

# **Power from Wind: Improving Rural Livelihoods through Renewable Energy Provision**

**Thematic Area:** Climate and Energy

by

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## 1.0 Introduction and Background

Many rural areas in Zimbabwe except for rural service centres are not connected to electricity. Rural communities are mainly dependent on fuel-wood in the form of wood and paraffin. About 70 % of rural households use firewood as a source of energy. Although paraffin is a subsidized commodity not many rural households can afford to buy paraffin. In addition the open fireplace is part and parcel of the traditional way of life in the rural communities. It was only in the early 1990s that the Department of Energy proposed the need for expanded rural electrification program. Due to limited government finances the program has been very slow and has mainly concentrated on providing electricity to rural hospitals and clinics and government secondary schools. Renewable energy use has been rather limited with NGOs being the main drivers in experimenting with solar, wind and biogas. Another initiative at providing renewable energy to rural communities was the GEF funded photovoltaic projects that provided subsidized solar panels for lighting purposes for rural household use. This project only benefited those households with enough income to purchase the panels.

The "Power from Wind" Project arose out of the growing need for and focus on renewable sources of energy. The project involved a three-year wind monitoring exercise conducted in the country in the late 80s and early 90s which found that there was potential for the development of a low wind speed turbine that could generate useful amounts of electricity. Through the efforts of its research staff, ZERO initiated this project mainly to prove that wind energy is a viable source of renewable energy in Zimbabwe and can be successfully tapped to provide electrical power. Monitoring sites were established in Chimanimani, Chivhu, Karoi, Mt Darwin and Rusape to find out how much wind was available and in what quantity. Pilot wind generators were installed at Dumbamwe and others in Chimanimani District at Chayamiti, Chikukwa and Shinja.

Although the tests proved that this technology works, a number of constraints were identified including the high costs of the turbines and the need to install turbines that would operate at low wind speeds. With the support of an engineering expert, ZERO designed a locally manufactured 1kW-wind turbine that can operate effectively in the low wind speed conditions, characteristic of Zimbabwe.

Comparatively speaking wind energy systems are cost effective compared to photovoltaics which would require a larger array of panels with every increase in the number of consumers. In this regard wind turbines are more suitable for larger institutional and community loads. On a suitable site, the system can provide power to clinics and schools for the use of:

- Projector, TV and Video
- Vaccine refrigerator
- Microscope
- Small autoclave
- Room lights

- Operating light
- Staff housing lights
- Radios
- Computer and printer
- Lights after hours for study
- Science equipment
- Sewing machine

This project is a unique initiative as it demonstrates the fruits of tripartite partnership between government, the private sector and the non-governmental community. The project was aimed at developing a wind turbine for the purposes of generating electricity for institutional and community use. It was felt that wind provided the most cost effective way of supplying power to large consumers or group of consumers compared to photovoltaics which would require a larger array of panels with every increase in the number of consumers.

Wind on the other hand is a once-off investment that can cater for several consumers without pro-rata costs. Electricity thus supplied would benefit a wide range of people, that is, those who would use the health centres powered by wind and those communities that would combine to draw electricity from a single turbine or have their batteries charged.

### **1.1 Involvement of the Community**

The local community at large was an integral component of this project. The establishment of the Dumbamwe Trust fund enabled the community to have a sense of ownership of the project. The target community, which comprised all the households within Dumbamwe ward, was involved in the setting up of the objectives and the purpose for the Trust. The majority of the Trustees are residents of Dumbamwe. In addition a project management committee comprising community representatives is responsible for maintenance of the turbines and monitoring the operation of the battery recharging system and the collection of payment for the electricity utilized by the business people at the Dumbamwe Centre.

The challenge in setting up the Trust was the high expectation that community had from the installation of the turbine, hence their ambitious plans in terms of the use of the Trust Fund. Although ZERO's plan had been to pilot test a locally generated turbine and to provide limited electricity for the business Centre, the community expected more. The community initially received the project with much enthusiasm expecting electrification of their homes. Much time was therefore spent on explaining the expenses involved in installing enough turbines to generate electricity for each household.

## 1.2 Objectives of the Project

The project's broad objective was to contribute in a meaningful and practical way, to the provision of an affordable energy alternative to the rural people of Zimbabwe.

The "Power from Wind" Project had the following expected outputs:

- Production and installation of at least six wind turbines;
- Wind technology demonstrations at selected village sites so as to showcase the technology;
- Production and distribution of training manuals and other awareness-raising material on the applicability and use of the wind turbine; and
- A better informed public on the use of wind to generate electricity.

The project was divided into two distinct phases.

### Phase 1

Phase 1 (January 1990-March 1993) which focused on monitoring of wind speeds and installations of pilot wind generators. Wind speed data collection was done at four sites: Chivhu, Karoi, Mt Darwin and Rusape.

This phase also yielded three small 50-watt Marlec 910 wind generators providing a 12 volts direct current (dc) which were installed during the period in Chimanimani District at Chayamiti, Chikukwa and Shinja. Another generator was installed at Dumbamwe clinic in Makoni.

### Phase 2

Phase II (1998-2001) had the main goal of designing and developing a wind turbine rated at more than 500W which could be manufactured in Zimbabwe and operate effectively in the low wind speed conditions characteristic of the country.

