several types of energy are in use in Zimbabwe. A total of about 280000TJ is consumed per year in Zimbabwe. The national energy consumption by type is as illustrated below (Figure 1). Biomass accounts for 50% of the energy used, while coal and electricity account for 13 and 12% respectively. Energy consumption has grown at a rate of about 3.5% per annum, which has exceeded GDP growth rate of 2.3% or even less than 1% recently.

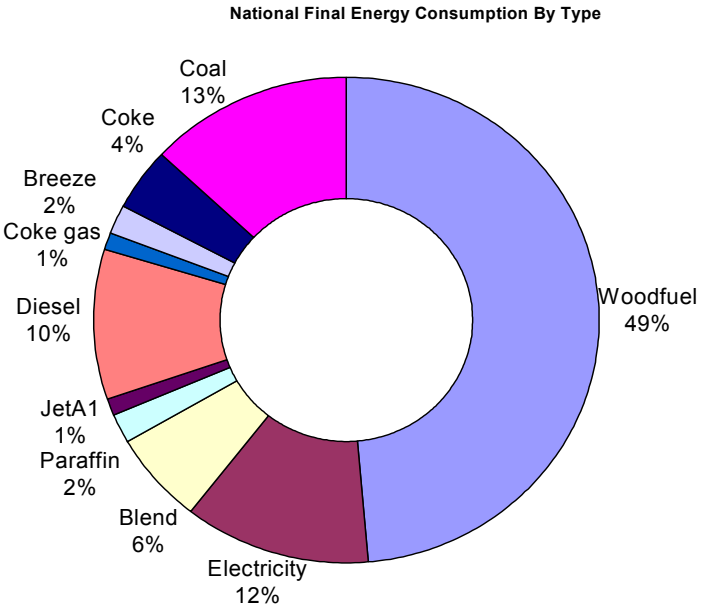

Figure 1. Zimbabwe's Energy Use by Type.

Fuelwood is the most important domestic fuel in the country. It is the major source of energy for cooking, lighting and heating for over 80% of the population mainly in the rural and peri-urban areas. Coal is the most abundant source of primary energy found in Zimbabwe apart from fuelwood. Zimbabwe has 30 billion tonnes of probable bituminous coal reserves in 21 deposits of which in situ reserves are estimated at between 10 and 20 billion. Proven reserves can last for 107 years and total reserves for over 200years at the present production rate of about 5million tonnes per annum.

Most liquid fuels are imported from the Middle East in refined form. The main liquid fuels are diesel gasoline, Jet A1, kerosene, Av gas, LPG and ethanol. Gasoline and diesel are imported as finished products while ethanol is produced locally.

Electricity is generated locally at Hwange Thermal Power Station[920MW], Kariba Hydro Electric power station [666MW] and three thermal power stations at Harare [135MW], Bulawayo [120MW] and Munyati [120MW]. Electricity supply is augmented by imports from DRC, SA and Mozambique, which accounts for up to 66% of the national electricity consumption.

Animal power is another very useful form of energy that remains unaccounted for in the Zimbabwean energy mix because it is not a conventional energy measure. Informed estimates put the equivalent national animal power use in the agricultural sector at about 6.8 million liters of diesel annually.

1.2 Sectoral Energy Use

Energy consumption in the various sectors in Zimbabwe is as shown in Figure 2 below.

The demand for energy comes primarily from industry (41.7%), followed by agriculture(39.1%), transport (9.9%), commerce (3.9%), and mining (5.2%).

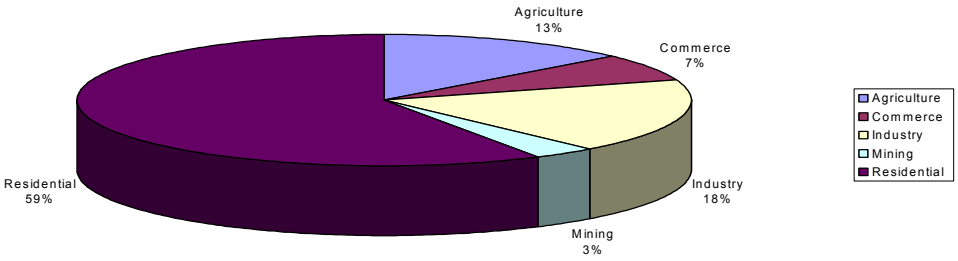

Figure 2 . Zimbabwe's energy use by sector

1.3 Energy resources and expansion plans

The energy supply options for Zimbabwe have a mixture of hydroelectricity coal and renewable. After the development and refurbishment of some coal fired thermal power plants in the past years the thrust is now on developing hydroelectric power plants as well. The country has several interconnectors for importing power from South Africa, DRC and Zambia.

Rural Zimbabwe as well as the low-income urban households are highly dependent on fuelwood. Fuelwood is legally not a commercial fuel as the collection and sale of fuelwood requires a license form the government. The emphasis here is on controlling the supply side. Rural areas are facing more acute shortage of wood as well as the associated land degradation. Table 1 below shows the biomass reserves for Zimbabwe

Table 1 : Biomass reserve for Zimbabwe

Classification	Area Covered (million hectares)
Fuelwood	8.4
Timber	12.1
Non-productive	14.2
Total	**34.7**

The remaining supplies are now in the less populated areas. Waste from commercial forests could be used for fuel wood but the transport cost makes the fuel too expensive for the target groups. Proposal have been made for the use of the waste to produce electricity but that would provide expensive electricity which might not compete well with grid electricity and

also the target group would not be the low income households but those more able ton pay. The estimated potential of waste from pine plantations is show in Table 2 below.

Table 2 : Waste from pine plantations

Thinning	**Volume in m^3 per hectare per year**
Forestry commission	4.3
Border Timbers	3.6
Wattle Company	0.9
Total estimate	**221500 m^3**
Clear Felling	
Forestry Commission	4.5
Border Timbers	2.2
Wattle Company	0.6
Total Estimate	**192100 m^3**

Coal is by far the largest commercial energy source. Table 3 shows the various coalfields in the country, some of which have large quantities of coalbed methane. Coal is however a commercial fuel and access by low-income groups is limited. Attempts by the Government to encourage the use of coal for small scale rural industry and households has not yielded significant results. Coal is a bulk fuel similar to wood but is more expensive from the household's perspective given the availability of wood. Also coal has characteristics of smell and dust that are not attractive to the end users.

Table 3 : Major coalfields in Zimbabwe

Coalfield	Reserves in million tonnes
Hwange	480
Dahlia	1400
Hankano	7850
Lubimbi	11800
Lusulu	3000
Kaonga and Sessami	1000
Mkushwe	4300
Sengwa	400
Total	30 230

1.4 Renewable Energy Potential in Zimbabwe

Renewable energy technologies available in Zimbabwe are Solar Photovoltaics and water heating, biomass technologies emphasizing on digesters, cogeneration, briquetting and gasification, mini-hydro, wind power and hybrid systems. Although renewable are already in use in the country their potential remains largely unexploited. Table 4 below compares the installed capacity of several RETS to the technical capacity of the whole country. As can be realized form the table below, a lot of potential for all RETS exists in the country and therefore sustainable methods of disseminating RETS should be established. Earlier attempts to disseminate the RETS have experienced minimal success due to unforeseen barriers. It is therefore very important that barriers removal work like this project be carried out so that future projects will avoid pitfalls experienced by earlier initiatives.

Table 4 : Technical potential for Renewable Energy(MW) in Zimbabwe

Technology	Installed Capacity(MW)	Technical Potential (MW)
Solar PV	0.8	>300
Solar WH	10 000 units	1 million
Mini Hydro	1.7	20
Micro Hydro	1	15
Biogas	250 units	5000 units
Wind		
Bagasse based cogeneration	45	150
Power generation from sawmill waste	0	250

1.5 Solar PV

Solar Photovoltaic installed in the country is mainly in rural areas at service centers like schools and hospitals as well individual homes. In rural areas PV is used for lighting, radio and television. PV has a lot of potential given the country's annual insolation of over 2000kWh/m^2 and the fact that, of Zimbabwe's over 2million households only 23% are electrified. With an estimated installed capacity of 800kWp the annual increase growth of this sector is estimated at 3%. The insolation received is uniform across the country and across all seasons. The recently ended GEF project facilitated large-scale importation and installation of a lot of PV systems around the country. This created a good number of companies who provided Solar PV services. The main barrier to the dissemination of this technology is the lack of capital by the majority of Zimbabweans to acquire the Solar Home systems. Solar PV market still remains open especially in very remote areas which are not likely to be electrified both in the short and long run.

1.6 Solar Water Heaters

It is estimated that over 10 000 solar water heating units are installed in the country. Installed units have capacities ranging from 50litres each to 1000 litres of water per unit. These units are mainly afforded by the middle to high-income groups in the country due to high capital costs of over US$1000. The greatest market potential for these units however exists in low-income households who however do not have the capital to acquire such units.

1.7 Biogas

Biogas digesters dotted around the country have been installed by three organizations that are the Department of Energy, Silveira House and Biomass Users Network (BUN). Two types of digesters are being promoted in the country namely the Chinese and the Carmetec (Centre for Agricultural Mechanisation and Rural Technology in Tanzania) but the former is the most popular. The units are located at schools, rural homes and selected industries. All these small digesters use livestock dung especially cow dung as the feed. As can be noted from Table 5, a lot of livestock dung is available in the country, and if exploited, meaningful biogas production could be realized.

Table 5 : Livestock Population

Livestock	Communal Area	Resettlement Area	Small Scale Commercial Area	Large scale commercial Area
Cattle	302 991	165 280	185 422	1 436 143
Pigs	111 970	9 056	57 444	118 474
Sheep	319 774	8 240	2 028	83 290
Goats	2 281 908	19 059	72 601	Not available

The national dung produced annually has energy content of up to 90PJ. The main problem facing the digesters is lack of technology appreciation All the major cities in the country treat their sewage anaerobically producing biogas. Table 6 below shows the potential of biogas production from sewage treatment works in 4 towns in Zimbabwe.

Table 6 : Methane production from sewage plants using biodigesters in Zimbabwe

Cubic metres/day	Sewage	Biogas	Methane produced
Harare	300 000	140 000	70 000
Mutare	30 000	1107	554
Masvingo	16800	621	311
Bulawayo	35 000	2951	1475

Although a small share of the produced gas is in some cases use to preheat the digesters, most of the gas is just vented into the atmosphere.

1.8 Bagasse based cogeneration.

Two sugar mills in the southern part of the country produce large volumes of bagasse. The bagasse is burnt as a disposal measure to generate electricity. The plants currently produce 61MW but the capacity could reach 150MW with technological improvements and shift of business focus from disposing the bagasse to efficient electricity generation. The are research studies currently underway to try sweet sorghum as a replacement of sugar cane. Preliminary results so far are encouraging.

Sawmills in the eastern part on the country produce a lot of sawmill dust (about 50PJ/year) which can be burnt to generate electricity. The only known use of the dust so far is the burning of the dust to fire a boiler that produces steam which is in turn used to dry wood. Besides this, most of the sawdust is burnt as a disposal measure. This area has a lot of potential given that the sawmills are concentrated in one region of the country, which has vast tree plantations.

1.9 Briquetting and gasification

Although the country has a lot of sawmill dust from timber estates in the Eastern highlands there are not known operational briquetting schemes. Two attempts have so far failed to take off the ground. In 1992 a local NGO, BUN acquired a 26kW plant situated at Forestry Commission (a parastatal). The concept of this project was to address the disposal problem of the sawdust. The plant however did not address the problem as it could only briquette 2% of the sawdust. The briquettes produced were solid cylindrical, which were not popular with the

locals. For combustion purposes briquettes with a hole in the center were required and this pushed the plant out of market and it is no longer operational. Briquettes have a lot of potential in the country especially for cooking at large institutions like schools or army barracks. The problem however is that little or no market research has been done up to this date.

