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NEW AND RENEWABLE ENERGY SOURCES IN ZAMBIA

1. INTRODUCTION

Zambia depends for its energy on water, oil, coal and wood as primary sources. Water accounts for 29 per cent of the total supply. It is estimated that the unexploited hydro potential may last from 25 to 36 years for an average growth rate varying from 4 to 7 per cent per annum.

Oil is imported energy. In 1980, oil represented 36 per cent of the total energy consumption. In the same year, 750,000 tonnes of crude oil were consumed at a cost of U.S.$140 million while in 1978 about 763,000 tonnes at a cost of U.S.$80 million satisfied the demand. Coal, a local resource, is consumed mainly by the mining and manufacturing industries, see Table 1. In 1978, Zambia had proved coal reserves of 146 million tonnes. The present consumption rate of 1.5 million tonnes per year is relatively low.

Wood and its derivative, charcoal, is an energy source for about 90 per cent of the population (both urban and rural). Its main use is for cooking, lighting and space heating (1). Fuel wood will remain a main source of energy for most people in Zambia for a long time to come because of generally high price levels of other sources of energy.

Zambia considers it essential:

(i) to increase use of electricity and coal in energy supply;

(ii) to reduce the oil consumption through conservation measures, increased use of local energy resources and development and commercialization of some new and renewable sources of energy;

(iii) to achieve efficient use of wood and charcoal through improved technology.

2. THE ROLE AND POTENTIAL OF NEW AND RENEWABLE SOURCES OF ENERGY IN ZAMBIA

In an attempt to increase the share of local sources of energy in energy consumption, the country thinks it imperative to acquire and develop technologies in new and renewable sources of energy. Some of these are those associated with hydropower, solar energy, biomass, wind energy, geothermal energy, oil shale, tar sands, peat and animal power.

(a) Hydropower

Much of the present hydropower development in Zambia is dominated by three major schemes:

1. Kafue Gorge Power Station on the Kafue river and,

2. The Kariba North and the Victoria Falls Power Stations on the Zambezi River which is a common riparian resource for Zambia and Zimbabwe.

The three major hydropower stations stated above tally up to 1600 MW which will be adequate for at least the next ten years at the present rate of internal consumption.

There are six other smaller hydro stations whose combined output is approximately 58 MW. So the present level of exploitation of large scale hydropower in the country is 1658 MW representing 36 per cent of the hydropower potential.

The country also posseses many small to medium rivers which have quite an appreciable potential in the micro and minihydro schemes. We have not so far done much to gauge this potential. However, plans to undertake a full scale country wide assessment of it are quite advanced.

The rural areas are supplied with electricity from small-scale hydro-stations and much more often from diesel power stations. As these areas lack major industrial activity, the demand for electrical power is mainly for commerce, domestic lighting, grinding and water pumping. Some of the provincial centres have significant commercial loads. Probably what will stimulate consumption in future will be the development of agro-industries and irrigation-fed farming. Such development would be consistent with making use of small-scale hydropower wherever this is feasible.

For the urban areas, demand for electricity divides into industrial, commercial, residential and farming loads. About 80 per cent of total demand is taken up by the mining industry. Major hydro schemes are realised through conventional technology most of which is imported. Technology transfer occurs through involving local personnel in site investigations, specifications of plant and equipment, supervision of contracts and construction and of course in the operation and maintenance of the facilities.

The limitations are easily deducible from the fact that there is as yet no local manufacture of hydro-electric equipment, plant and appurtenances. Consequently foreign exchange sometimes becomes a serious constraint. Also certain skills and know-how have to come from outside. Fortunately, a number of centres within the country are showing great interest in research and development in hydro-electric engineering and its applications.

Training and education have a much higher local content because of a good School of Engineering at the University of Zambia. However, for manufacturing experience, overseas training is still necessary.

Small-scale plant and equipment have also to be imported. In time, it might be necessary to stimulate interest in the local business community through indications of a sizeable local market.