The project was implemented over a three-year period as follows:

**Table 1: Implementation of the "Power from Wind" Project**

Year	Activities
Year 1	<ul style="list-style-type: none"><li>- Wind monitoring</li><li>- Market study</li><li>- Production and installations of wind turbines</li><li>- Village demonstrations</li><li>- Training</li><li>- Technology assessments</li></ul>

	- Production of publication
Year II	- Wind monitoring - Village demonstrations - Training - Production - Technology assessment
Year III	- Production - Publications

### 1.3 Institutional Framework

The institutional framework of the project was as follows:

- Department of Energy and **ZERO** as co-researchers;
- Manx Wind Energy Services (**UK**) provided consultancy services in the development of the low speed turbine generator;
- Meteorology Department assisted in wind monitoring;
- Powervision (Pvt.) Ltd. manufactured and installed wind turbines and also distribution and marketing; and
- Rural District Councils assisted in the mobilisation of communities and setting up of district pilot demonstration centres.

### 1.4 Project Activities and Accomplishments

- The turbine manufacturer, Powervision (Pvt.) Ltd. has conducted a market survey to gauge market response to the turbine;
- The setting up of battery charging systems at Temaruru Business Centre, Chikukwa Permaculture Centre and Msampa Fishing Camp. This became necessary for income generation purposes. The income accruing from battery charging contributes towards payments for security services and purchasing of inputs such as battery water and grease. This ensures project sustainability long after the withdrawal of the project implementor;
- Socio-economic study around the Dumbamwe area. This was done for the purposes of assessing the economic viability of the wind-powered water pumping system to be used for irrigation. The gender dimension was also critically analysed since the assumption was that it would be mainly women and children who would be involved in the agricultural activities evolving from the provision of water. Most men were presumed to be working or looking for employment in urban centres;

- Assessments have been carried out on electricity generating capacity of wind at higher heights of above 20m at Chikukwa Permaculture Centre in Chimanimani. At Wiltshire Headquarters Clinic in Chivhu and Vungu Secondary School in Lower Gweru;
- Commercially viable wind turbines have been produced, tested and installed for use at Dumbamwe Clinic and Secondary School, Temaruru Business Centre, Chikukwa Permaculture Centre and Msampa Fishing Camp. The power is used to power radios, black and white TV sets, lights, water pumping and operation of a computer at Chikukwa;
- As a means of raising awareness about wind energy technology, a national seminar on the technology was held from 28 - 29 July 1999. A number of papers on renewable energy technology in general and wind energy technology in particular were presented at the seminar. The report was widely circulated to seminar participants and those who could not attend the seminar for one reason or another.

Seminar participants were also taken on a tour of the Dumbamwe Clinic and Temaruru Business Centre wind turbine systems. The wind turbine systems at Dumbamwe and Temaruru Business Centre were officially commissioned by the Minister of Transport and Energy and a video clip of the proceedings was shown on national television during the main news bulletin;

- Local attendants were trained to maintain the system and conduct basic repair work. Battery charging is also being undertaken at the sites with the turbine systems. This activity has proven to be a viable income-generating activity;
- An operators' training manual for the wind power system was produced. This was used to train operators and attendants at all project sites. Also published were papers on wind energy technology; and
- Partnerships have been created between the Government's Department of Energy, Powervision (Pvt.) Ltd. and ZERO. The partnership has resulted in the building of expertise among the project personnel and greater awareness and understanding of wind energy technology among staff of the three institution.

### **1.5 Unfulfilled Project Objectives**

Two turbines remain outstanding due to exhaustion of project funds. Also, the unexpected high inflationary environment that saw costs for fuel, turbines and all ancillary equipment going up drastically strained the budget. This resulted in two sites, Wiltshire Headquarters Clinic in Chivhu and Vungu Secondary School in Lower Gweru not benefiting from wind power as the two turbines could not be paid for. This is despite the fact that both sites showed very high wind speeds to warrant installation of the turbines.

## **1.6 Was the target group reached?**

This target group has been extensively reached as wind turbines were installed at:

- Dumbamwe Clinic and Secondary School, and Temaruru Business Centre in the rural area of Makoni District Council, Rusape;
- Chikukwa Permaculture Centre in the rural area of Chimanimani District Council; and
- Msampa Fishing Camp along the shores of Lake Kariba in the rural area of Nyaminyami Rural District Council.

The surrounding rural communities have seen the practical application of wind energy technology in providing electrically useful energy. Furthermore, wind-monitoring systems were installed at Wiltshire Headquarters Clinic, Makanda Clinic and Vungu Secondary School in the rural areas of Chikomba, Wedza and Vungu Rural District Councils respectively. The communities around these sites collectively ensure the security of the equipment.

Skills capacity of ZERO, Powervision and Department of Energy (DOE) staff involved in the project has been built. Powervision's staff now feel confident of building their own model based on the prototype. ZERO and DOE staff are now capable of mounting wind monitoring systems and conducting basic repair work on the wind turbine systems. Despite facing initial teething problems, Powervision is now capable of manufacturing 1kW (or higher) turbines.

In order to investigate the size of the battery store for a wind turbine, a computer model has been applied to the raw data from the turbine test site at Dumbamwe.