Gasification technology on the other hand is very limited in the country although a lot of potential exists on several specific plantations in the country. Due to this technology's need for continuos and steady supply of feedstock, the rural areas in the country cannot adopt this technology, as they do not have centralized production of waste. This technology however could be feasible on large-scale plantations where waste production could be centralized.

1.10 Micro and Minihydro

Micro and Minihydro potential exists in the country but mainly in the eastern part of the country due to its terrain and rainfall patterns. Several schemes, mostly private owned, are generating electricity mainly for private used with only one scheme feeding into the national grid. Schemes already in place include Claremont (250kW), Aberfoyle (25kW), Nyafaru (30kW), Rusitu (700kW), Mutsikira (3kW), Svinurai (10kW), Sithole-Chikate (25kW) and Kuenda (75kW). Studies done by the then Ministry of Energy, Water Resources and Development identified six existing dams that could be developed to have microhydro schemes. These are : Manyuchi(250kW), Mwenji (250kW), Ngezi Palawan (220kW), Ruti (250) and Smallbridge (220kW). Other bigger schemes identifies are Mazvikadei (700kW), Rusitu (4500kW), Lusitu (700kW), Sebakwe(310kW) and Siya (350kW).

1.11 Wind Energy

Zimbabwe as a landlocked country, does not have very large wind resources. This is so when compared to countries with long coastlands and flat landscapes. Preliminary data, which was collected by the Department of Meteorological Services, indicates that the highest wind speeds at 10 meters above ground level are found near Harare, Chivhu, Gweru, Bulawayo Airport and Chipinge in the Eastern Highlands. The average wind speed of these areas is only 3.8m/s. Given such low wind speeds, the only feasible application of wind energy is in water pumping windmills. In the eastern part of the country there are projects currently going on which are looking at using the energy produced by the windmills for battery charging. The results have so far been impressive. Another project is also looking at measuring wind speed at 20 meters above ground, which is the useful height for electricity generation from wind.

CHAPTER 2 : ASSESSMENT OF THE NATIONAL ENERGY SECTOR POLICIES

2.1 Energy Supply Policy

Prior to 1980 the energy supply policy was meant to support the generation of economic benefits for the country. This however was not immune to the urban biased planning policies that were followed at the time. Electricity, roads, rail and other energy supply infrastructure was therefore restricted to the urban areas as well as the large-scale commercial farming areas. To-date, only 20% of Zimbabwean households have access to electricity. Nevertheless the grid is well developed with efforts after 1980 having extended supplies to rural business and government administrative centers. The objective of the post 1980 policy was to increase access to electricity by the rural community as a way of enhancing their contribution to the economy. Lacking was the provision of access to financial and technical resources that would enable the communities to utilize the electricity. As a result access has been achieved by those who are able to pay, whilst a large number of households are within reach of the grid but are not connected.

Alternative energy sources were recognized as a viable solution for the energy needs of the poor. This included the introduction of efficient cook stoves to save energy, trials with various new and renewable sources of energy including solar PVs, biogas digesters, crop waste briquetting and community wood lots development.

As on date, three major policy indications for expanded access have been put in place:

- The first is the Rural Electrification Master Plan
- The second is the Alternative Energy Strategy Document
- The third is the National Biomass Strategy Document

A recent study to assess the market for rural electrification with the objective of drawing a master-plan showed that some growth centers remain unelectrified even though they have sufficient economic output to make a meaningful contribution to the development of their communities. Such centers are remote from the grid. The Rural Electrification Fund has had minimal success due to the limited resources and the fact that intended beneficiaries are required to raise 50% of the cost of grid extension. The later has been a major constraint as most rural dwellers do not have meaningful income generating activities. In cases where rural customers group together to apply for grid extension the fund does not demand 50% cost but beneficiaries will have amortised repayments for a period of 5 years. Besides this initiative the costs are still out of reach of the majority of people in the rural areas. This opens the opportunity for alternative energy supplies where the cost of supply would be lower than a grid hook-up. The major policy questions remain as:

- Will alternative energy sources offer the same opportunities as conventional energy sources in terms of technology support, end-use technologies and availability?
- What policy administrative framework is required for introduction of alternative energy?
- Who will carry the transaction cost for introducing new sources of energy?

In a bid to answer the policy questions above, the government in consultation with all stakeholders formulated the Alternative Energy Strategy Document and the National Biomass Strategy Document. These two documents set out technology evaluation guidelines, the intervention strategy and the institutional arrangements of all stakeholders in the

dissemination of RETS. The role of the DoE in the dissemination of RETS moved from implementation to facilitation and policy formulation. This change of role by DoE has had positive impacts so far as potentials RETS business partners can now easily come together and even consult DoE on matters of relevance. Besides this initiative the success of the dissemination of RETS has been very rudimentary due to the high capital cost and in some cases equipment failure.

Petroleum fuels are imported as refined distillate. The main fuels are diesel, gasoline and kerosene. Liquefied Petroleum gas is used by some households and also as an industrial fuel for some special but limited applications in industry.

Planning of fuel imports is based on demand. There is minimal regulation of end-use through special programs or incentives. Until recent years diesel has had a subsidized price due to its importance to agriculture and transport. Gasoline has had more economic pricing even though the price levels have failed to smoothen price bumps. The pricing structure is however transforming into a more economic one with the gap between diesel and gasoline prices closing. Difficulty in maintaining a balance of payments has forced a quicker pace in reforming the fuel pricing structure as shown in figure 3 below for the years after 1996. It can be noted that after 1996 the price of diesel and petrol rose drastically which is due to both the devaluation of the local currency and market pricing of all fuels.

Difficulty has been experienced with the price differential for paraffin for industrial use and paraffin for residential use. The subsidy afforded to low income groups is abused by industrial or transport users who buy paraffin under the pretext of using it for household purposes. A decision to price all kerosene at the higher price to reduce use in transport was reversed as it had a negative effect on the poor. The pricing structure does not address the food industry such as bakeries where kerosene is used as a fuel for ovens to produce bread, which in the most instances is consumed by the poor. Bakeries are considered bulk or industrial consumers of kerosene and cannot therefore benefit from the kerosene subsidy even though they serve the same economic group that the subsidy is meant to protect.

Coal policy is guided by commercial considerations since this fuel is used mainly in industrial applications. Household use of coal has always been limited. In this sector, however, government has remained captive to the needs of private investors who sought certain price guarantees as a condition for expanding coal supply. This is why coal pricing is based on a “cost plus” formula, rather than long run marginal costing or imports parity. The bulk of the coal price is the transport cost for moving it from the mine to the distribution points.

Coal remains an industrial fuel with attempts to promote diffusion into rural areas having failed. The government would like to see coal use extending to rural small-scale industry as a way of reducing fuel wood consumption for commercial activities.

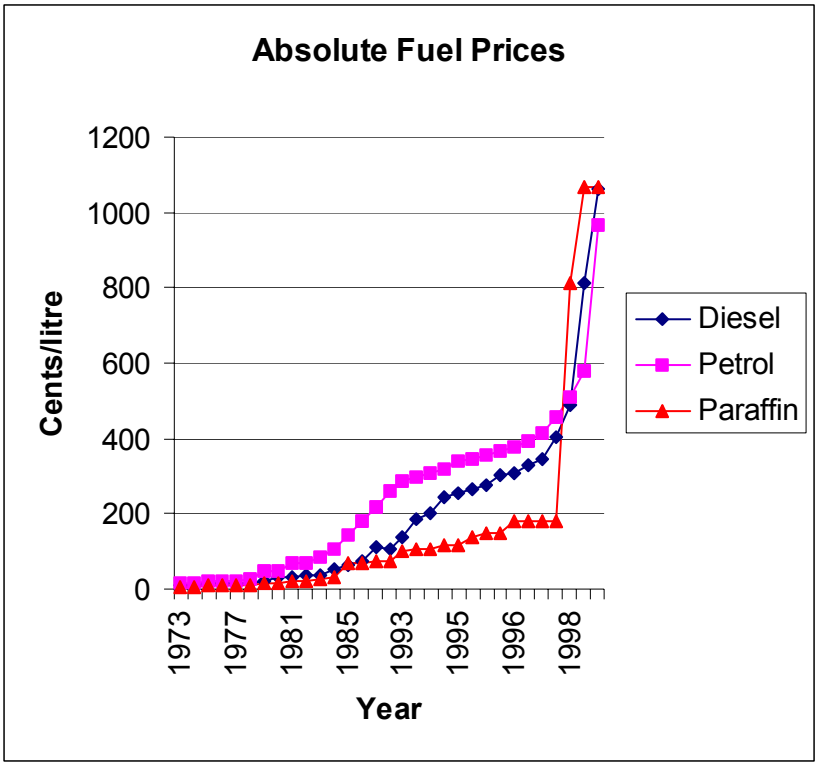

Figure 3: Historical Fuel Prices

The Electrification Master Plan is in fact a formalization of many years' effort in providing electricity to rural development centers. These are categorized as Growth Points, Service Centers, and Business Centers with the first being the most advanced and the last being the least developed providing only for a few retail shops and other limited services. The policy of electrifying these centers which started as early as 1980 is in fact a trickle down policy which sees electricity connections expanding from the rural service or demand centers to individual households in the long run. This policy does not preclude those individuals willing and able to pay for independent connections from doing so but it is a least cost infrastructure development approach.

The liquid fuels sector saw maintenance of preferential pricing for diesel and paraffin. However, with the advent of economic reforms introduced in 1991, Government subsidization programs and to some extent some cross-subsidization policies were abandoned. The general thrust of the new policy is the full passage of cost to the end-user. Despite this policy, the actual decision to allow full passage of cost has remained difficult due to the social implications of full passage on some fuels – indeed on all fuels including electricity. As in history, the policy price controls remains in place with all fuel price increases being granted by Government.

2.2 Key End-use Management Instruments

Energy consumption in Zimbabwe is basically adlib. There is no major debate on the extent of consumption. Two major instruments have however affected consumption. The first is forced shortfalls, which were quite frequent during the war and have continued to much less extent due to other supply constraints. The second is the pricing of energy. In practice, energy pricing has not been used to control demand or to engender more efficient energy use. Its

only late in the 80s that discussions with such institutions as the World Bank have brought forward the issue of using pricing as a measure for enforcing energy efficiency. This has been more the case with electricity than with all the other fuels.

Even then, the goal has not been to bring about rational use of energy but more to curb the cost of supply expansions. This cost, is the primary reason why after the economic reform period, government has sought to allow price increases as it has increasingly found difficulty with subsidization. This view is depicted more by the more liberal increase in the price of diesel and paraffin, which hitherto had increased only marginally, compared to other fuels.

We show in figure 4 the differences in increase between the historical changes in diesel and paraffin prices and those of today.

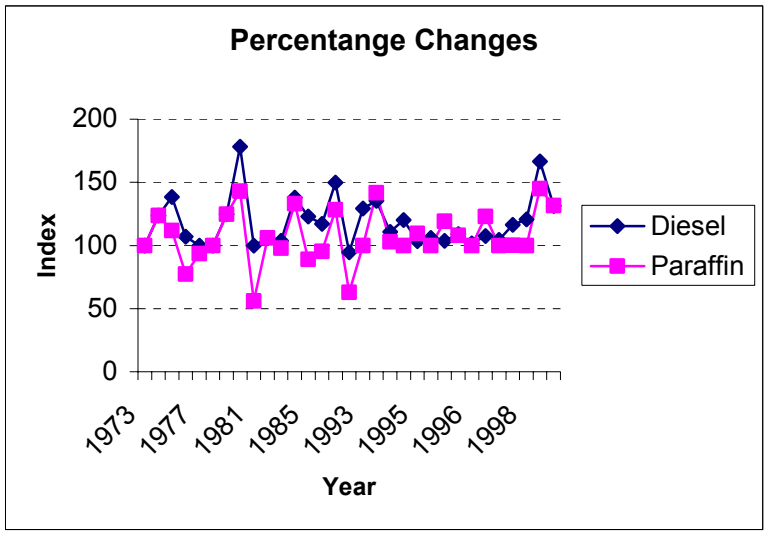

Figure 4: Difference in increase in Diesel and Paraffin Prices

To confirm that price changes have not been a tool for demand management, we also assessed the relative impact of price changes on demand for the four major fuels diesel, paraffin electricity and coal.

