ENERGY

SOUTHERN AFRICAN DEVELOPMENT COORDINATION CONFERENCE

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CONTENTS

NOTE ON PROJECT NUMBERING

The Projects have been numbered according to a system based on three digits. The first digit indicates the sector as follows:

0 - Overall Coordination/Multimodal
1 - Oil
2 - Coal
3 - Electricity
4 - New and Renewable Sources
5 - Woodfuel

The second digit indicates the country as follows:

0 - Regional	5 - Mozambique
1 - Angola	6 - Swaziland
2 - Botswana	7 - Tanzania
3 - Lesotho	8 - Zambia
4 - Malawi	9 - Zimbabwe

The third digit is a serial number, to differentiate among several projects having the same sector and country.

Section I

STRATEGIES FOR THE NEXT FIVE YEARS

1. INTRODUCTION

All SADCC Sectors have been required to prepare policies and strategies for the next five years in order to define priorities which shall govern the project selection and implementation.

In the Energy Sector several important studies are, however, still underway or about to commence:

- Project 0.0.5. Information Coordination System
  Under this project a comprehensive energy data base will be established as a basis for a regional energy development, conservation and security plan.

- Projects 5.0.1.-5.0.5. - Energy Development Woodfuel
  This combined project will form the basis for a more correct assesment and drawing up effective woodfuel strategies in the region.

- Project 1.0.1. Strategies for the Supply of Oil Products
  This project will evaluate options in oil supply, transport local refinery structure and market development.

- SADCC Macro Economic Study
  Energy is but one element in the development of our region, and energy planning must be carefully integrated in the overall macro economic development.

- Project 4.0.2. - Energy Conservation in Industry
  This project will help to develop a practical strategy for Industrial Energy Conservation in the SADCC Region.

These projects, and several smaller ones of a similar nature, will together contribute significantly to increasing SADCC's understanding of the Energy situation in the region and will form a basis for further refining strategies in the Energy Sector. The policies and strategies proposed in this Strategy paper are, therefore, of an interim nature.

The strategies will be refined and updated as more data becomes available and in the light of SADCC's experience of implementing programmes of regional cooperation in the energy sector.

2. POLICY FRAMEWORK

The Lusaka Declaration, Southern Africa: Towards Economic Liberation, issued on the 1st of April 1980, provides the overall objectives and a preliminary identification of a long run strategy for SADCC development.

The declaration highlights the following main objectives:

- The reduction of economic dependence, particularly but not only, on the Republic of South Africa;
- The forging of links to create a genuine and equitable regional integration;
- The mobilisation of SADCC's own resources to promote the implementation of national, inter-state and regional policies
- Concerted action to secure international cooperation within the framework of the strategy for economic liberation.

In accordance with these objectives, the Energy Sector adopted its own sectoral policy document: Towards an Energy Policy for Southern Africa (issued in Luanda, February 1982), where the member States committed themselves to developing a coordinated approach to the problem of energy development, conservation and security in the region.

3. REGIONAL ENERGY SITUATION

3.1. General overview

Over the last decade, two main problems have characterised the energy situation in most SADCC member States:

- Dependence on the import of petroleum and petroleum products.Member States have witnessed the rapid depletion of their foreign exchange reserves following the series of sudden increases in petroleum prices and the increase in recent years in the value of the dollar. In addition,disruption of supply poses a major problem.
- Depletion of woodfuel resources making energy supplies less available to low and medium income households which are almost exclusively dependent on woodfuel.

At the same time the region is rich in undeveloped energy resources. In developing these resources, however, another major constraint to development is noted :

The rate of transfer of capital and technology from the industrial countries is too slow to meet the requirements of the region.

The problems referred to have contributed significantly to the severe economic difficulties experienced by the SADCC member States during the period 1980-1985. Actions by South Africa to destabilize the political and economic development of the region continue and these conditions further affect both energy consumption and production.

Except for the Angolan petroleum production, the main trend is a levelling off or a reduction in the production and use of commercial energy (coal, oil products and electricity) over the last five years, whereas the consumption of traditional fuels (mainly wood) has increased, roughly proportional to the growth of population. It is estimated that the population in the SADCC region has increased from 59 million in 1980 to some 100 million by the turn of the century. This represents an average growth rate of around 3% per year. The decrease in consumption of commercial coal should be seen in connection with low economic activity and low industrial production.