## **1.7 Project Impact**

Prior to commencement of the project, project staff (except those from Powervision) had little practical knowledge of the operations of a wind turbine system. Most of the little knowledge the staff had was drawn from visual observations of already functioning wind turbines. However, with the hands-on experience and practical application of the technology to situations at home, the skills of project staff have been enhanced. There has also been a diffusion of skills from the main technical partner, Powervision, to selected local personnel living at project sites who are in charge of maintaining the wind turbine systems and undertaking basic repair work. This personnel has also been trained to run a battery charging system.

## **2.0 AGENDA 21 RECOMMENDATIONS ON ENERGY**

Agenda 21, the United Nations' blueprint for sustainable development, notes that energy supplies in many countries are not commensurate with their development needs and are highly priced and unstable. Like in many developing countries, the chief sources of

energy in Zimbabwe's rural areas are woodfuel, crop residues and animal waste. For increased productivity of human labour and for income generation, more intensive energy inputs are required. To this end, rural energy policies and technologies should promote a mix of cost-effective fossil and renewable energy sources that is itself sustainable and ensures sustainable agricultural development.

Agenda 21 encourages governments to:

- (a) Initiate and encourage, not later than the year 2000, a process of environmentally sound energy transition in rural communities, from sustainable energy sources, to structured and diversified energy sources by making available alternative new and renewable sources of energy;
- (b) Increase the energy inputs available for rural household and agro-industrial needs through planning and appropriate technology transfer and development;
- (c) To implement self-reliant rural programmes favouring sustainable development of renewable energy sources and improved energy efficiency;
- (d) Promote pilot plans and projects consisting of electrical, mechanical and thermal power (gasifiers, biomass, solar driers, wind- pumps and combustion systems) that are appropriate and likely to be adequately maintained;
- (e) Initiate and promote rural energy programmes supported by technical training, banking and related infrastructure;
- (f) Intensify research and the development, diversification and conservation of energy, taking into account the need for efficient use and environmentally sound technology; and
- (g) Collect and disseminate data on rural energy supply and demand patterns related to energy needs for households, agricultural and agro-industry.

### **3.0 GOVERNMENT'S DRAFT ENERGY POLICY TO PROMOTE ENERGY EFFICIENCY AND USE OF RENEWABLE ENERGY**

The opening up of the economy and the emphasis by Government on economic efficiency in Zimbabwe's parastatals has sent clear signals to the energy sector to seriously consider improved efficiency in its operations. The dominant objective of economic efficiency and growth implies that sufficient energy, at least cost, has to be supplied to accommodate economic growth. Further, energy supply and demand management must be achieved in an environmentally sustainable manner. As a general principle, the Government of Zimbabwe is committed to creating an enabling environment for the attainment of economic efficiency in parastatals with the economy as a whole playing a facilitatory role.

Following the completion of the Integrated Energy Strategy Evaluation in July 1992, the then Department of Energy Resources and Development proceeded to prepare a draft energy policy for the country. The document has now been submitted to Cabinet for approval.

The objectives of the proposed energy policy are to:

- a) Ensure adequate, secure, reliable and safe supplies of energy to all sectors of the economy at least cost, and consistent with economic growth and equity objectives of Government;
- b) Provide efficient utilisation of energy resources including inter-fuel substitution, more particularly of imported fuels;
- c) Assess utilisation of indigenous energy resources such as coal and hydro-electricity in energy supply;
- d) Encourage research, development and promotion of new, renewable and environmentally friendly energy technologies;
- e) Plan in an integrated way the optimal mix of energy supply through appropriate energy policies and pricing signals;
- f) Facilitate regional and cross-border co-operation in the production and supply of energy where it is economic and strategic to do so; and
- g) Encourage and promote the establishment of manufacturing and trading organisations in the energy sector.

The main features of the policy relate to energy planning and co-ordination, the electricity sub-sector, the liquid fuels sub-sector, the coal sub-sector, energy conservation and efficiency, energy pricing, and research and development. An interesting point in the document is Government's stated commitment to promoting coal as a substitute for woodfuel in the domestic sector, both in urban and rural areas. A high level of planning will be required to ensure that there is a proper mix of elements that will address the needs of the economy. Such a process will need the participation of all the actors in this debate.

Government's draft energy policy and the subsequent strategies are consistent with the overall objective of enhancing the efficiency and resilience of the economy by supplying energy reliably and at least cost. Since security of supply is not synonymous with self-sufficiency, it becomes important to assess energy projects in terms of their impact on supply rather than their location.

In order to achieve these objectives the policy will focus on the following strategies:

- 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 cost, subject to political considerations;
- Enhancing rural development through provision of adequate forms of energy;
- Integrated energy planning; and
- Balanced energy management.