In all instances, it is clear that demand is basically unresponsive to increases in fuel prices. The one area in which price elasticity would be felt is industrial consumption. Our assessments (see figures 5 and 6) show that demand of the two key industrial fuels, coal and electricity is not responsive to price hikes. This is an important consideration in respect of one of the stated policies of government: Namely demand side management and energy efficiency improvement in industry.

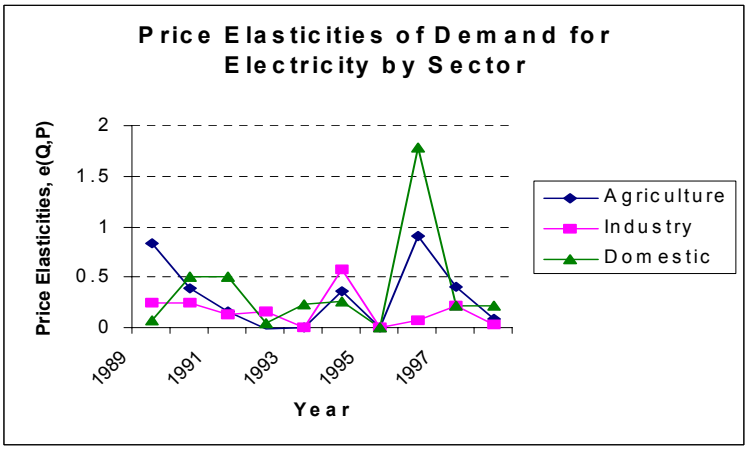

Figure 5: Price elasticities of Demand for Electricity by Sector

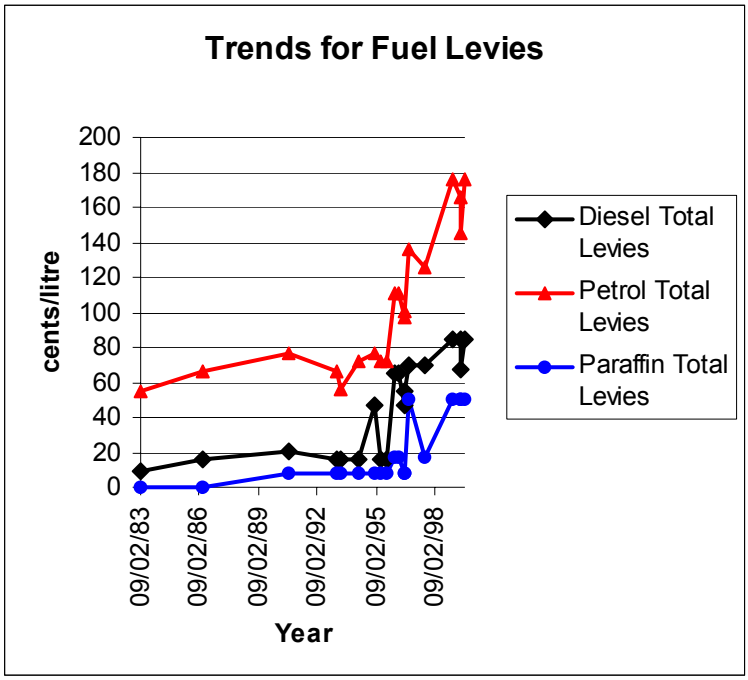

Figure 6 : Trends in Liquid Fuel Levies

But even with these charges, price elasticity of demand remained low. The main reason for this situation may lie in the low load factors for electricity and the lack of alternative fuels for urban household energy. Information based on a study done by the Forestry Commission and the World Bank on Patterns of Fuelwood Utilisation in Harare Zimbabwe shows that 16% of urban households use firewood, 47% use paraffin. Paraffin is used mainly for cooking and is the main fuel for lighting in poor urban households and in rural households. Paraffin has been subsidized until recently and the subsidies are still to be lifted completely. The poor households do not have many alternatives for lighting and therefore will continue to use kerosene. Demand for paraffin would not be elastic to price since the subsidies still exists and there is no competition from alternative fuels.

2.3 Energy Supply Policy

Zimbabwe has always been conscious of the cost of supplying liquid fuels being a non-oil producer and being a land-locked country, which endures high cost of transferring oil from far away, sea ports to its consumption centers. At one time oil imports stood as the single largest foreign currency cost item to the country. Typical ratios to this effect are indicated in figure 7.

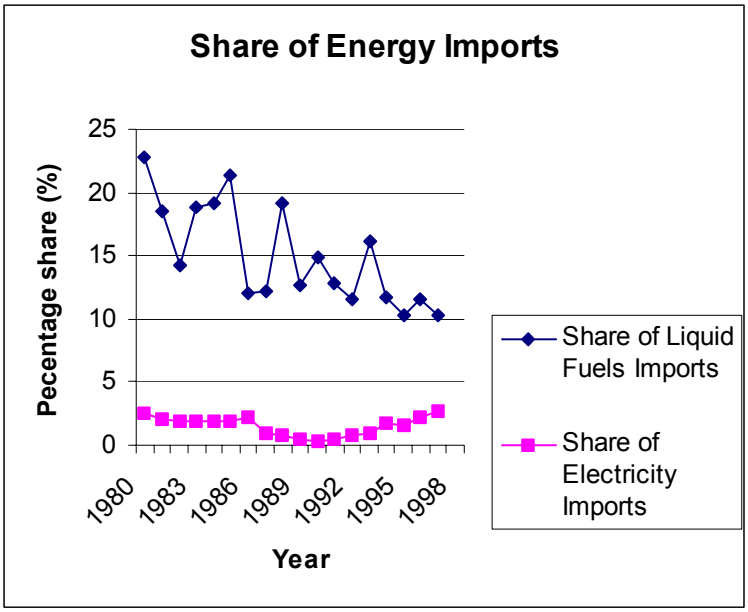

Figure 7: Foreign Currency cost share of Energy imports

On oil and electricity, state parastatal has been the main supply policy.
In the power sector, the traditional policy was to reserve supply for state monopolies. Initially this was the Central African Power Co-operation, which sold power to distributors. Local authorities were also allowed to develop their own sources

In the electricity sector, however, this approach has been relaxed and independent power producers are now allowed. Petroleum procurement remains the monopoly of state agencies.

Of late, the power sector became a major consumer of low-grade coal, which was hitherto discarded as overburden. Production economies forced a transition seeking the greater utilization of all products including this overburden and coke oven gasses, which were traditionally flared.

The traditional energy sector, fuel-wood, has not been historically considered in terms of ensuring adequate long term supplies. While there was a strong policy in terms of developing commercial forests and protecting some indigenous forest parks, no specific policy or institution was charged with ensuring the supply of fuel-wood to households.

In the mid eighties, however, policy redirection was engendered based on improving the fuel efficiency of wood stoves and the introduction of family and community wood lots. This was a combination of supply side and demand side management.

Policy on new and renewable sources of energy is also a late comer into the energy policy scene. Prior to independence, NRSEs were restricted to solar PV and solar hot water devices. A few enthusiasts and some industries treating the product as a second line to their primary core business led the development of the sector. After 1980, there was realisation that NRSEs could be useful in providing alternative energy to rural areas where it was too expensive to supply grid electricity and where fuel-wood supplies where threatened.

2.4 Policy Implementation – Approach and Capacity

Government has not been able to implement a major part of its policy pronouncements. Initially, in the early 1980s, Government tried to make policy and use its own resources and institutions to implement it. For example, after a policy decision to support energy efficiency in rural households, they established a unit within the Department of Energy to conduct research into this area and to actually design and install more efficient cook stoves. The idea was to promote renewable energy technologies whilst at the same time keeping the transaction cost low. The barrier was that in the absence of commercial interests the technologies would diffuse slowly.

In later days, the Department of Energy was streamlined more towards the formulation of policy and towards a more policy facilitation role than on policy implementation. This transition, however, remains incomplete. Government still gets to approve/control prices of petroleum fuels and approves price increases for coal and electricity. Its facilitation role remains stifled by lack of accompanying policies and policy support mechanisms for the development of private investment in the direction preferred by government. For example, there is little private investment in the supply of efficient energy devices, there are no energy services to support energy efficiency in industry and private capital flows into the NRSE sector are limited.

By and large, what is lacking is the ability to finance any preferred policy direction. To a large part, energy sector activities in the NRSE industry and in energy efficiency improvement are funded mainly by donors. Few local companies have put their own resources into this sector. Government financial policy, which greatly influences such key investment parameters as interest rates, is not deliberately designed to support investment into these sectors. Where regulations are the preferred policy instrument, little capacity exists to police and enforce the regulations.

The policy on NRSEs in particular is significantly intertwined with donor activities in the country.

2.5 Legal, Financial and Institutional Mechanisms with Reference to RETS

The most preferred mode of financing NRSEs would be private investment. This mode, unfortunately takes time to achieve in most circumstances requiring significant public financial support at various levels including, research and development (R&D), pilot testing, private investment support and market development.

Key NRSE technologies in Zimbabwe include solar photovoltaics, Solar hot water systems, biogas digester and small scale or micro hydro systems.

The Department of Energy has on-going projects that fully support the goals of both the National Energy Policy and renewable energy in Zimbabwe. These projects are implemented with support from various Governmental and Non- Governmental Organizations.

The renewable energy projects have a crucial role to play in supplementing and substituting conventional energy resources. In this capacity they will act to conserve scarce foreign exchange resources of the country. This will ensure improved quality of life in the rural areas through their key supportive role in economic development.

The role of the Department of Energy, in particular will be to coordinate activities and create an enabling environment for promoters of the projects. The projects are implemented by the relevant government departments, non-governmental organisations and/ or the private sector.

Funding for the projects is mainly from donors as well as the government itself. The government receives some grants from the donor community that support the promotion of the use of renewable energy. In most cases the donor community disburses money on a government to government basis and also to local non-governmental organizations. There are however rare cases when such funding is forwarded to the private sector. The Government through its various departments identifies local partners to carry out the projects. The Department of Energy and several other interested organizations have so far done projects with support from the donor community and the government.

The budget allocation from the government to the Department of Energy since 1994 stood at an average of 8.4 Million Zim$. Of this amount an average of 1.3 Million Zim$ is allocated for the Renewable Energy projects. In spite of the reduction of the overall budget allocation to the Department of Energy by the central government, the allocation for RETS from within DoE continued to increase as shown in Figure 8. This also goes to show the importance attached to RETS by DoE.