(b) Solar Energy

Zambia lies between 8° and 18° S latitude at al altitude ranging from 1000 to 1300 metres. There is a sizeable network of sunshine and solar radiation measurement stations in the country. Annual sunshine averages from 2600 to 3200 hours per year (2). Global radiation lies between 5 and 6 kWh per square metre, peaking in October-November. These figures indicate that solar energy prospects are quite good for the country. For the immediate future, solar energy will be used for water heating for both industrial and domestic purposes and air heating for drying agricultural products. Photovoltaic generation of electricity and using solar energy for cooking may take place in the distant future. On the other hand, solar refrigeration has some potential particularly in the rural areas although it also requires more research, development and demonstration. During the last decade a certain number of prototypes (mainly for water heating) has been either imported or locally built. Some of these have been tested and are still working. However, applications have not yet reached commercial stage. Recently, two companies have been created with the purpose of manufacturing flat plate collectors for water heating. Also at the present time, research in solar energy in the country is concentrated at one centre.

(c) Biomass

Data on the use pattern of wood derive from consumption patterns in urban centres. A total of 500,000 tonnes of charcoal equivalent to 5.0 million tonnes of raw wood, were consumed in 1978. Wood consumed directly as fuel was estimated at 464,000 tonnes. See Table 2 below.

The figures above indicate that a considerable amount of wood is consumed per annum. Without a corresponding reforestation woodlands may diminish in time. One way of reducing the consumption of wood as fuel is to seek, acquire and develop technologies in biomass such as those dealing with direct combustion, pyrolysis, gasification, biogas and alcohol production. We view such new technologies as beneficial in enlarging and diversifying the energy base.

(i) Direct combustion

Presently wood and charcoal are burned directly for cooking. The stoves presently in use (4) have low efficiencies of 5 per cent and 10 per cent respectively. It is obvious that if stove efficiencies were improving as is intended, by say a factor of two, the saving in wood consumption would be significant. Present research is aimed at an improved design of charcoal stoves.

(ii) Pyrolysis

Prompted by the need to improve upon the traditional way of producing charcoal from earth clamps with a restricted air supply (efficiency about 10 per cent), one centre has over the last decade carried out research projects on the production of charcoal. These projects have included research on both steel and brick kilns. The programme now involves six steel kilns manufactured locally and taken to rural areas for demonstration. Similar work is being pursued at another research centre in an effort to achieve higher efficiencies in charcoal production.

(iii) Biogas

Biogas has a large potential in urban areas for both cooking and lighting. It is, however, improbable that it would be socially accepted in Zambia. The alternative materials for biogas generation are animal and crop wastes. The use of, for example, cow dung has a large potential in some parts of the country where the cattle population is high. In view of the possible use of biogas for lighting, cooking and to some extent as fuel for a modified diesel engine design in rural areas, a pilot digester is being tried using cow dung, grass and agricultural wastes as feedstock.

(iv) Alcohol Production

Zambia's climate is favourable for production of sugar cane, cassava, sorghum and eucalyptus. These crops are being grown in appreciable quantities so that the production of various alcohols like ethanol, is feasible. For example, sugar production in Zambia satisfies fully the local market which in 1980 was 800,000 tonnes. The by-products, molasses and bagasse, amounting to 40,000 and 200,000 tonnes respectively are used for animal feed, heat and electricity generation. A feasibility study on an ethanol plant using bagasse and molasses as feedstock is well under way. Cassava, sorghum and eucalyptus would be proper raw material too provided their quantities were more than their demand as food.

(d) Wind Energy

Windmills have been used for pumping water over a long time. For example, the Lusaka district, which is one of the windiest in the country, has 100 windmills in operation. Wind energy for other applications is still only an intention. R. Peacock et al (3) have shown that at the current price of oil, commercially available wind pumps are competitive in areas with mean annual speeds of 2.5 m/s and above. Their use is, therefore, viable in wide areas of the country especially in connection with water pumping during the dry season when speeds are highest and when water tables, lowest.

We have no hard data for wind-driven generators but given a regime of low speeds it is unlikely that they would turn out to be viable unless the prices of diesel rose sharply.