The rationale behind the draft energy policy is as follows:

a) Accelerated economic development requires that energy choices be made so as to enhance economic growth and development. This implies that energy resources are to be exploited in such a way as to optimise energy production and consumption and to minimise negative effects on the environment. Optimal strategies require economically justifiable pricing of energy and effective measures to improve energy efficiency. In particular, non-renewable resources are to be used at a rate consistent with long-term national needs and goals and renewables are to be exploited within sustainability levels;

b) Reliability of supply must balance the requirement for adequate energy supplies with minimising the costs of supply, thereby freeing up resources for investment in other sectors. The actual reliability achieved will depend to a large extent on how uncontrollable uncertainties (risks) resolve themselves over time. Sub-sectoral planning targets (for example, 60 days supply of liquid fuels, 20% limit on electricity imports) are to be reviewed periodically in the light of changing circumstances;

c) Opportunities for regional co-operation in energy need to be utilised. This applies to regional supply options, which are lower-cost and more reliable than national alternatives. The direct benefits for neighbouring countries of Zimbabwean energy imports (such as more stable economies, improved security on their part and increased capacity to import) should therefore be given due consideration. Currently, the SADC has formed the Southern African Power Pool (SAPP), which will facilitate power sharing arrangements within the region;

d) Rural development requires that energy supplies to rural areas be increased, especially coal, electricity and renewables (such as solar) in order to promote growth and arrest environmental degradation caused by deforestation. The woodfuel problem is to be tackled directly with woodlot programmes, improved new techniques as well as by providing energy substitutes;

e) An integrated approach to planning allows for a comprehensive review of energy carriers and end-use sectors, firmly embedding the energy sector in the economy and in economic development policy. As a planning tool, it permits early co-ordination of sub-sector targets and facilitates sector-wide consistency in energy policy decisions, notably on investment and energy pricing; and

f) Balanced energy management means that meeting unfettered energy demand (particularly of electricity) must be ruled out as it curtails investment elsewhere. Rather than keeping future energy demand within limits consistent with economic growth, it is to be achieved by higher energy efficiency and correct pricing and if justifiable, non-pricing measures.

Implementation of the above strategies will be achieved with the help of the following instruments:

**a. Resource and Supply Management**

The supply of energy is designed to facilitate economic development. In future, environmental compatibility of supply choices is to be assured in all cases. Adequate and safe supplies of energy are to be ensured at least cost relative to reliability and self-sufficiency criteria. Where it is feasible, the utilisation of indigenous sources is to be encouraged. Energy supply technologies are to be improved towards high efficiency.

**b. Pricing**

Pricing is to ensure the economically efficient utilisation of energy with Government prerogative to adjust prices according to overriding considerations. Pricing principles are to be differentiated by energy subsector, for example, cost plus pricing for liquid fuels such as to ensure the long-term viability of the national oil industry; and long run marginal cost based on tariffs for the electricity sector. Pricing guidelines for coal will be worked out between the relevant Ministries, ZESA, Wankie Colliery Company and other companies that will have come onto the scene.

**c. Demand and Demand Side Management**

Households are to be given access to higher quality forms of energy, offering a wide range of end-uses, in particular access to electricity. Subsidies to low-income consumers, where considered justified from equity considerations, are to be made explicit. Energy efficiency is to be furthered by demand side management. In this direction energy efficiency standards will be developed and enforced.

**d. Environment**

Environmental considerations are to be made an integral part of energy policy implementation. While mainly relevant to supply choices, the environmental impacts of demand side measures must also be carefully assessed. In this regard, environmental impact assessment will be an integral part of any energy development projects. It should be noted here that although Zimbabwe is now a party to the Climate Change Convention, it does not yet have a policy that integrates climate change and development. It is hoped that the National Communications Report being worked on by Government will provide the linkages between climate change and national development policy.

Currently, the concern for the environment is more pronounced at the national level rather than at the global level. It will be noted therefore that environmental protection efforts so far, although beneficial to the global climate, are generally targeted at the local environment. For example, the efforts in energy efficiency are aimed at improving national economic efficiency rather than reducing greenhouse gases. Greenhouse gas reduction is a spin-off from these activities. Also, specific investments in the environment such as pollution monitors and standards are aimed at improving the local environment. To this end, Zimbabwe has not adopted a "business as usual" attitude towards environment and climate change issues but has taken

on board whatever can be accommodated to improve the environment in its development activities. Thus, aspects such as Environmental Impact Assessments, Pollution Standards and Land Rehabilitation have been made integral aspects of planning and implementation of most, if not all, energy projects.

Although there is an increased awareness of the need for environmental protection, and to ensure environmental sustainability in all energy sector activities, the worry is over the local as opposed to the global environment.

#### **e. Institutional Framework**

The institutional framework has to be commensurate with the expected contribution of the energy sector towards economic development goals. A consistent energy policy requires an integrative view of the energy sector. This postulate implies that fragmentation of decision making, notably in the energy sub-sector pricing policy, be overcome. Here the major concern is that with regard to coal pricing, guidelines will have to be developed with consultations between the DOE, Ministry of Mines, Wankie Colliery Company, ZESA and other companies that deal with coal.

In brief, the above guidelines direct energy sector investments in Zimbabwe. In general the guidelines given above are expected to shape all energy sector activities in Zimbabwe.

### **3.1 Energy Policy *vis a vis* the Environment**

Any energy policy cannot be described as holistic if it fails to address the likely impacts of energy use on the environment. It is on this basis that alternative energy sources are given special preference in the draft energy policy of Zimbabwe. Use of alternative energy policies would curtail deforestation and reduce emissions of greenhouse gases (GHGs) that inevitably contribute to global warming. These environmental impacts due to energy use should be internalised into long-term energy policy planning.

As is common in most of the SADC region, Zimbabwe is experiencing high rates of deforestation due to the cutting down of trees for construction purposes and woodfuel. The promotion and adoption of renewable energy technologies in areas where there is heavy dependence on woodfuel will therefore have a lasting effect on combating deforestation.