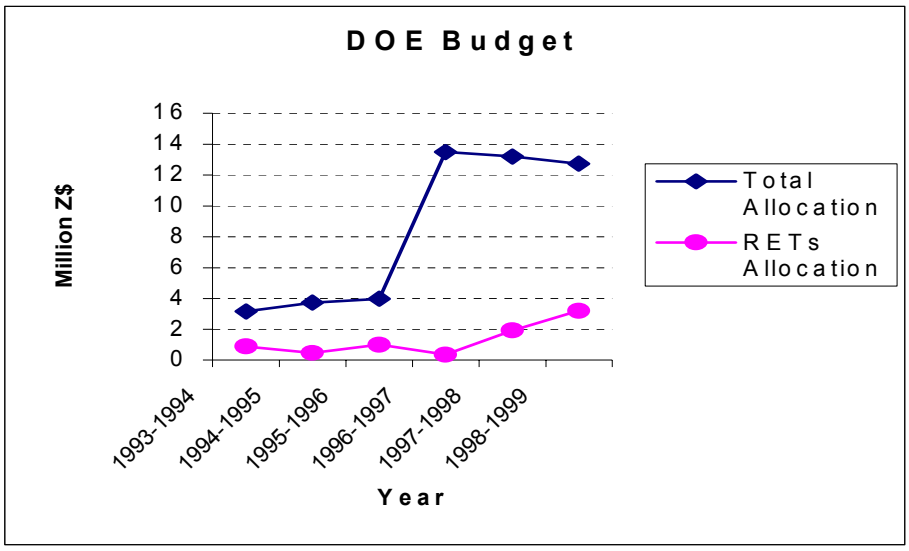

Figure 8: DOE Budget from the government

CHAPTER 3 : HISTORICAL INITIATIVES ON RETS

This chapter looks at the renewable energy dissemination potential in Zimbabwe, historical push for renewable as well as lessons learnt from several projects that were implemented in the country. For all the projects that are going to be discussed below, we are going to look at the barriers that each project faced, attempted to address them as well as other barrier related lessons that could be learnt from such initiatives.

Zimbabwe has a long history with renewable energy. The pressure to reduce the import bill for petroleum fuels and the need to provide for the energy needs of the rural poor was the major driver in the early eighties. Studies had shown that fuel wood sources were rapidly being depleted with major environmental consequences. It was therefore a priority by government to find alternative energy sources that would not negatively affect the balance of payment. Fuel wood stocks were meant to be depleted by the late 1990's according to studies by the Beijer Institute [Energy for Rural development in Zimbabwe, 1988]. These early assumptions drove government to implement several projects in support of adoption of renewable energy. Surveys carried out on behalf of SADC showed that emphasis by Zimbabwe was on planning biomass supplies, management of existing resources and coordination of donor activities. This indicated an observation that greater success could be achieved through the use of the same resources but in a more efficient manner. The need for bringing rural communities into the mainstream economy saw the initiation of projects on higher forms of energy from renewable sources. An interest was built on PV power with projects being implemented on water pumping, lighting and refrigeration.

3.1 The UNDP GEF PV project

Zimbabwe hosted the GEF PV pilot project with significant success in technology diffusion. The GEF project was conceived to address the following barriers to the use of PV power.

- Lack of locally produced components and raw materials
- Lack of private sector capacity in serving the PV market
- Lack of data for the design of PV systems
- Limited availability of foreign exchange
- Cost of PV
- Inadequate financing programs
- Lack of trained manpower
- Lack of public awareness of the technology
- Lack of institutional structures for renewable energy
- Inappropriate taxes and duties
- Lack of clear government policy

The identified barriers also applied to other renewable energy types. Experience with the barrier removal process showed that financing and technology supply can distort the market with serious implications for the after project scenario. Closing of the donor funds and removal of the government assisted procurement programme changed the price structures and terminated the entire small suppliers and installers who were supported by the project. The number of companies in PV business remained almost the same as those, which were there before the project. In fact those companies who remained outside the project have survived better than those who were supported by the project have. The reason being the reliance by

PV companies on other business lines that are not renewable energy. The major success of this project was the dissemination of the technology as by the end of the project, PV technology was found even in very remote areas.

Income generation is a major need for rural communities. It was realized that renewable energy technologies could only be delivered successfully if the rural community is able to pay or there is a source of income, which is available to meet the initial cost of the technology. In most cases even recurrent expenditure would have to be met by the donor fund. This was not addressed by this project as the beneficiaries still needed other sources of income to pay for the systems

3.2 The GTZ funded PV pumping project

The Department of Energy with support from the GTZ implemented a pilot project on PV pumping for rural water supply. The concept was to provide a source of clean water but with the households contributing to the operating cost. The technology was delivered with donated funds and the equipment was entrusted to the Department of Water in the Ministry of Water Resources and Rural Development. The project has avoided the pitfalls that have led to the failure of the earlier PVP initiatives. This pilot project was conceived to address the following primary and secondary barriers

- Poor technology delivery

New technologies such as RETS need not to be poorly delivered or fail to perform as such experiences would kill the market of the technologies. This project avoided this pitfall by supplying working , tested and state of the art technology. Such technology would create a good impression thereby developing its market.

- Lack of government support of renewable

The involvement of the Department of Energy in the project from the planning to evaluation stage demonstrated the government's support for renewable

- Ignorance of government policy

The rural populace, like those that benefited from this project, is generally never informed of the several government policies on renewable and the related policy instruments. By involving the government, the project gave the DoE the chance to explain and demonstrate the provisions of government policy on renewable.

- Inability to develop and present bankable project proposals

The project addressed this barrier by making the funds for the implementation of the project available. Not only were the fund used to acquired the equipment but it was also used to train the locals in maintaining the installed capacity.

- Lack of appreciation of the benefits

People in the rural areas have always used water from open and shallow wells. The potential health risks of such a water source are not appreciated that they would not really see the advantages of the new technology

- Lack of information about the technology

Information about the technology was disseminated to the beneficiaries of the project by educating them on maintenance procedures and upkeep of the equipment. This created an awareness of the technology.

- Lack of private sector participation in technology dissemination.

Local companies were tasked with the provision of the equipment. They also benefited from contacts made from the whole project. Although the beneficiaries of the project did not pay for the technology, private companies did the procurement of the equipment.

Dialogue was maintained with the target communities through their leadership to ensure their participation and support. Responsibilities are as for now clearly defined within the various participating institutions. The industrial base has been well developed to ensure future sustainability. Enough interest has been generated within the DWR to the extent that now they are playing a leading role in equipping further water stations with PVP.

3.3 UNIDO gasification project

UNIDO carried out experience project on biomass gasification with the hope of proving the viability of small scale gasifies for rural energy supply. The hope was to use agricultural waste to promote development whilst reducing the reliance on fuel wood. Since this was an experience projects barriers as above were addressed. The testing of the technology on site with the help of the local community instilled an aspect of the need of technology innovation in the locals. Gasification technology was however found to need development especially regarding fuel cleaning and use in engines. The technology is also relatively complex and maintenance in remote areas where it is viable would be difficult.

3.4 The JICA assessment of PV market in Zimbabwe

A study was carried out by JICA in March 1997. The study was to assess the potential market for PV systems in rural Zimbabwe and the ability of the end users to pay for the technology. The survey, which was carried out in collaboration with Southern Centre, gave the following results (Table 7) as the priorities for rural households.

Table 7: List of Household Priorities and Preference for Energy Source

Ranking	General Needs	Energy Preference
1	Food	Photovoltaic Electricity
2	Money	Firewood
3	Water	Paraffin
4	Health care	Grid electricity
5	Education	Generator electricity
6	Electricity	

Source: JICA, Zimbabwe Field Survey.

The people interviewed were in an area with PV power experience. It is therefore probable that the knowledge of the intention for the survey influenced the priority for energy. However Firewood and PV power are the major sources of energy and in most rural homes are not exclusive of each other hence they rank highly. One would expect energy for cooking to be higher than energy for lighting. In any case the fact that the surveyed communities understood the application of PV power and ranked it highly to the extent that they would pay for the service is a plus for the technology. This means the technology can now be moved to a more commercial level with minimal public sector participation.

3.5 The UNDP-Dutch funded FINESSE project

The FINESSE (Financing Energy for Small-Scale Energy Users) program that was originally implemented in Asia was brought to Africa through funding from the Dutch government and

UNDP. The program sought to identify opportunities for business ventures that would rely solely on renewable energy as a product. The program acknowledges the limited resources that are available to the rural poor and the potential investors. Through the project a number of investment projects were identified where some entrepreneurs would invest in a renewable energy project. The FINESSE program would identify the market and the sources of finance for the project. The program would also provide consultancy services for the presentation of the project proposal and negotiation of the financing. The methodology of the program was meant to ensure that each identified project had the following.

- Identified owner who would be responsible for loan repayments.
- Demonstrated positive cash flow.
- Proven technology
- Real market
- An account of environmental impacts/benefits
- An identification of public sector support activities.

Given that the project had technical support and was well funded one would expect to find a few successful projects funded through the program. The situation on the ground was, however, that:

- The investors were identified late in the project and they did not have say over the development of the identification of the opportunity and nature of project.
- The financiers did not appear keen to fund renewable energy projects.
- The FINESSE program did not include a project development fund.
- The investors were not keen on contributing to developing a project that would be open to public review.

The projects identified in Southern Africa were as follows;

1. PV power for household and schools
2. Wind pumps for rural water supply
3. Biogas for rural household energy
4. Minihydro electricity plant
5. Solar water heaters for household use
6. Solar heating for homes.
7. Electricity from urban waste

Others indicated that the experience with FINESSE in Southern Africa was similar to that in Asia.

3.6 Designing and development of a wind turbine

The Dutch Embassy in Zimbabwe in conjunction with several consultants embarked on a wind project whose principal objective was to design and develop a wind turbine rated at 500 watts which could be manufactured in Zimbabwe and operate effectively in the low- wind speed conditions characteristic of the country, for the period 1995-1997. The projects had 3 main stages namely, technical research and development of the turbine, wind monitoring and contextualisation. In the first stage the turbine was designed for low wind condition, aiming to produce 50 kWh / month in a typical monthly mean wind speed of 4m/s (9 mph, 8 knots,

14 kph). The design is based on producing the electrical equipment to a multi- panel photovoltaic system intended for remote electricity supply to schools, clinics, and rural enterprises-rather than on competing with a single PV panel as an economic alternative for domestic use. The design methodology has enabled the prototype turbine to be manufactured and installed in Zimbabwe, using local skills, materials and production technologies.

The wind monitoring stage saw the installation of data-loggers and the collection and analysis of the data at selected sites around Zimbabwe. The final stage involved the performance of a cost analysis of the wind turbine to assess its competitiveness relative to other renewable and an overview of the turbine potential in the region. As a result of this project, ZERO managed to manufacture a working prototype. Selected companies in the country can now produce the turbine. The project has demonstrated the potential achievements of technology transfer and capacity building if the locals are part of the process.

3.7 The GTZ funded Jatropha Project

GTZ in collaboration with Biomass Users Network (BUN) carried out the Jatropha Plant Oil project which was designed to promote the production of an oil producing plant, Jatropha Curcas L which has been grown and tested elsewhere in the world. The project's aim was to demonstrate various end-uses of the Jatropha plant oil. Successful use of the oil could benefit growers, who presently are rural peasants with little by way of income generating activities. The plant oil can be used for soap making, for lighting and cooking, as diesel substitute and for candles and as an industrial chemical. It also has potential of powering appliances and machines such as grinding mills and electricity generators in rural areas. The Plant Oil and Engine Development Group (POEDG), is already selling some JL oil to the tanning industry for use in softening hides. Tests on using the oil to replace diesel were not so successful due to different characteristics of the oil from that of diesel. Stoves that use the JL oil have been designed and tested successfully. What remains to be done is the market dissemination of the stoves and the use of the oil. Barriers that the project is addressing are as following

- Lack of social acceptance by the people of the technology
- Lack of a level playing field for all sources. Plant oil faces some stiff competition from other heavily subsidized sources of energy. This creates an uneven playing field for all sources of energy

It is clear from this project that the involvement of the local populace in project development especially involving new technologies is very important in overcoming social acceptance of the technology.