Consideration of local production of wind pumps is being encouraged by rising demand. A number of designs are being examined in order to find the most appropriate for local manufacture.

(e) Geothermal

Zambia has, despite the relatively large number of hot springs, a very low potential for high temperature steam. Relatively low temperature steam is, however, more plentiful but has not yet been put to widespread practical use.

(f) Peat, oil shale and tar sands

No deposits have been identified as yet. Peat formation in the tropics is unusual and a minimum rainfall of 40 inches per year is considered necessary. Certain swampy areas having marginally higher annual rainfall (Bangweulu and Lukanga swamps) have also revealed no peat formation. Prospecting, mainly for coal, is being carried out in the Western Province and any shale deposits would be examined for the presence of oil. The existence of tar sands is considered very improbable.

(g) Animal power

Zambia has a cattle population of 1.7 million which is mainly used for cultivation and transportation.

3. CONSTRAINTS ON UTILIZATION OF NEW AND RENEWABLE SOURCES OF ENERGY

The utilization of new and renewable sources of energy faces hurdles similar to those encountered when introducing new technologies in a country with a limited technological base. To name a few:

(a) Financing

Against conventional fossil fuel sources, new and renewable sources of energy have high initial investment costs and relatively low running costs. These factors tend to restrict interest investment in and use of new and renewable sources of energy, only to commercial enterprises and organizations that have access to big finance. The majority in rural as well as urban communities may consequently be marginally benefited. Large amounts of money will be required for the development, demonstration and commercialization of new and renewable sources of energy. Encouragement of local manufacture of plant and equipment will necessitate spending large sums of money.

(b) Rural Energy Including Its Utilization in Agriculture

The diffusion of energy-related applications into the rural community is not without difficulties. The low incomes, scattered settlements, local traditions, and lack of education are some of the factors that have to limit widespread use of new technologies including those associated with new and renewable sources of energy. Commercial agriculture, however, is favourably disposed to new and renewable sources of energy in the face of rising oil prices.

Government policy is to boost economic development in rural areas through an attractive package of incentives which include very low income taxation and economic pricing. The very important role of new and renewable sources of energy in such cases is recognized.

(c) Industrial Uses

Hydropower is presently widely used in industry. Because this renewable resource is also finite, other new and renewable energy resources will play an increasingly significant part in the future.

(d) Research, Development and Transfer of Technology

Although research and development activities in Zambia have tended to slow down due to lack of competent manpower, equipment and finance, progress, however, is being made. We have a few very important active research centres. With coming into being of a National Energy Council last year, 1980, it is expected that it will finance and give guidelines for research, development and demonstration activities. Thus it is bound to play a leading role in technology transfer.

(e) Education and Training

Considerable effort and resources are being put into education and training particularly in engineering and scientific disciplines. It has, however, so far proved not easy to meet local requirements. Energy related courses have already been incorporated in educational programmes conducted in schools of higher learning in the country.

(f) Information Flows

The National Energy Council is the focal point for the collection, storage, dissemination and exchange of information on energy. International information exchange is necessary so that Zambia greatly appreciates and welcomes the timely call for a conference on new and renewable sources of energy by the United Nations to be held in Nairobi, Kenya, in August this year, 1981.

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Table 1. Coal Usage (in Thousand Tonnes)

Consumer	1977	1983	% Annual Growth Rate
Mining	426	440	15
Manufacturing	171	494	19.3
Transport	5	11	14.0
Services	6	12	12.2
Domestic	5	16	21.4
Export	20	33	8.7

Table 2. Wood Consumption in 1978

Sector	Population size (million)	Firewood	Charcoal (FE)	Firewood & Charcoal	Total wood Used $10^6 m^3$	Area of Land Required (km^2)
Rural	3.21	2.43	0.72	3.15	7.8	911
Urban	2.27	0.50	1.68	2.18	4.95	446

FE: Firewood equivalent assuming $3m^3$ of firewood weighing 3 tonnes and producing 300 kg of charcoal.