Other environmental effects linked to patterns and levels of energy consumption are air pollution and climatic changes. All these environmental impacts associated with energy usage do have costs which must be accounted for and deliberately internalised into long-term energy policy planning. This approach requires commitment on behalf of national governments and donors. Unless this happens, energy policy will work counter to sustainable development objectives.

## **4.0 GOVERNMENT'S RESEARCH EFFORT**

The Department of Energy has supported a number of research efforts especially focusing on domestic stoves, but these have generally been few and far between. There are also questions as to whether the DOE should actually be concerning itself with such micro-level interventions or whether it should concentrate on providing the policy environment that is conducive to the development of technology. Woodfuel technology is currently unattractive for investment due to the limited applications that the energy can be put to. Woodfuel also lacks commercial interest and backing and hence little is done to invest in new or improved technologies that will enhance woodfuel use. Institutions such as NGOs and national research institutes that could make a difference in technology development are hampered by their dependence on donor funding whose focus shifts rapidly from one fashionable topic to another, rendering important efforts in the woodfuel sector redundant.

### **4.1 Use of Renewables**

Concerted efforts have been made by the DOE to bring renewable sources of energy into the spotlight with various initiatives on biogas and solar being proposed. The funding of the US\$7.5 million "Photovoltaics for Household and Community Use Project" by the UNDP added impetus to the thrust towards solar as an energy source worth investing in. The hosting of the 1995 World Solar Congress also brought the subject sharply into focus as did the World Solar Summit in 1996. Such enthusiasm, in some quarters, for solar is understandable given the relatively high solar energy potential in the country with daily radiation estimated at 2kJ per square centimetre and most parts of the country receiving approximately 3 000 hours of sunshine per year.

The focus by DOE on the commercial fuels serves to highlight their utility as opposed to the traditional forms of energy. The woodfuel sub-sector and other renewables have received very little attention from a policy perspective in Zimbabwe, mainly on account of a failure to attach an official market price to the resource. Such a position is misleading considering the environmental costs that result from deforestation and soil erosion which ultimately end up being paid by the economy as a whole.

At present, the use of renewable energy options is usually considered only when conventional energy sources are exhausted or are not available. This use has therefore not allowed a full assessment of the potential of renewable energy in contributing indirectly towards environmental rehabilitation. Environmentally damaging activities like cutting of trees for woodfuel would be reduced if renewable energy is used on a wide scale.

Presently, the Ministry of Transport and Energy does not have the capacity to handle the production and implementation of new and renewable sources of energy to meet large-scale demand, but can and does assist in the use of new and renewable technologies. However, the biggest production capacity is in the private sector. An effort has been made for co-operatives (predominantly male) to build and install biogas units, but these

are still highly localised. The importance of women's involvement in the practical aspects of NRSE development cannot be overemphasised.

By hosting the World Solar Summit in 1996 and being the Chair of the World Solar Programme, 1996 - 2005, the Government of Zimbabwe has shown its commitment to the promotion and adoption of renewable energy as an alternative to conventional energy. The Programme attempts to promote renewables through broad partnership and co-operation amongst government departments, private and non-governmental organisations.

## **4.2 Vegetable Oil as a Diesel Fuel**

The Institute of Agricultural Engineering has investigated the feasibility of using vegetable oil such as sunflower oil, soyabean oil and cotton seed oil as fuel for diesel engines. However, due to a number of factors such as high evaporation temperature, incomplete combustion, and high viscosity, gumming occurred.

The research came up with the following findings:

- air-cooled diesel engines tested appear to operate satisfactorily only up to 50% sunflower oil mixture,
- use of more than 20% vegetable oil mixed with diesel in an unmodified water cooled tractor engine was unwise, and
- older tractors and those with any faults such as low compression are likely to have further problems if they are powered with vegetable oil.

## **4.3 World Solar Summit Project Initiatives**

Since the landmark High-Level Expert Meeting, "The Sun in the Service of Mankind", held at UNESCO Headquarters in 1993, the Government of Zimbabwe has submitted to the WSSP International Organising Committee four project proposals in the field of renewable energy. These are:

### **a) Building the Capacity for Training in Renewable Energy Resources in Schools, Technical Colleges and Universities.**

The proposed project aims at educating the entire Zimbabwean nation so that solar energy becomes as familiar as any other energy resource in terms of the technologies, economics, benefits and disadvantages. The project will assist in building capacity for teaching school pupils and students, training of skilled workers, planners and engineers in renewable energy technologies through revised school syllabi, institute new curricula at the technical training level and revised curricula at university level.

### **b) Development and Demonstration of Selected Biomass Fuels and Appliances.**

The project is designed to contribute significantly to the efforts being made to alleviate environmental degradation caused by the burning of fossil fuels. The project therefore

focuses on the provision of liquid fuel extenders or substitutes and improvement in the efficiency of the combustion of biomass fuels, particularly woodfuel, which is the main fuel for over 70% of Zimbabwe's population. Biomass wastes such as sawdust are also included together with the provision for new stoves to handle such fuels.

The project is expected to result in the development of indigenous vegetable oil fuels that can be used without the need for chemical modification, and to demonstrate appliances developed for the vegetable oil and also for ethanol which is produced in Zimbabwe but not presently used for household energy. The utilisation of by-products is also addressed.