3.8 Microhydro potential in the Eastern Highlands

There are three existing micro hydro electricity generating schemes namely Claremont (250kW) near Nyanga, Aberfoyle (25kW) near Juliasdale, Nyafaru (30kW) near Troutbeck. At Claremont Orchards, the principal load includes lighting, grain milling and refrigeration; At Aberfoyle it includes lighting and refrigeration while at Nyafaru it includes heating, refrigeration, lighting, cooking (low wattage cookers) and social services such as hair clipping. ENDA- Zimbabwe and Zimbabwe Electricity Corporation have developed a 700kW scheme at the confluence of the Risitu and Nyahode rivers near Chimanimani This scheme that is called the Rusitu Generating Plant, it is operational and feeding into the national grid. This concerted approach to projects reduced investment risk and the project addressed the

following barriers;

- Lack of private sector participation

A good number of RETs projects in the country failed, as they did not have the participation of the private sector. These project are however different as the whole idea was a private sector initiative and the approach to the project was business oriented.

- High investment capital

Projects of such high magnitude require high capital investment. Bringing the private sector and government together in the implementation of the project minimized this.

- Lack of maintenance facilities

Local industry does not have the capacity to carry out maintenance work on equipment brought in from abroad. To address this most project had their equipment locally designed and there was considerable capacity development on the beneficiaries of the projects.

- Lack of information on

Information on small hydro power plants and means of developing such plants is not readily available.

- Ignorance of government policy

Independent power producing was generally unknown before this project. The implementation of this project however illustrated that the current government policy encourages IPPs and the government was actually willing to learn from the private sector and change its policy.

- Inability to connect with relevant government bodies

Government departments or utilities are generally seen as inaccessible and intolerant to new ideas. However the business like approach adopted by the local utility showed that given feasible ideas and good attitude relevant government department are more than prepared to work together with the private sector.

The success stories of privately owned and run hydro plants fully demonstrate the potential of such plants in the country. Most of the potential on existing agricultural dams has not been exploited due to lack of capital. However the one at Manyuchi is being developed under AIJ with the aid from utilities in G7 countries called E7

3.9 Solar Water Heater Project

A project on solar water heaters was proposed in 1997. The proposed project intended to install water heaters in urban households and rural institutions. The target was 2000 units over the project period of eight years. However if successful the project was to continue beyond the five years using revolving fund as the support for the activities. Loans were going to be provided to households for the purchase of the solar water heaters. Each household would be expected to pay back the loan in three years.

The project was to be owned by The Venture Capital Company of Zimbabwe (VCCZ) who has expressed a strong interest in the project. Solarhart was to be the co-investor. Interest had been shown by other organizations such as Solar Energy Industries Association, Solarmatics, Impact Solar, and Capri. Funding was to be met by a loan from the project fund and the loan was to be repaid over three years at an interest rate of 27 %. The VCCZ and its partners (who included Solarhart) were appointed as fund administrators who would disburse loans and collect revenue. This project however did not take off as the macro-economic conditions in the country deteriorated and interest rates shot to over 60% thereby deriving the cost out of reach of most potential customers. The project idea however wanted to address the following

barriers;

- Lack of business aspect in technology dissemination that the technology is viewed as welfare good.

The cooperation of the Venture Capital Company and several private companies ensured a total business approach to the technology dissemination.

- Inability to develop and present project proposals

The involvement of an investor on the planning of the project ensured that the project would be feasible and bankable.

- Failure to secure investment funding

Since VCCZ was one of the partners in the planning of the project they would surely fund the project if they are satisfied with the work.

- Poor institutional framework

Institutions concerned with development usually lack the framework to cooperate in developmental project

- No local technology base for renewable

The project would have enticed several companies to move to move to RETs thereby creating a local base for renewable.

3.10 The DoE Woodstoves project

A DOE (Department of Energy) rural Woodstoves project was started in 1982 in response to the shortages of fuelwood, which were being experienced in some districts of the country. The project was aimed at conserving existing woodfuel resources by improving end-use efficiency, complementing afforestation efforts as well as giving time for natural regeneration of trees. The Department of Energy had initiated a woodstoves project based on an improved prototype. This prototype, the Chingwa stove, had been widely disseminated and acceptance of this prototype had been encouraging. The characteristic features of this stove are :

- 3 pot holes and a hot plate for multi cooking
- brick body and a flue chimney for safety during cooking and elimination of smoke
- an oven for baking

Other tested prototypes like the metal Tsotso stove were also disseminated throughout the country. Dissemination of the Chingwa stove had gained momentum since the beginning of the 1990's with some NGOs, such as Africa 2000 Network, Jokes Pfungwa, Church Organisations, Plan International and the Zimbabwe Women's Bureau taking it up in some of their programmes. The Department of Natural Resources played an active role in promoting the use of the Chingwa stove. More than 15 000 stove units were constructed in the country and more than 80 builders were trained in the construction of the stoves. The project saw the installation of 114,000 stoves country wide to give a total of 2,000 stoves for each of the 57 districts of Zimbabwe. A recent survey has however established that most of these stoves are no longer in use as people just resorted to their usual open fire. The main problem was that the stoves that were developed aimed at increasing the efficiency of the stove but did not take into consideration the social aspects of an open fire. The general barriers faced by these stoves are

- lack of social acceptance and poor local participation
- financial barriers
- the technology failed to match the required heating levels of the rural folk
- lack of appreciation of benefits from using such stoves

More research however needs to be done so that a new prototype can be developed which

compromises the need for burning wood efficiency and the need for space heating.

3.11 The Global wind pump evaluation programme

In 1996, the World Bank and UNDP funded the Global windpump evaluation programme. For this purpose the World Bank and UNDP assigned CWD (Consultancy Services Wind Energy Developing Countries, Netherlands), who subcontracted part of the work to Haskoning, Consulting Engineers and Architects, Netherlands. The project has shown that there is some potential for utilisation of windpumps for some specified applications including cattle watering, game ranching, small domestic water supplies as on farms, and primary water supplies as institutions. Realizing the current increase in prices of diesel pumps on one hand and appreciating the high reliability of windpumps on the other, the number of windpumps in use countrywide would be seen to grow if the benefits of the Windpumps were publicised to the potential users. The project has also shown that there is sufficient meteorological (Wind) and hydrological data available that would make implementation of the next phase of the Global Wind Evaluation Programme feasible in Zimbabwe.

3.12 Temaruru Windpower project.

A wind power scheme established by the Temaruru Community Power Trust is currently taking place in the Eastern Highlands of Zimbabwe. Started in 1998, the project is expected to provide electrical power services to the people of Temaruru and Dumbamwe and the wider community by the provision of limited 230-volt AC supply and battery charging services. The scheme developing in phases, expanding with the success of the initial installations, is in its second phase. The initial phase involved the rehabilitation of the original test site at the clinic and the production of new version of the PT3600 turbine and an inverter to provide a micro-grid supply to the clinic and staff houses. The second stage involves the supply of limited 240V AC supplies to a business centre (15- 20 kWh/day) and initial battery charging facility (4 kWh/day). The last stage will involve the development of a new 4-kilowatt wind turbine to be installed to power the school, initially linked to the clinic system, but with the intention of connecting to the main system via a high voltage link if this appears feasible. This ongoing project has been successful so far and has built on addressing the real needs of the community and in this case renewable are being used in income generating ventures.

3.13 The DoE Solar cookers project

In a bid to promote solar cookers in Zimbabwe, the Ministry of Transport and Energy brought in 100 solar cookers and used them to test acceptability at two peri-urban locations in Ntabazinduna North and at Epworth near Harare. This timely project comes at a time when fuelwood has been exhausted in these areas and the price of paraffin has increased by more than 300% in the past year. The tests proved that users would want this type of a cooker. As a follow up to the test exercise, 3500 cookers have been produced locally by Hunyani Holdings, and are being tested for acceptability and durability. It is expected that the Development Technology Centre at the University of Zimbabwe or any other Non Governmental Organisation will be invited to undertake promotion and dissemination of these cookers. Training of users will form a major component of this project. The project will disseminate 560,000 solar cookers by year 2005.The beneficiaries of this project will be low-income households in selected wood deficient areas. This project approach helped in first

testing the technology under local conditions and create a market for the technology at the same time. So before the business aspect in technology dissemination is introduced the potential recipients are made aware of the limitations of the potentials and limitations of the technology. Barriers that this projects is addressing are ;

- lack of appreciation of the potential of the technology

Solar cookers generally have a great potential, however this potential is not appreciated, as the technology has not been adequately marketed.

- Technology failing to meet the immediate needs of the recipients.

Cooking is an immediate need compared to lighting for which PV is normally used.

- Lack of information about the technology.

Information on solar cookers is very scanty especially when it comes to the rural populace who can benefit the most from such a technology

- Poor policy on RETS.

The policy on RETS in the country is not well developed to meet the real need of the country

- Inability to assess potential benefits and lobby government for policy improvement.

The real potential benefits of solar cookers are not fully assessed that there is not concrete information that can be used to lobby the government to change its policy on RETS

- Lack of business aspect in the dissemination of the technology.

Most initiatives on RETS lacked the business aspect that RETS are then viewed as welfare products.

3.14 Solar Dryers Project

The University of Zimbabwe, the Agricultural and Rural Development Agency (ARDA) schemes in Chinamano and Murewa Districts are having isolated efforts to develop local manufactured solar dryers for drying fruits and vegetables. Solar crop dryers can dry crops/ vegetables without losing nutritional value of these food items. Rural people would be able to preserve foodstuffs for a longer period. The project targeted 10 irrigation schemes, which were assisted in the use of the dryers and marketing of dried produce. At the end of the project, irrigation scheme farmers are to commercially dry excess horticultural produce for the local and export markets. The project, which is still ongoing, has produced some good results, what is left is the market dissemination of the technology with the help of local industry. Primary and secondary barriers conceived to be addressed by such an approach are;

- lack of appreciation of the benefits of the technology

The benefits of this technology are tangible thereby increasing the appreciation of the technology.

- poor technology performance

By testing the technology with a research institution before mass production the project avoided a situation where a technology would poorly perform.

- technology fails to address the real needs of the recipients

70% of the country is based on agriculture thus by using RETS in agriculture production, the technology becomes a means of production of the beneficiaries.

- technology cannot be used for income generating ventures

Crop dryers are very useful especially in the horticultural industry, which is a big money spinner in the country.

- high initial investment cost as units are locally produced

The units are 100% locally produced thereby reducing the capital cost of the equipment to make it affordable.

CHAPTER 4 : BARRIERS TO RETS IN ZIMBABWE

4.1 Methodology of this study

Various studies have been carried out to determine the barriers to cleaner energy technologies in Zimbabwe. A typical method employable would be to interview the stakeholders and ask them on what they see as the barriers to implementation of renewable energy technologies or more energy efficient production systems. The interviewer then tries to determine the actual barrier from the responses. Such a conventional approach has its own problems as it does not give enough room for comprehensive dialogue with the interviewer. To avoid such pitfalls this study adopted a different strategy. The strategy adopted in this study involved the following steps.

1. Desk study of existing energy strategies, policies etc

The aim of this desk study was to look at the overall energy situation of the country and look at the potential of RETS in the national energy supply chain. A review of the existing national energy strategy and plans was done to establish possible areas of possible improvement.

2. Assessment of lessons learnt from already implemented RETS projects and barriers they tried to address

Several initiatives into RETS were then examined. This section looked at RETS projects that were already implemented and those that are currently going on with the aim of establishing the barriers they attended to as well as deduce lessons from such projects.

3. First national workshop , who was invited and why

The main purpose of this workshop was to bring all stakeholders together and introduce the project. An advisory team for the project was selected. This stirring team included all the possible experts in RETS from industrialists to academics. Several RETS barriers removal projects were also presented at this event and the advisory team in consultation with the attendants were to lead the development of the proposals so the 4 good projects would be selected.

4. Selection of projects.

Four institution were then asked to develop their project and present them before the advisory team. These were SIRDC, Department of Energy, Biomass Users Network and Power Vision. However SIRDC ended up developing four proposals and an extra project was presented by Southern Centre. The projects were circulated to all stakeholders for barrier identification, removal options and analysis. Several comments were obtained from different organizations that responded.