There are large regional differences concerning the consumption of oil products. Angola, as an oil exporting country, has increased its consumption of oil products by almost 50% in the period. Lesotho, Swaziland and Botswana have also increased consumption. The other countries of the region have registered a decrease, the largest in Mozambique and Malawi with about 30% reduction over the period. Petroleum consumed in the region is used largely for transport.

The electricity consumption has not increased since 1982. This is also due to low industrial activity. Public institutions and households have in fact increased their share of the total consumption.

The bulk of electricity consumption is concentrated along the central, interconnected 330 kV/220 kV grid between northern Zambia (the Copperbelt) and southern Zimbabwe (Harare/Bulawayo), reflecting demand from the mining and urban sectors in Zambia and the industrial and urban sectors in Zimbabwe.

Total installed capacity in the region was around 6760 MW in 1984 (of which 5200 MW comes from hydropower), an increase of about 5% from 1980. The main reason for this increase is the commissioning of a new thermal power plant in Zimbabwe.

There is, therefore, a significant potential for increasing demand for all commercial energy sources once economic conditions have improved and industrial production increases.

Over the past five years, traditional fuels, in particular woodfuel, have increased their significance in terms of energy consumption. In 1984 they counted for about 80 percent of the

total energy consumption in the region. The figure would, however, be considerably lower if this energy were used more efficiently.

In 1984 the total per capita consumption of energy corresponded to 750 kg coal equivalents. The SADCC per capita annual consumption of energy was spread over different forms of energy as follows: 250 kWh electricity, 45 kg of oil products, 45 kg of coal and 1.5 m3 of wood.

3.2. Dependence on petroleum imports

A major problem for most SADCC member States is their dependence on energy imports, particularly oil. Angola is the only net exporter of oil in the region. For all other countries oil imports impose heavy constraints on their ability to import other commodities.

It is estimated that in 1980 SADCC member States, with the exception of Angola, spent between 20% and 50% of their foreign currency earnings on oil imports.

Most of the SADCC countries have reduced their consumption and hence their imports of oil since 1980, but in relation to total export earnings the figures remain high.

3.3. The woodfuel crises

More than 80% of the population of the SADCC region live in the rural areas.

The average SADCC per capita consumption of woodfuel (including charcoal) is 1.5 m^3.

However, patterns of consumption vary greatly. The annual consumption of 40 mill. m3 wood in Tanzania corresponds to more than twice the sustainable yield. In Malawi the wood demand exceeds sustainable yield by more than 30%, and this figure will increase. Even if other countries are better off when considering the total national figures, deficits exist within the countries with shortages in some districts. For example, in Mozambique the annual growth in forest resources is some 50% higher than the need for wood. Nevertheless, the supply situation is described as satisfactory in only four out of the ten provinces.

In addition a significant portion of the urban population still follow rural habits and technologies in their household activities such as cooking, heating, washing and other energy-consuming tasks. Therefore, in spite of urbanisation, the woodfuel

consumption in the region is expected to increase for many years to come.

Overexploitation of wood resources can, in the long run, lead to depletion of forests causing desertification, erosion and hence reduced food production. Scarce wood resources also have a negative impact on food production in the short run, since dung which should be used as fertilizer, is used as fuel. In the SADCC region the use of dung as fuel is relatively most significant in Lesotho. It has been estimated that dung constitutes 20% of Lesotho's final energy consumption.

Furthermore, in many rural households, a considerable amount of time is spent, mainly by women, collecting fuelwood. This time could be used for other purposes if energy were more readily available.

3.4. Indigenous energy resources

The SADCC energy resources and reserves are vast compared to the energy production and consumption in the region.

However, harnessing these resources requires the development of a corresponding transportation and distribution capacity. There is presently an underutilization of installed electrical capacity in the region.

The region's large coal reserves are mainly located in Botswana, Zambia and Zimbabwe. The development of local coal markets is necessary if the coal reserves are to be used as a substitute for other energy sources. It does not, however, seem economically viable at the present time to exploit these resources, because of the high transport costs involved.

Proven crude oil reserves exist only in Angola. However, natural gas deposits have been found in Angola, Mozambique and Tanzania. Tanzania plans to build a fertilizer plant using gas as a feedstock, while Mozambique is now appraising the feasibility for commercial utilization of its gas.