In recognition of the fact that woodfuel will continue to be the major fuel for most rural households, more efficient use of this resource remains a crucial issue which the project addresses through an improved woodstove initiative.

**c) Solar Energy for Lighting Rural Industries.**

Electrification has an important role to play in rural development. To this end, Government is pursuing a rural electrification programme in order to trigger economic development. Grid electricity is not accessible to all parts of the country and so alternative energies should be used. Photovoltaic systems are increasingly proving to be an attractive and viable solution to rural electrification problems. This appropriately scaled renewable energy technology will demonstrate that it can effectively meet most rural institutions' needs for electricity in a way that will not harm the environment.

This programme is expected to raise the standard of living of people in the rural areas by supplying basic electrical services to rural institutions lacking access to grid extension. It is intended to substitute kerosene, dry batteries and candles with solar electric power.

It will also raise the standard of education in rural schools by providing light for studying at night and power to carry out experiments. Qualified teachers would be able to stay and work in the rural areas due to the availability of solar electric power. Health services would also benefit since patients will be attended to at any time of the day.

The programme is intended to create a balance between development and environmental concerns. In line with Government efforts, the programme will enable a large number of rural institutions to receive solar energy. Industry, financial institutions, Government ministries, Rural District Councils, NGOs and other bodies will demonstrate that solar can play a key role in Zimbabwe's energy future while enhancing economic development.

**d) Manyuchi Dam Electrification for Development of a Remote Rural Area.**

The project has the following objectives:

- i) To provide electricity through renewable energy to a remote zone for economic and social development of the surrounding area;

- ii) To develop a self-supporting, replicable pilot project demonstrating compatibility of environment preservation and economic development; and
- iii) To realise, during the Pilot Phase, an "Activities Implemented Jointly (AIJ)" project following the UNFCCC.

The Manyuchi Dam Electrification Project constitutes the core of an integrated development project which should combine three areas:

- i) Agriculture and fishing,
- ii) Handicraft and trade, and
- iii) Social development.

## **5.0 CONCLUSION AND RECOMMENDATIONS**

### **5.1 Need for a Comprehensive Energy Planning Process**

As was noted earlier energy planning process in Zimbabwe is not comprehensive. As the planning process does not involve a multi-sectoral approach, there is therefore need to involve all stakeholders so that all institutional, economic and environmental factors can be integrated into the energy policy. Identification of bottlenecks and inclusion of all stakeholders will also make it possible to predict future energy shortages.

Planning must permit a multi-sectoral approach so that the principles of sustainability (economic, social and environmental) can be fully integrated into energy policies. Energy planning must be influenced by an *end user* approach in which energy production is determined by defined needs (Katerere, 1991).

As Jackson (1998) has noted, when decision makers in local and national governments, multi-lateral organisations, donor agencies or NGOs develop policies and strategies for improving access to energy supplies in rural areas, a number of criteria have to be considered, such as:

- a) Availability of energy resources,
- b) National and local economic conditions,
- c) Financing options and markets,
- d) Local and global environmental impacts,
- e) Associated development strategies, for example employment, small enterprise development and social services,
- f) Technical capabilities and human resources, and
- g) Institutional capacity.

An approach that combines all of the above interlinked aspects therefore stands a good chance of success and sustainability.

## 5.2 Holistic Energy Policy

In endeavouring to come up with a holistic energy policy for Zimbabwe, the energy needs of the different sectors of the country need to be assessed and appropriate policy responses drafted. In this process integrated energy planning is an absolute necessity if the supply is to meet present and future demand.

The need for a new policy direction is clear. Falling commodity prices, mounting debts and restructuring programmes have ushered in a new economic climate. Furthermore, better understanding of the environmental impacts of energy use, at both local and global levels, requires a radical departure from traditional policy approaches (ETC Foundation, 1990).

The present economic performance of the country characterised by high inflation with concomitant high interest rates, low investment levels and high unemployment levels make the need for a holistic energy policy more imperative than ever before. Informal sector industries which are generally recognised as the engine for economic growth should have more access to electricity as this will allow the operation of more efficient machinery. Research should therefore centre on the most reliable, efficient and least cost forms of energy that could be accessed by the informal sector so as to generate more employment opportunities for the thousands of unemployed youth.

As the different institutions working on the provision of energy are working independently with very little synergy, there is need for harmonisation of these institutions to reduce duplication of activities with resultant saving of scarce financial resources. The ETC Foundation (1990) identifies the following basic principles that should guide the operations of energy institutions:

1. Institutions must be responsive to energy demand. This requires an end-use approach in which energy production capabilities are driven off defined needs. As part of this, there must be pro-definition of technical choices and as much flexibility over timing of interventions as is possible.
2. Institutions must contain effective channels for the participation of energy users and providers in the planning process. Bottom-up approaches should be implemented at all stages of planning for local communities who are the intended beneficiaries of energy projects. Large organisations such as oil companies also have a role to play in providing expertise, knowledge of market conditions and co-operation to achieve set goals.
3. Institutions must permit multi-sectoral co-operation. It is expected that the Department of Energy will continue to take a leading role in the planning process. However, this department should be provided with resources to effectively execute research and extension activities.
4. The principles of sustainability in environmental, economic and institutional terms must be fully integrated into the procedures of energy planning institutions.
5. The role of the State as a facilitator means that effective decentralisation, in which control over natural resources is given to local communities, is needed.