5. Final RETS national workshop.

With all the comments and information a final workshop was organized present the outcome of the work. Stakeholders were then invited to give their perspectives on barriers identified and their removal options. The presented projects were then analyses to find out how best they address the identified barriers. The list of the barriers removal projects selected is included in the next chapter.

4.2 Barrier Analysis

A deduction made during the UNDP-GEF study on industrial energy efficiency is that there are primary and secondary barriers. The primary barriers are the actual reason why technologies are not implemented and the secondary barriers are often the apparent reason as seen from the stakeholders' perspective. Table 8 illustrates some of the primary and secondary barriers that are often quoted.

Table 8: Barrier Analysis

Primary Barrier	Secondary Barrier	Barrier effects
Inability to Develop and Present Project Proposals	Failure to secure investment support	Investor diversion to other areas. Poor volume of RETS trade Continued demand for grant funding
Inability to assess benefits and lobby government for policy improvement	Poor policy on RETS Subsidized fossil fuels Unfavorable taxation Poor baseline information	Continued view of RETS as a welfare good. Continued view of RETS as a small energy source.
Ignorance of government policy	No government incentive Inaction by government Inability to connect with relevant government bodies	No policy evaluation and feedback. Failure to benefit from existing policy.
Poor Fiscal/macroeconomic policy	No local technology base for RETS Poor institutional framework Poor infrastructure	Exclusion of RETS in energy planning. Exclusion of RETS from main stream industry. Lack of coordination of RETS programs. RETS disadvantaged by energy pricing. High initial investment cost. Limited skills base. Market ingress of sub-standard technologies.
Threat of natural disaster e.g. droughts and storms	Consistent food security problems Persistent water shortages and crop failure	Diversion of investment focus to basic needs.
Absence if curricular support in Schools	Poor academic consideration of RETS	Limited skills base.

After identification of the primary and secondary barriers it is then important to identify the least cost intervention for successful barrier removal. It is important that on removing the current barrier no new barriers arise from the removal process. An example is the 1993-1998 GEF-PV Pilot project, which tried to remove the market awareness barrier by providing a scheme with low cost funding removal of import duties and technical support to encourage widespread use of PV panels. The duties are however back on the imports at the moment.

This resulted in a new barrier that a large number of companies were formed, which could only survive under the program. Once the project closed the numerous small companies closed and the technical support dwindled. This created a new barrier of lack of trust of technical programs for renewable technologies.

Barrier removal should be very specific and should not displace the natural development process that a technology would follow in a market with nominal barriers.

4.3 Economic barriers

Investment costs

Renewable energy investment costs are normally higher than the comparable conventional energy option. The cost is mainly due to the limited scale of units that are bought for similar applications in the country. The GEF PV Pilot project that was implemented between 1993 and 1998 encouraged an increase in demand for Solar PV systems. Various suppliers were therefore interested in delivering systems or system components to the project. The result was lower prices compared to the previous case where individual companies imported equipment. At the same time government was persuaded to lift import duties from the equipment. The cost of equipment remained too high for the target group. A loan scheme, which was a feature of the project, encouraged high penetration rates but the equipment remained a privilege for the 'rural rich'. When the project was completed the benefit of duty exemption was lifted and the price of equipment rose to the local market levels. The mechanisms that had been set up were terminated and the delivery of systems dwindled. Most of the small companies that had been formed also closed. The project had not included a strategy for long term sustenance of the delivery mode therefore there was no institutional framework to continue the activities.

A project to use saw mill waste for energy remains undone in the Eastern Highlands. The project has now been analyzed for CDM funding with the hope that the concessionary funding under climate change would improve the viability of the project. The proposed project involves the production of electricity for sale to the grid. The timber producers who are the main stakeholders, are not able to provide the capital requirements for the project. At the same time the project fails to beat the competition from the conventional sources of electricity especially when environment benefits are not accounted for.

The question of investment cost is ambiguous because for the same cost the project would be viable if energy prices were higher. However the ruling criteria for most investment in small-scale energy technology is ability to pay and local perception of benefits. If the social benefits were seen as much more than the investment cost then the investor would set the acquisition of the technology as a high priority.

O&M costs

RETs have been viewed as the energy supply option for the remote and rural poor in Zimbabwe. This is the view taken by government as well as the private sector and other development agencies. As a result the end-users for most RETs projects in Zimbabwe have been in the rural areas. The GEF-PV Pilot Project was structured to supply equipment to rural households with almost no provision for urban households, the UNIDO initiative on

gasification targeted agricultural residues as fuel and the biogas program by the Department of Energy was structured to train rural builders to deliver systems to rural households. Given that the technology is new to rural communities with limited or no technical support based in the rural areas to support the end-user, it is obvious that the maintenance question becomes a major criterion for decision making by the end-user. The GEF-PV project had a set of guidelines or standards whose main objective was to limit the operational cost within the initial two years. These guidelines required a warranty period for components, provision of technical support and training. The project however had limited provision for the recovery of maintenance cost. In a way the guidelines were meant to protect the rural end-user from poor installer performance. Regardless of the provision several systems failed to operate successfully and complaints continue to be received by the Project Management Unit after the project closed. This serves to explain that some potential clients for renewable energy technologies are prevented from adopting them due to the fear for technology failure in the absence of technical support. The fact that technology information is mainly by word of mouth makes it even more critical that performance be good since a negative comment can discourage a large number of potential clients.

4.4 Financial barriers

Availability and access to domestic or foreign (venture) capital
The energy sector has previously been dominated by state owned agencies such as Zimbabwe Electricity Supply Authority for electricity, National Oil Company of Zimbabwe for petroleum fuels, Wankie Colliery Company (44% Government shareholding) for coal. The financial sector is therefore structured to deal with such agencies when it comes to the energy sector. Given the size of financing required in such cases the dominance of World Bank, African Development Bank, European Investment Bank and other bilateral and multilateral development agencies and Government guarantees has been the basis for rules for investment in the energy sector. Small investors are therefore a new and least understood option for the energy sector. As a result finance for renewable energy investment is difficult to access. Off shore financing comes with more favorable interest rates and repayment conditions but faces a major barrier in exchange loss cover where the local administrator for the funds is forced to collect a large premium to protect for exchange variations. The African Development Bank has a facility through the Zimbabwe Development Bank where the interest rates are as low as 5% but the on-lending rates by the ZDB have to be as high as 30% to 50% due to exchange loss cover. Such high exchange rates make the funding inaccessible.

Micro financing has not been successful in promoting RETS. The only time when micro-financing was used was when a local agricultural bank (AFC) was tasked to collect revenue from beneficiaries under the GEF-PV project. The main barrier to micro-finance is that RETS were generally directed towards benefiting the rural poor who do not have knowledge on such financing methods and cannot afford repayments due to high interests rates.

The first reporting point for the energy sector to government is the Department of Energy within the Ministry of Transport and Energy. A public body such as ZESA for electricity, NOCZIM for petroleum fuels and Ministry of Mines Environment and Tourism for coal regulates each energy sub-sector. The Department of Energy has so far been taking the initiative to guide the renewable energy sub-sector but without the regulatory framework as is the case with the other sub-sectors. The renewable energy resources fall within other non-energy regulatory agencies hence their control maybe biased towards the alternative usage.

An example is the forestry sector where the forests are linked to Parks hence the Ministry of Mines Environment and Tourism has a special interest on how the forests and plantations are regulated. The Department of Energy is not represented at Provincial or District level hence local planning has limited input from the Department in terms of energy development. A factor recognized by the District Environmental Action Plan DEAP which is being administered by The Department of Natural resources. The DANIDA funded program has one of its proposals as increasing DoE representation at local levels.

In the absence of a regulatory body renewable energy remains fragmented with special interest groups forming their own institutions with an interest in promoting the groups' objectives without much effort being put into coordination and regulation of activities. There is also no representation in the case of special policy or investment initiative other than by the bodies formed for the purpose within the framework of the initiative or by Government. The GEF-PV project had a large administrative budget because the administrative structure for a community project with loan financing was non-existent. It had to be set up as an exercise of the project.

4.5 Technology Barriers

Access to technology is often seen as a barrier to its use. This maybe true but in most cases access is restricted by other factors which on their own stand as barriers to adoption of the technology. Given the improved trade and communication ties between countries it is no-longer material that technology be available from local sources. The limitations on availability of foreign exchange are real but would not stop the successful transfer of a technology that meets the development needs of the host country. Large volumes of foreign exchange are spent on meeting the energy needs through conventional means and renewable energy technologies would provide an alternative to these options without exerting additional financing burden. The real need is for localizing technology know-how to allow for local screening in favor of renewable energy. Successful localization of technology know-how requires demonstration of performance, transfer of technology assessment skills, transfer of technical knowledge and building of a local technology assessment matrix that includes financial, technical and social criteria for technology acceptance. Commercialization is also a major need for successful diffusion of renewable energy technologies. Effort to date has been by development agencies that seek to increase interest in renewable energy by private business. At the same time market development has received large volumes of funding with minimum movement in terms of market adoption of technologies. The main reasons for limited success could be the mismatch between time of introduction of technology and readiness of market to shift from conventional to more modern technologies.

Technologies have to be localized at the various levels from technology supply to end-use including local maintenance.

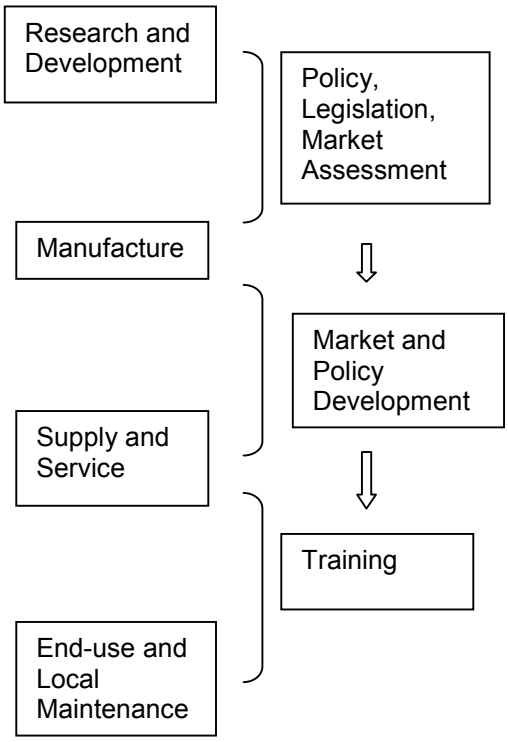

Figure 9 : Steps in Technology delivery

Figure 9 shows the basic steps in technology delivery. In practice the boundaries are not so clear and interaction with other activities within the economy has great influence on the decision to adopt technologies. It therefore means if a barriers exists at any stage of this delivery line then the technology delivery will fail.

4.6 Social Barriers

Poor matching of individual and national development objectives. Most renewable energy projects implemented in Zimbabwe have been based on the assumption that rural communities need alternative energy to displace fuel wood. A further assumption is that they could do well with renewable energy sources because they are cleaner and help protect the environment. To this end renewable energy technologies have been promoted with enthusiasm. "The Alternative Energy Strategy for DoE" a workshop report sponsored by GTZ indicates this factor as a barrier to adoption of alternative energy. The report gives biogas digesters as an example technology with limited relevance to the individual but the same point can be made by analyzing PV power. Rural communities need electrical energy and they are familiar with its applications as can be seen in urban areas. PV systems deliver electrical energy but fall short in meeting the major energy needs for rural communities. The general comment to the GEF-PV project has been that PV power cannot cook hence the need is still unmet. During an evaluation of the DANIDA Renewable Energy program in Zimbabwe one community group was found to be thinking of PV power to drive ostrich incubators. There was no mention of lighting, as a primary need. The community had to face a major bill for grid extension to link their project to the utility supply. The need for new

economic activities has not been taken as a major criterion for energy planning in rural areas as far as renewable energy is concerned. The global objective has been to meet the current household activities with renewable energy technologies thereby creating a technology market without empowering the market to pay.