Hydrocarbon potential exists in several other SADCC member States but no commercial discoveries have yet been confirmed.

Increase in supply of energy is considered a prerequisite for the overall development in the region. At present, however, energy production in the region is structured in a manner which fails to meet the needs of the mass of the population. Therefore, new investments to develop energy resources must lead to increased regional supply and use of energy, and not only to increased capacity.

Energy investments must be carefully integrated in the overall macro economic development of the region.

4. OVERALL OBJECTIVES AND STRATEGIES

With reference to the defined policies in SADCC and the overall characteristics of the energy situation in the SADCC region, the main short and medium term objectives of the SADCC Energy Sector are to:

1) REDUCE THE DRAIN ON FOREIGN EXCHANGE RESERVES CAUSED BY EXTENSIVE IMPORT OF PETROLEUM PRODUCTS.
Angola is the only oil net exporter in the region. For all the other countries oil imports impose heavy constraints on their ability to import other commodities. In 1980 all countries except for Angola spent between 20% and 50% of their foreign currency earnings on oil products.- Most of the SADCC member States have reduced their consumption and hence their imports of oil since 1980 but related to total export earnings the figure remains high.

2) REDUCE THE DEPLETION OF WOODFUEL RESOURCES.
The average per capita consumption of woodfuel (including charcoal) is $1.5m^3$. Overexploitation of wood resources can in the long run lead to depletion of forests, causing desertification, erosion and reduced food production. In the traditional sector the alarming ecological by-effects of deforestation demands effective action to reverse the present trend.

3) DEVELOP EXPERTISE IN ENERGY TECHNOLOGIES AND PROMOTE TECHNOLOGY TRANSFER TO THE REGION.
Given appropriate support from SADCC's international cooperating partners, the region aims to develop local experience in energy technologies. This objective also covers the establishment of adequate training programmes for local experts.

4) ESTABLISH DETAILED KNOWLEDGE OF THE ENERGY SITUATION AND ITS INTER-RELATION WITH MACRO ECONOMIC DEVELOPMENT IN THE REGION.
This objective presents two aspects which may be more specifically addressed:

- The knowledge of the energy supply;
- The knowledge of the energy demand

A comprehensive study of the demand at the regional level is particularly important in order to optimize the relation between supply and demand.

The development of regional energy master plans is required to coordinate national and regional optimization of supply and demand.

5. STRENGTHEN REGIONAL COOPERATION IN THE VARIOUS ENERGY SUB-SECTORS
Overall coordination of the Energy Sector is the responsibility of Angola through the Technical and Administrative Unit, TAU. Cooperation will, however, be further strengthened by developing contacts between utilities and operating agencies in the Energy Sector. Regional development can only be achieved through committed and concerted actions at all levels.

6) ESTABLISH EMERGENCY SUPPLY AND DISTRIBUITION MECHANISMS
In case of disruptions in the supply of energy, e.g., petroleum, provisions should be made to secure stored reserves and alternative supply options.

7) PROMOTE BETTER KNOWLEDGE OF THE CAPITAL AND TECHNOLOGY REQUIREMENTS OF THE REGION
The industrialized countries must be made fully aware of the region's requirements in terms of capital and technology. Such knowledge may serve to speed up the transfer of capital and technology from these countries.

8) CONTINUE REHABILITATION PROGRAMMES
Rehabilitation programmes should be given priority to ensure effective utilisation of existing installations.

To meet these eight objectives the following priority actions will be undertaken:

- Development of conservation programmes;
- Increased exploration and development of indigenous reserves;
- Development of substitution programmes;
- Establishment of pilot studies and pilot installations;
- Promotion and development of professional skills;
- Development of Regional Master Plans to complement national programmes and serve as a regional frame of reference;
- Support and promotion of national and regional institutions to ensure effective implementation of energy programmes.

5. STRATEGIES FOR THE ENERGY SUB-SECTORS

5.1. Overall Coordination

STATUS

Overall coordination comprises the Energy Sector administration and general professional efforts in the Energy field such as training, seminars, overall studies, data acquisition and energy planning. The sector also comprises the activities of the Energy Bulletin.

The Technical and Administrative Unit of the Energy Sector (TAU) is established within the Ministry of Petroleum and Energy of Angola through a mandate given by SADCC the Council of Ministers in Luanda, June 1982. The TAU is organized into three major departments: the Technical Department, the Administrative Department and the Energy Bulletin Department.