6. Positive action to create effective management structures and enhanced management skills is needed to counter the negative impact that poor capacity in this field produces.
7. The role of external donors also needs re-evaluation to ensure that their operations facilitate the creation of sustainable planning procedures. This means that existing practices such as the pre-definition of technical solutions and external control over expenditure decisions must be reformed to incorporate environmental concerns.
8. Energy planning must be more flexible, frequently seeking indirect strategies and building a partnership between local communities and planning institutions. Central to this is the integration of indigenous knowledge into planning.

### **5.3 Need for Equity in Energy Distribution**

In order to hasten economic development in the rural areas (which is one way of curbing rural-to-urban migration, and reducing dependency on woodfuel) the issue of equity between rural and urban areas needs to be addressed. As energy costs continue to soar, this will result in more and more urban families resorting to woodfuel for energy provision. In cases where the development in the urban areas is taking place at the expense of rural areas, this will result in ever-increasing rural-urban migration.

### **5.4 Need to Maximise Energy Efficiency**

One way of minimising environmental degradation, primarily deforestation, is to maximise energy efficiency of energy-reliant operations. This is particularly the case in woodfuel-deficient areas which are characterised by long distances that women have to walk to gather woodfuel and pay high prices charged for the energy source. Policymakers and energy planners need to gather traditional ways of maximising energy efficiency and build upon these local initiatives so as to avoid introducing recommendations that could be in conflict with local social and cultural practices. However, as the ETC Foundation notes, energy efficiency in Zimbabwe does not necessarily mean energy conservation as anything saved should go to another development end-use (ETC Foundation, 1990).

Energy policies must also encourage use of public transport. Radical policies such as punitive taxation on use of private cars could be enforced and the revenue transferred to public transport (Katerere, 1988).

### **5.5 Issues in Institutional Development and Co-ordination**

The discussion thus far not only reveals that numerous constraints exist in the development, sourcing and delivery of energy, but that close co-operation, co-ordination and implementation of decisions is imperative if success is to be achieved in the development of this important sector. The need is especially more apparent in the rural areas where energy issues have never been addressed in a coherent way. Interventions in this area have at best been scanty, and lacking in real focus.

Government and NGOs addressing energy issues need to work together closely and not regard each other as adversaries in the development process. As conduits for international development aid, NGOs can assist Government raise capital for energy projects. In turn, Government should also seriously review the level of taxation imposed on imported renewable energy equipment and gadgets. If possible such taxation should be completely removed as it is an affront to massive adoption of renewable energy technologies.

Moyo (1991) identified problems of institutional co-ordination as a key factor to solving future energy problems in the rural areas. This problem is not limited to Government institutions alone but is also a feature of the NGO sector. In both types of institutions there is poor documentation resulting from poor information.

In order to promote institutional co-ordination, the following recommendations should be followed up:

- a) As the Government agency responsible for energy planning, the DOE should develop a strong extension arm through decentralisation into rural areas;
- b) The DOE should also spearhead training programmes for all development ministries to sensitise them on energy issues. Training programmes should also be targeted at NGOs, women's groups and energy planners in both public and private sectors. The Curriculum Development Unit of the Ministry of Education could be called upon to include comprehensive energy and environment components into existing curricula for schools, colleges and universities. In the same vein, the Department of Women's Affairs should also train more women in skills that enable them to fit and contribute to energy policy formulation; and
- c) All energy stakeholders should be consulted before crucial energy investments are undertaken.

To foster greater synergy between macroeconomic arms of Government and energy planning, there should be a strong institution within Government that takes the lead in preparing and implementing decisions on technology transfer, investment priorities, regulations and skills development in the energy sector. Perhaps the role of the National Economic Planning Commission could be broadened in order to accord energy planning the same priority as the traditional growth sectors such as agriculture and manufacturing.

## **5.6 Need for Decentralisation of Planning Structures**

Government structures that are mandated with energy policy formulation, planning, implementation and monitoring are centralised thus making it difficult for quick policy decisions to be made and effected. In some cases, when the decisions are eventually made these are rendered ineffective because of changes that would have occurred in the intervening period. Also, the absence of decentralisation of DOE policy makers and researchers does not ensure that grassroot perceptions are considered during policy formulation, let alone taken on board. The energy policy formulation in Zimbabwe is thus characterised by a "top-down" approach that is stifling the development of a people-oriented energy policy.

The Government therefore needs to decentralise energy planning structures so that it understands energy issues better and become more responsive to the needs of communities in the different parts of the country. If need be, there could be some institutional reform to better position the Government energy institutions so that they can effectively face and address the energy demands of the new millenium.

### **5.7 Use of Alternative Energy Technologies**

The energy investments in Zimbabwe are characterised by heavy reliance on hydroelectricity power generation at the expense of renewable energy technologies. This is despite the fact that the latter offers the best hope of electrifying remote rural areas and does not need the huge capital outlay that the former requires. Another related recommendation to promote research and local manufacturing of renewable energy technology would be to introduce tax breaks and other incentives. This will also see greater adoption and use of renewable energy technologies as they will be comparatively cheaper.