4.7 Institutional Barriers

A key factor influencing the implementation and promotion of RETs in the country is the existing institutional infrastructure. A strategically set up and conducive institutional framework has in most cases shown to be a requirement for successful technology dissemination.

Table 9 below shows the importance of interventions in competitive technologies. Although the two countries have the same potential, positive institutional and policy inventions in Botswana have realized a much higher solar water heaters installed capacity than Zimbabwe.

Table 9: Comparison of SWH situation in Botswana to Zimbabwe

	Botswana	Zimbabwe
Population	1.5 million	14 million
Latitude	35°	
Domestic electricity tariffs	6.6 US cents/kWh	5US cents/kWh
SWH cost normalized to US$/100 liter of systems	US$520	US$300
Installed domestic SWH capacity collector area	50 000m^2	10 000 m^2

The two countries have an active private sector involvement and strong market growth potential for SWH. However the market in Botswana is more developed than in Zimbabwe due to several government interventions like state contracts to provide services to public buildings, testing facilities and advisory services. The dissemination of SWH systems in Zimbabwe has been very rudimentary although the prices of electricity are almost the same and SWH systems are actually cheaper in Zimbabwe.

4.8 Discussion of Barriers at Final Project Workshop

Several barriers were identified at a project workshop held in Harare on 29 August 2000. Below is a list of barriers, which were identified at the workshop :

- Poor institutional framework and infrastructure;
- Inadequate RETs planning policies;
- Lack of co-ordination and linkage in RETs programs;
- Pricing distortions which have placed renewable energy at a permanent disadvantage to other conventional fossil Fuels.
- High initial investment costs coupled with absence of supporting financial instruments;
- Weak dissemination strategies and excessive emphasis on the service and welfare functions, rather than production and entrepreneurial-based approaches;
- Lack of requisite skilled manpower;
- Poor baseline information;
- Inadequate technological bases necessary for the large-scale manufacture and distribution of RETS;

- Weak maintenance service and infrastructure
- Technology Failure, inappropriate technologies, not matching with rural user needs
- Lack of liaison with rural development units;
- Natural Barriers such as water shortages, poor wind speeds and other natural causes
- No serious official follow-up to the all ready implemented projects.
- Lack of Curricular support in RETs in schools and institutions of higher learning.
- No official co-ordination from Donors. Donors end up funding the same project over and over again without any follow-ups. This depresses local initiatives.
- Unfavorable macro-economic policies. Sector affected by the state of the economy.
- Lack of a level playing field for all sources. Some energy sources are heavily subsidized at the expense of other technologies thereby creating an uneven playing field.
- No strategic view and planning on the future of RETs. Project sustainability not taken seriously.
- Lack of transparency on project allocation by the government and the donors.

4.9 Assessment of National Sustainable Development Policies

Sustainable development is achievable through action by all government bodies to implement policy that promotes sustainable development activities. Zimbabwe produced a National Conservation Strategy in 1987. This was in response to the World Conservation Strategy. The National Conservation Strategy acknowledges the need for optimizing use of water and other natural resources. The need for economic growth is well acknowledged and some of the policy objectives are given in Table 10.

There are at least 18 pieces of legislation that deal directly with environment protection. There is currently a process to combine all this legislation into one piece of environment protection legislation that is easier to administer. The present fragmented legislation causes problems of implementation, as responsible authorities cannot easily lease on various operational issues. An example is the Mining Act that literary overrides all other legislation. Also the Factories Inspectorate which is responsible for safety inspections in industry has no Jurisdiction outside the factory premises whilst industrial activity may endanger the lives of those outside the premises. The Ministry of Health would have to send it's own inspectors to enforce pollution legislation even when the Factories Inspectorate will have approved a plant for safety.

The Ministry of Environment and Tourism is responsible for producing the new legislation. This new legislation aims to bring together all aspects dealing with environment thereby making it easy to enforce comprehensive and sustainable environmental utilisation and management. This move towards creating environment awareness of all sectors of the economy including the energy sector is aimed at conscientise planners on environmental

Table 10: The National Conservation Strategy's policies and their objectives

Policy Objective	Effect on Water/Resource Use
Increased standard of living of population as a whole.	Increased individual/domestic water consumption from 10-20l/person-day to 100l/person-day
Increase employment opportunities	To increase industrialization and urbanization hence increase resource use hence increase overall water use from $133m^3$/person-year to $365m^3$/person-year
	Increase irrigated agriculture
	Increase processing of raw materials hence increases waste production.
To provide for the inevitable increased population (at least doubling in 20 yrs)	Increase food production and increase provision for housing and other commodities.

Source: The National Conservation Strategy.

friendly practices. In the case of the energy sector, planners are naturally invited to consider environmentally friendly sources like RETS to minimize environmental impacts of their projects. As part of the process the Ministry has produced Environmental Impact Assessment Guidelines for all project developers10]. Currently the responsibility of the Minister on receiving the assessment reports is to review and approve the project. It is hoped that the guidelines will be developed into a legal instrument, which will set compliance requirements. The following are the guiding principles of the EIA Policy.

- Sustainability for future generations is the cornerstone of environment management.
- Dependence on a complex and diverse ecosystem requires management approaches, which integrate economic, social, cultural and natural environments.
- EIA must enhance development by contributing to its environmental sustainability, not inhibit it.
- EIA is means for project planning, not just evaluation
- Project impacts must be monitored and managed throughout the life of the development.
- The EIA policy depends on the normal regulatory functions of authorities to implement EIA results.
- The EIA policy involves the participation of all government agencies with a mandated interest in the project.
- Particular attention must be given to the distribution of project costs and benefits.
- Many decisions concerning the environment are dependent upon meaningful public consultation.

At present the EIA guidelines cover:

- Mining and Quarrying
- Forestry
- Agriculture
- Transport
- Energy
- Water

- Urban Infrastructure
- Tourism and
- Waste Management

Specific to Energy the Ministry of Transport and Energy produced an action program for implementing the National Energy Policy in 1999. The main objectives of the Energy Policy are:

1. To ensure accelerated economic development
2. To facilitate rural development
3. To promote small to medium scale enterprises
4. To ensure environmentally friendly energy development and
5. To ensure efficient utilization of energy resources

The proposed strategy included:

- Limiting energy demand to the extent consistent with maintaining growth through pricing based on economic costs and more efficient use of energy.
- Choosing an appropriate level of reliability of supply,
- Exploiting regional co-operation opportunities to reduce supply costs, subject to political considerations,
- Enhancing rural development through provision of adequate forms of energy,
- Integrated energy planning, and
- Balanced energy management.

4.9 Barrier Removal Actions

It may appear easier to attack the primary barrier in barrier removal but the effects of barriers in some cases become a barrier. Barrier removal programs therefore need to include measures to overcome the secondary barriers as well as the effects of barriers before the system can gather sufficient momentum to run on market forces alone. An example is the need to improve the quality of proposals for RETS projects where seed money and entrepreneur development would be needed to make the barrier removal action effective. Table 11 details the actions recommended by the final workshop and also those recommended by the research team.

The final workshop of this project recommended the following general barrier redress mechanisms

- Technology specific stakeholder meetings
- Communicating with development programs / projects
- Internal DOE capacity commitment and mandate to consider R.E
- Linkage with other stakeholders for implementing policy
- Regular meetings with DOE
- DOE newsletter as a communication tool with stakeholders
- Human resources audit in the Department of Energy
- Private sector should present recommendations to government
- Information programs for parliamentarians
- Web-sites for Zimbabwe alternative energy strategies
- Fiscal policy to promote R.E

- Research and development to reduce imports
- Promoting technology information exchange
- Screening of equipment for quality
- Development of the curricular on R.E. in schools and colleges
- Information publicity and dissemination through competitions in the rural areas, schools and colleges on renewable energy
- Set up local finance- micro finance schemes for the implementation and promotion of RETs

Table 11: Identified primary barriers and removal options

Primary Barrier	**Removal Action**	**Responsible Parties**
Inability to develop and present project proposals	Set-up finance schemes; Develop guidelines for proposals	DOE, Development Agencies
Inability to assess benefits and lobby government for policy improvement	Technology specific stakeholder meetings. Capacity building within DOE and Industry	RETS Industries DOE External Development Agencies
Ignorance of Government Policy	Regular meeting between DOE and stakeholders.	DOE, RETS Industries
Poor Fiscal/macroeconomic support for RETS	Capacity building within DOE, Industry Promote technology information exchange. Information programs for legislators	DOE, Industry External Development Agencies
Absence of curricular support in schools	Development of RETS curricular in schools Information programs for schools	Universities, DOE Industry External development agencies

The next chapter looks at some of the barriers mentioned above and attempts to look at projects that may help in the removal of some of the barriers. Although some of the barriers that will be considered here are project specific others are general barriers to RETS.

CHAPTER 5 : PROFILES OF CANDIDATE RETS PROJECTS

The first national workshop that was held in Harare on the 4th of November 1999 recommended the setting up of an Advisory Committee in renewable energy in Zimbabwe. The committee which comprises of various stakeholders from the government, the private sector, interviewed end-users and the NGO community was tasked with the responsibility of coming up with recommendations to barrier removal and the promotion of the technology. Interested stakeholders were asked to present candidate barriers removal RETs projects proposals for discussion at the final national workshop held on 29 August 2000.

Barriers that each of these projects was designed to address were identified and recommendations for successful implementation were pointed out. Five institutions submitted their project proposals: -

Scientific and Industrial Research Development Centre (SIRDC)

The Scientific and Industrial Research and Development Center (SIRDC) presented four project proposals for discussion: -

5.1 Entrepreneur Business and Technical Skills Development in Renewable Energy

Project Ownership: - SIRDC

Project Concept:

Zimbabwe has emerging small and medium scale (S & M) Industries in renewable energy, which needs an immediate support on both the technical and business areas in order to remain as a viable industry in the present harsh economic environment. This project aims to capacity build both the business and the technical skills of selected Small and Medium (S & M) scale industries in solar, solar thermal, biomass and mini-micro hydro industries through the provision of structured practical training courses and the transfer of appropriate technologies. The Energy Technology Institute at SIRDC will structure and deliver the required training programme for each industry in collaboration with Twente University, Netherlands and through its other linkages with Cape Technikon and Pretoria University in South Africa.

Technology Needs: -

Technical Design Tests facilities and business management skills.

Technology Suppliers: -

Energy Technology Institute, SIRDC

Market Assessment: -

Obvious lack of scientific knowledge, skilled manpower and absence of test facilities.

Barriers to be removed by the project :

- Weak dissemination strategies and excessive emphasis on the service and Welfare functions, rather than production and entrepreneurial-based approaches:
- Lack of requisite skilled manpower;
- Poor baseline information;
- Inadequate technological bases necessary for the large-scale manufacture And distribution of RETS;
- Technology Failure, inappropriate technologies, not matching with rural User needs:

Barrier removal actions: -

(1) Through training courses
(2) Provision of information dissemination channels
(3) Making available the test facilities

5.2 Country Strategy on Renewable Energy Technologies

Project Ownership: -SIRDC

Project Concept:

A number of renewable energy projects have been implemented in Zimbabwe with varied degrees of successes regarding the achievement of the project objectives. There are a number of varied causes, which contributed to project failure in achieving its objectives. Among these are the absence of reliable information about the renewable energy market in Zimbabwe, its strengths and weaknesses, the users' actual needs, choice of the appropriate technology which matches the user's needs and can be practically maintained and sustained. This project is a multi-phase and its first phase aims at carrying out a survey study of the renewable energy market in Zimbabwe with the main objectives of identifying its strengths and weaknesses in the manufacturing, distribution and maintenance sectors of the market. This initial phase of the study will also compile a list of the most common renewable energy systems available and the technologies involved, with the aim of matching the requirement of each system with the market capabilities for manufacturing, installation and maintenance of such systems. The overall objective of the study is to come up with a guide line or strategy to be followed when it comes to the selection of a particular renewable energy technology to be implemented in a new project which would ensure that the most appropriate technology is chosen, implemented and can be practically maintained and sustained.