The technical and administrative capability of the TAU is developing rapidly. The current total staff of 35 include experts in electricity, petroleum, coal, energy planning and administration.

The establishment of the TAU represents an important step in the development of regional know-how. The Unit is required to:

- Prepare and submit regional development plans and projects;
- Recommend measures to optimize the utilization of existing facilities;
- Recommend immediate, medium and long term measures necessary to meet energy demand.

The TAU receives technical support from a number of SADCC's cooperating partners, either in the form of foreign experts resident in Luanda and working on a day-to-day basis within the Unit, or on a coordinated expertise "on request" basis (Project 0.0.3.)

The SADCC Energy Bulletin is now published quarterly and has a regional and world wide circulation of 10,000 copies in both English and Portuguese (project 0.0.4.).

STRATEGIES FOR THE NEXT FIVE YEARS

1. Strengthening of TAU

In order to develop an organization with the skills and capacity required for regional administration and coordination in the Energy Sector, the TAU will be further

strengthened in terms of professional staff and administrative support. The TAU will be instrumental in attracting and developing expertise which is adapted to the specific conditions of the region.

TAU will in the near future be strengthened by further experts in New and Renewable Sources of Energy, in Energy Planning and in Informatics.

The Angolan nationals working in the Unit are undergoing professional training at appropriate levels, in order gradually to reduce dependence on external technical assistance.

2. The Development of Regional Master Plans

In order to meet the objective of strengthening regional cooperation it is necessary to develop regional master plans for the various energy sub-sectors.

The ultimate goal of the project Information Coordination System(0.0.5.) is to establish the basis for such master plans.

It is envisaged that such regional plans will be based on the national development plans of the member States and will, at the same time, constitute a useful reference for national planning. This will ensure that the national programmes are developed as part of a concerted effort to achieve the region's overall objectives.

National contributions are essential to develop a set of data on the basis of which such regional models can be established. Therefore, national agencies with relevant energy data will be urged to cooperate fully with TAU in this matter. National plans will be conveyed to TAU in the same manner. TAU intends to begin the development of energy models as soon as the data base permits.

3. Promotion of Professional Contacts

It is SADCC's ambition to organize at least one Energy Seminar every year. The seminars will promote association of professionals within the region and establish contacts with relevant professional agencies outside the region.

It is further intended to promote and support technical and scientific publications within the SADCC context. SADCC intends to encourage the creation of associations of utilities and companies operating in the various energy sub-sectors.

5.2. Petroleum

STATUS

Although the situation varies greatly among the SADCC member States, all countries with the exception of Angola suffer large petroleum import bills. Petroleum import are equivalent to from 20 - 50 % of total export value, which adds to an already unfavourable balance of trade for many countries.

The current fall in real prices for crude oil does not significantly change the situation, and the depletion of foreign exchange reserves caused by petroleum imports will continue to constitute a severe constraint on development.

The situation in Angola, which is a net exporter of petroleum, is very different. The 1984 export volume was nearly 9 million tonnes of crude oil and petroleum products.

Angola, however,has a problem arising from a surplus of fuel-oils. Although Angola produces LPG in Cabinda, a conversion is necessary to meet the needs of the country. There also exists a deficit of jet fuel B. Increasing the distillation capacity might solve the problem but this would create a problem of surplus production for all other refined products.

In view of the large refining overcapacity all over the world, it seems preferable to import the missing quantities of refined products.

This policy seems the most economic. Another solution would be the installation of facilities to convert the distillation residues. Hydrocracking is one possibility, but this high pressure process is very expensive both in capital investment and in operating cost.

Apart from Angola, three other countries operate refineries: Mozambique, Tanzania and Zambia. A refinery exists in Zimbabwe but has been closed for the past 19 years. The project Study on regional self-sufficiency in the Supply of Oil Products (phase 1)(1.0.1) undertaken in 1982 emphasizes the present imbalances between production and demand, and forecasts a deterioration of the situation in the coming years. Of particular concern is the heavy fuel oil surplus. This fuel does not move easily on the international market. Imbalance may be partly solved by importing blends of crude oil and refined products.

Given the current prices for crude oil and refined products, and the high costs of the technologies for reprocessing residues, investments to increase refining and residue processing capacity must be carefully assessed. Profitability in relation to current market prices is not assured.