To achieve wide-scale adoption and use of renewable energy, at least three activities are necessary:

- (a) The need for awareness building cannot be overemphasised. Most rural folk are not aware of renewable energy, let alone its advantages and disadvantages. Marketing of renewable energy technologies should therefore be vigorous enough to capture some of the market share of conventional energy sources.
- (b) If renewable energy technology is to benefit the target groups, there is need to remove it from the research domain to a market domain (Southern Centre for Energy and Environment, 1997). Other incentives in the form of an enabling policy framework with bias towards renewables and financial support in the form of tax rebates for such promoters could be an important starting point in promoting the technology.
- (c) Government should as a priority set aside financial resources to promote this technology since market response to renewable energy technology is slow as this is a relatively new technology. This is important since an investor with sufficient capital would not like to risk his investment by venturing into "uncharted waters", hence most investors opt to invest in the conventional forms of energy.

### **5.8 Need to Promote Use of Coal**

Zimbabwe should take advantage of its abundant coal reserves and promote the use of coal in both urban and rural areas. At present coal use is confined to thermal power plants, schools, hospitals, farms and a few other private and public institutions. To increase the use of coal, the following policy instruments could be put in place:

- a) Removing or reducing taxes on coal purchases to increase demand;

- b) Provision of subsidies on coal purchases to the low-income bracket. Recently, the prices of imported fuels have increased tremendously due to currency depreciation and this trend is set to continue in the foreseeable future. This trend tips the balance in favour of locally produced coal that does not need any foreign currency to purchase;
- c) Provision of tax breaks to coal mining especially new entrepreneurs; and
- d) Awareness raising campaigns to educate users on the advantages of using coal. The health implications of using coal should also be explained to users so that they adopt safe use practices.

### **5.9 Need to Improve Management Skills**

Generally there is lack of requisite management skills in public, private and non-governmental sectors in as far as energy policy implementation is concerned. Effective energy policy formulation, planning and implementation will therefore require skilled managers and planners in all these sectors. Therefore, the need for training along these lines should be treated as a priority.

### **5.10 Short and Long-term Prognosis**

It is unfortunate that there has been very limited forward planning in the energy sector. The work of energy authorities has revolved around administrative issues and dealing with crises as they arise at the detriment of examining the long-term requirements of the nation in terms of energy.

Rapid urbanisation in Zimbabwe has resulted in a dramatic increase in energy consumption. An effective energy policy should therefore consider the effects of urbanisation on the national energy economy. In particular, proactive energy policies should look at providing alternative energy sources for all urban sectors. These policies would be in contrast to past policies which have concentrated almost exclusively on the needs of the well-off and the formal sector, and electricity-dominated investment at the expense of the urban poor and rural dwellers.

The dependence of the rural population and most of the urban poor on woodfuel for energy calls for clearly defined energy policies in order to arrest environmental degradation. Other environmental problems like air pollution and climatic changes do have costs that must be accounted for and deliberately internalised into long-term energy policy planning. This approach requires the commitment on behalf of national governments and donors. Unless this happens, energy policy will work counter to sustainable development objectives (Katerere, 1991).

The future for urban areas lies with commercial fuels, and in particular with coal and kerosene. Electricity will continue to be an elite fuel, both because of the costs involved and because of the problems of provision to mobile populations in often temporary housing. Urban energy policy should thus seek to assist the transition from wood fuels to

fossil fuels as rapidly as possible. This can be achieved through improvements to market systems and measures to ensure the availability of fuel supplies.

It would appear that to combat the deforestation in peri-urban areas and mitigate the effects of poverty on energy use urban areas, coal, kerosene and affordable renewable energy technologies be extensively promoted. Forecasts are that electricity will continue to be the preserve of the elite because of its ever-increasing costs exacerbated by the depreciating local currency.

In trying to meet the projected energy demand levels, a number of problems have to be solved:

- a) At policy level there is need to recognise the great diversity of women's energy requirements in the rural economy with special consideration for the domestic, agriculture, rural industries, transport and water haulage. Specific provisions should be made in the policy to ensure efficient supply and access;
- b) Policy focus needs to be shifted from the current bias towards commercial/industrial/urban sectors to rural/communal areas;
- c) National commitment (through a master plan) to prioritise energy as a basic need/right for rural people; and
- d) Positive action towards making energy an issue at the grassroots level through existing development structures.

To conclude, it is hoped that the energy policy that Zimbabwe will eventually adopt will address the following energy problems:

- a) Ever-escalating costs of imported fuels mainly due to the decline of the Zimbabwean currency against major currencies. This scenario will necessitate that policy makers devise strategies to source least expensive fuels and vigorously promote renewable energy technologies that can be manufactured locally with little foreign currency input;
- b) Increasing shortages of fuelwood in both peri-urban and rural areas. This is against the backdrop of 95% of the rural population depending on fuelwood for their energy needs. Desperate rural people could eventually be forced to use agricultural residues for fuel at the expense of agricultural productivity;
- c) Growing poverty within the populace thus making it difficult to adopt and use renewable energy technologies that could have an initial high capital outlay; and
- d) Need for more active women's participation in energy policy formulation process since they are the major actors in rural household decision-making.

In the long-term future to 2020, Zimbabwe's energy investment will need to be focused on an increase in the use of oil and coal and the rehabilitation of wood resources. The requirement is for modern technology that has a high energy efficiency and a low environmental impact (ETC Foundation, 1990).

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