The second phase of the project will extend the study to cover the users' side where a market survey will be carried out to cover the users' actual needs and to see how it could be best met through either a choice of a particular type or a combination of renewable energy systems. Questions like the social acceptability of the renewable energy system, the ability of the users to operate and use the system and the user financial capabilities will be covered under this phase. Prioritization of the introduction of renewable energy systems/technologies based on user needs will come up as a recommendation at the end of the second phase of the project.

Phase three of the project will focus on the production of guidelines for the selection of a particular renewable energy technology / system based on the country's geography, solar

radiation data, wind speed, availability of water streams, availability and location of biomass, the system cost and previous experience of projects implementation.

Technology Needs: -

Advanced data collection and processing facilities

Technology Suppliers: -

SIRDC

Market Assessment: -

To be carried out as part of the project.

Barriers to be removed by the project

- Poor institutional framework and infrastructure;
- Inadequate RETs planning policies;
- Lack of coordination and linkage in RETs programs;
- Poor baseline information;
- Inadequate technological bases necessary for the large-scale manufacture and distribution of RETS
- Technology Failure, inappropriate technologies, not matching with rural User's needs

Barrier removal actions: -

Establishment of the market status quo, stakeholders' strengths and weaknesses and preparation of draft country strategy based on the study findings.

5.3 Development of House-based Solar Power Generation Scheme

Project Ownership: -SIRDC

Project Concept

Development of 3 to 5 kW solar power generation scheme which is synchronized with the power grid. The scheme will operate in parallel with the electrical system to meet the house need from energy and to export the excess energy back to the supply when it is not utilized. Energy bill will be based on the difference between energy import and export to and from the supply.

Technology Needs: -

(1) Synchronization of solar generator scheme with varied voltages to the ac network
(2) Inverter designed and production technology
(3) Two ways metering system.

Technology Suppliers: -

SIRDC and international R&D institutions

Market Assessment: -

None of this scheme is available at present.

Barriers to be removed by the project :

- High initial investment costs coupled with absence of supporting financial instruments;
- Pricing distortions which have placed renewable energy at a permanent disadvantage to other conventional fossil fuels:
- Lack of requisite skilled manpower;
- Poor baseline information;
- Inadequate technological bases necessary for the large-scale manufacture and distribution of RETS;

Barrier removal actions: -

(1) Usage of local resources for system development
(2) Provision of expertise
(3) Provision of information
(4) Provision of channels of information sourcing and adequate technology baseline.

5.4 Development of Affordable Solar Cookers for Both Rural and Urban Users

Project Ownership: - SIRDC

Project Concept:

To develop affordable solar cookers with different cooking capacities and performances for both rural and urban users. The development designs will be built using locally available materials and tested to show its cooking capabilities and its temperature profiles. Different designs are to be developed to give solar cookers with varied cooking capacity and costs to suit users varied financial capabilities and needs.

Technology Needs: -

(1) Data on thermal radiation, convention and enhancement techniques.
(2) Design expertise
(3) Manufacturing and testing facilities

Technology Suppliers: -

SIRDC and local manufacturers.

Market Assessment: -

Badly in need of solar cookers.

Barriers to be addressed by the implementation of this project: -

- High initial investment costs coupled with absence of supporting financial instruments:
- Pricing distortions which have placed renewable energy at a permanent disadvantage to other conventional fossil fuels;
- Poor baseline information;
- Technology Failure, inappropriate technologies, not matching with rural user needs:
- Unfavorable macro-economic policies. Sector affected by the state of the economy.

Barrier removal actions: -

(1) Provision of appropriate, home grown technologies and products which take both the needs of users and their financial capabilities into account
(2) Provision of an appropriate solution, which is sustainable through the use of locally available materials and expertise.
(3) Involvement of the local manufacturing sector.

5.5 African Windpower- Powervision Project Proposal

Form

The project aims to install 10 owner-operated income generating wind-charging systems around Zimbabwe

Brief Outline

Suitable sites will be surveyed and if suitable a wind charger system will be installed. These will comprise:-
i) A tower
ii) A Wind generator
iii) A controller
iv) A battery bank
v) A DC-AC Inverter
vi) An automatic battery charging system
vii) Limited 220volt AC distributor

Operation

The owners will use the systems to: -
a) provide power for lights and entertainment for owner's use
b) Operate a commercial battery charging system
c) Sell limited Ac power to small business tenants

Barriers to be addressed by the project

1. Inadequate technology
2. Inappropriate technology
3. Unavailable funding
4. Private sector led development
5. High investment costs
6. Dissemination of information

Potential Owners

a) Mr Elias Mabvuramiti- Chimanimani
b) Mr. S. Ngwenya- Bulawayo Area
c) Mr Moses Ruwana- Mt Darwin
d) Mr Moyo- Nyanga

Project cost and financial Estimates

Project Costing	**US$ 5100**

Monthly Income and Expenditure

Loan Repayment at 60% interest rate	ZW$ 1520
Monthly Income from battery charging	ZW$ 1680
Other business income	ZW$ 500
Total Income	ZW$ 660
Add Value of home power use	ZW$ 300
Total equivalent income	**ZW$ 960 = UD$ 17**

System Costing	**US$**
Turbine and controls	1800
Tower	1000
Batteries	800
Inverter	750
Transport and Installation	750
Total	**5100**

5.6 Biomass Users Network Project Proposal

Project Title: Identification of Desirable Stove Characteristics and development of prototype Stoves for field-testing.

Project Ownership

The project will be community based and the key stakeholders are rural women, small rural enterprises and NGO's. The Biomass Users Network will execute the project. Women making food for hospitalized family members will test the stove.

Project Concept

The proposed approach is to identify user modifications to the open fire and to existing "improved stoves." The next step is to develop a set of prototype designs of stoves based on the findings and then field-test a selection of potentially suitable stoves developed. The results are expected to be used by small-scale rural enterprises to produce and market the stoves.

Technology Needs

Essentially there need to be information collection and dissemination tools (multimedia for example), stoves testing equipment, basic workshop tools for fabricating metal and clay prototypes.

Technology Suppliers

Some of the equipment will be fabricated by small and medium enterprises or rural women while other technology equipment will be of foreign origin.

Market Assessment

The concept clearly shows that the market issue arises later in the project. The suppliers are expected to be SMEs and the market will be urban poor and rural households. This will be much the same as the metal grate stoves.

Barriers removed by the implementation of this project

Difficulty in capturing cultural issues, conflicting requirements indicated by users, potential high cost of stoves are some of the barriers to be addressed by the project

Barrier Removal Action

- Involve women closely in all stages of project execution.
- Develop different prototypes optimized for different needs
- Involve SMEs in the process to capture ideas on cost reduction measures in production.

5.7 Department Of Energy Project Proposal

Project Title: Solar Water Heaters

Project Concept

Conservative estimates are that over 500 GWh of electricity is used for water heating in homes in Zimbabwe per year. The electricity is produced from a mixture of coal-fired power plant and hydroelectric power plant. 60% of the electricity used in the country is now being imported from neighboring States.

The utility is starved of investment capital due to the shortage of hard currencies and the import bill for electricity has been rising beyond manageable limits. The domestic tariff does not include a demand charge. As a result there is no sensitivity to time of use in the residential areas. The utility has been forced to shed load as a way of controlling the system peak.

The cities of Harare, Gweru and Bulawayo have a system for switching domestic water heaters on and off for peak management. This system is however very old and dogged by poor performing equipment.

The proposed project is to install solar water heaters as a way of reducing energy demand for water heating by households. The solar water heaters would supply alternative energy to the households and therefore relieve the electricity system of at least 60% of the energy used for water heating. Previous experience showed that at least switching off water heaters that were connected to the control system in Harare could reduce 40MW of demand. Given the construction of new houses and the subsequent installation of new water heaters, this figure has grown significantly. In addition to new installations the connection of a larger number of the old water heaters will also increase the load that can be controlled. 1993 estimates were that there were 100 000 electric water heaters in Zimbabwe households. This number has increase with the construction of new houses and the installation of electric water heaters in some old houses.

Project activities

The first part of the project would be to determine the number of solar water heaters that could be installed. In addition the potential energy savings would need to be estimated so as to determine the potential for greenhouse gas emissions. Once this information is established a proposal can be drafted on the contribution of cost and sharing of benefits from the project. The stakeholders who would be involved in the project would be house owners, electricity utility, government and global community.

The cost would include;

- Capital investment for water heaters and maintenance facilities.
- Installation cost.
- Recovery and decommissioning of electric water heaters.
- Cost of electricity supplied as standby energy.

The benefits would be;

- Reduction in demand for electricity
- Reduction in energy consumption cost
- Reduction in energy supply cost
- Reduction in greenhouse gas emissions

Technology Needs

1. Thermometers for measuring water heater skin temperature.
2. KWh meter for measuring energy consumption.
3. Solar water heaters.
4. Time switches for controlling standby electric elements.

Known Technology Suppliers

Solarhart, Monarch Solar, Capri, Siemens, GEC, Solar Impact etc.

Market Assessment

Electric water heaters are mostly in medium and high-income households. Multiple units are quite common with some houses with as many as five water heaters. Switching to solar water heaters will depend on the available income per household.

Barriers removed by the implementation of the project

- High relative cost of solar water heaters when compared to electric water heaters.
- In ability to assess benefits on the part of house owners and utility.
- High capital cost on the local money market.
- Shortage of mortgage finances.
- General shortage of disposable income in households.

Barrier Removal Activities

- Assessment of benefits of solar water heating and presentation of results
- Establishment of a revolving fund or new mortgage funding.

5.8 Southern Centre Project

Project title: Assessment for potential of renewable energy resources and technology applications in urban areas.

Project ownership: Southern Centre for Energy and Environment

Project concept: Renewable energy technologies have been viewed as an option for developing rural areas. As a result all development is guided by requirements for rural applications of the technologies. Given the limited resources in rural areas the technology options lack a cost carrier with the result that the technologies have a high initial cost. If urban applications of the technologies were identified the potential market for the

technologies would have a mix of high, medium and low-income buyers and the initial cost would fall significantly. This project seeks to identify the opportunities for applying renewable energy in urban areas. The hope is that once identified the urban market would be able to carry the development cost for the technology and therefore reduce the cost burden on lower income groups.

The target resources will be amongst others;

- Food waste from the food industry.
- Wood waste from timber outlets.
- Municipal solid waste
- Municipal sewage waste
- Urban household applications
- Absorption refrigeration.
- Lighting applications

Technology Needs

The main tool will be methodology for estimating energy potential of various materials. The project would collect raw data that would be converted to energy potential. There is also a need for technology information for use in assessing the viability of the various technology options. This would include prices, efficiency, operating cost, skills requirement as well as technology sources.

Barriers to be addressed by the implementation of this project.

- Lack of systematic data records.
- Uncertainty in the viability of the particular business.
- Competition from conventional energy sources.
- By-laws restricting handling of waste material.
- Commodifying of waste material – unknown fuel prices.

Barrier Removal Action

- Conversion of production data to energy resource data.
- Partnership with conventional utilities.
- Estimation and recommendation of raw material/fuel prices.
- Cost/benefit analysis from the utility perspective.

Proposed Budget

50 Man days	US$	17 500
Transport	US$	2 000
Communication	US$	1 000
Reporting (stationery)	US$	1 000
Total	**US$**	**21 500**

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