However, special supply conditions for oil and refined products,

or alterations in the market situation, may justify certain investments, which might reduce refining costs and permit partial recovery of residues.

Supply

The basic question of security of supply and regional self-sufficiency in oil products is not addressed in the current stategy, nor is the question of economic optimization of the supply pattern.

These questions are currently being evaluated in the project (1.0.1.) concerning Optimization of the Oil Products in the SADCC Countries and will be addressed at a later date.

Exploration

Further exploration for oil and gas is ongoing in Angola, Tanzania and Mozambique. Botswana, which has prospective sedimentary basins, has prepared a scientific and legislative framework to attract investment in exploration.Also Zambia has made concrete steps to start exploration for which several international companies have shown interest. Malawi, which includes part of the East African Rift Valley, has made geophysical investigations which indicate possible hydrocarbon potential and further work has been proposed (Project 1.4.1.).

Also Zambia and Zimbabwe have areas which should be investigated with respect to potential hydrocarbons. As stated in the general overview, the consumption of petroleum has decreased as a result of stagnation in the economic activity in the last few years. No substantial measure of energy conservation or improvement of efficiency of industrial process has been undertaken.

However, a project on Energy Conservation (4.8.2.) has been adopted by SADCC and funding has now been secured. It will hopefully contribute to identifying measures to reduce unnecessary consumption and develop an industrial conservation programme in the region.

STRATEGIES FOR THE NEXT FIVE YEARS

There are no immediate solutions for the problem of foreign exchange depletion resulting from the petroleum import bill. However, long term programmes to reduce the consumption of oil should be started and continued within the next five years.

1. Exploration

Exploration programmes to prove further reserves of oil and gas will be given priority. Such exploration is underway on

a comparatively large scale in Tanzania and Mozambique. Programmes to ascertain the potential of other non producing countries will be encouraged. Although such exploration may be promoted on a commercial basis, SADCC programmes may assist member States to establish data by seismic investigation and limited drilling to provide a base for commercial promotion.

2. Substitution

Most imported petroleum products are used in the transport sector and in power stations. There exists a range of substitution possibilities. The possibilities will be evaluated and pilot tests will be undertaken during the next five years.

In the transport sector the following substitution may be made:

Ethanol
Ethanol is produced in Zimbabwe and Malawi and production is being considered also in Zambia. It is possible to add 15-20% ethanol to gasoline. Further investigations will be made regarding the possibility of blending ethanol and diesel.

Compressed Natural Gas (CNG)
Pilot projects to evaluate the practical possibilities of using CNG as a road transportation fuel will be implemented. If the results are positive further programmes will be designed.

Synthetic Liquid Fuels from Natural Gas
A feasibility study to analyse the conversion of natural gas into liquid fuels is proposed in Mozambique. The synthetic fuels are methanol, gasoline and diesel. New technologies in this field will be carefully evaluated for possible application in the SADCC region.

Railway electrification is a priority area for substitution.

3. Conservation
Energy conservation methods to reduce consumption of oil products will be further evaluated and concrete measures taken within the next five years.

4. Evaluation of Supply Strategies
The project Strategies for the Supply of Oil Products (1.0.1.), which will commence shortly, addresses both the problem of internal and external supply and the problems of transport and refinery structure in the region. Concrete strategies should be formulated after the results of this study are available.

5. Development of Expertise
The SADCC Petroleum Training Center in Sumbe (Angola) (1.0.2.) has initiated a training programme for students in the region.

5.3. Coal

STATUS

The export potential studies which have been undertaken in Zimbabwe, Tanzania, Swaziland and Botswana do not lend support to export programmes at this time due to the long and costly rail transport of the coal to the sea. This istuation will, however, be kept under review and as new possibilities arise, or if there is a major change in the international coal market, this matter will be considered further.

Coal conversion studies and an investigation into possible low temperature carbonization (LTC) of coal are presently underway. These studies will include a market survey on the supply and demand of coal conversion products followed by a pre-feasibility study with sampling and testing of the different coal types to determine whether one of the many existing coal conversion processes could be a feasible technology for better coal utilisation.

Opening of new mines is now taking place in Tanzania and Malawi in order to supply the domestic market with coal. This development is gratifying since it shows a trend towards self-sufficiency. However, some of the existing coal mines are situated far from the main centres and this often more than doubles the cost of coal to the consumer. This situation will encourage the opening of small scale mines closer to the market and in rural areas where people cannot afford to buy coal from distant mines. Otherwise the transport costs have to be subsidized. Most of the SADCC member States do not have a distribution system for coal and in order to introduce this commodity to the market it will be necessary to engage agents for the distribution of coal. It is therefore important to popularize the use of coal stoves and to promote coal as a substitute for woodfuel and charcoal.

The current domestic market is less than five million tonnes. About 25% is used for power production, more than 50% is used in the industrial sector and the remainder is used for transport, domestic and other purposes. The household consumption of coal is very small.

The amount of data on coal exploration, geology and mining as well as studies and reports in the SADCC countries have gradually taken such proportions that it is difficult to remain up to date in this sector. An inventory of coal data should be collected in a centrally located coal information centre for the SADCC countries. The SADCC Energy Sector will consult with the Mining Sector to this end.

STRATEGIES FOR THE NEXT FIVE YEARS

1. Conversion and substitution. Coal is one of the energy sources that may have real significance as a substitute for woodfuel and charcoal. Several programmes are underway to investigate methods of substitution and these efforts will be intensified.

Coal Briquetting
The project Investigation into Coal Briquetting (2.8.1) has been expanded to comprise the implementation of a pilot plant for coal briquetting. If the results are positive further efforts will be made to introduce this fuel as a woodfuel substitute.

Low Temperature Carbonization (LTC)
The Coal Conversion Study (2.0.2) and the Investigation into the Possible Low Temperature Carbonisation of Coal(2.2.1.) evaluate the various options for conversion processes and the potential market for the product. The findings may lead to a full feasibility study on the construction of a coal processing plant in the region that will be able to substitute a substantial part of the demand for oil derived products, fertilizers, chemicals and smokeless fuel.

Coal Stoves
The project Coal Stoves in Rural Areas (2.9.1.) is under implementation. It includes pilot deployment of 1400 low cost coal stoves in rural and urban areas of the SADCC coal producing nations. Depending on the results of these efforts, larger programmes will be designed to introduce stoves which may make coal more widely used.

3. Exploration and Opening of New Mines
In order to reduce transport costs and provide economic distribution of coal for domestic and industrial purposes, the development of new and even small scale mines should be considered. In areas where the situation for alternative fuels, ie woodfuel, is critical, mines may be justified even if they are not financially attractive. Furthermore, where economically viable the development of coal mines for export will be encouraged.

4. Regional Coordination
To organize the vast amount of data on coal it is recommended to develop a coal information centre for SADCC which may include professional services in coal data analysis.It is further recommended to establish a coal analysis laboratory which may serve the SADCC region. Today such coal analysis are sent abroad. Zimbabwe has the necessary equipment, but requires technical assisstance support before the laboratory can serve the region.

In order to further coordinate work in the coal sector,

efforts should be made to establish contacts and coordination between utilities and companies operating in the coal sector. Work in this area will be undertaken in consultation with the SADCC Mining Sector.

5.4. Electricity

STATUS

The present structure of the electricity sector in SADCC is characterised by the large surplus in generation capacity in the region as a whole. At the end of 1984 approximately 6760 MW were installed in more than 160 hydro- and thermal power plants, of which 4885 MW were available for use in the region. However, the sum of peak demand has been estimated to be approximately 3300 MW, leaving a spare capacity of more than 1500 MW in the present system. Even taking into account that some of this unused capacity is represented by old and uneconomic thermal plants, there is a considerable potential for increased electricity production from the existing system. According to information from the SADCC member states, the growth rate in the electricity consumption is anticipated to be substantially lower in the next five years than expected some years ago. Though this has also affected development and investment programmes in the electricity sector, with several projects temporarily shelved, it is expected that the SADCC region as a whole will have a substantial surplus of production capacity for several years. However, there are large differences among the nine member states. While Angola, Tanzania, Mozabique, Malawi and Zambia have a surplus, Lesotho, Swaziland, Botswana and Zimbabwe have deficits varying from insignificant to near 100 per cent in the case of Lesotho. This has led to the identification of a series of interconnection projects or studies currently under implementation:

- North East Zambia/Malawi/Tanzania
- Zimbabwe/Zambia/Botswana
- Zimbabwe/Mozambique
- Mozambique/Swaziland
- Mozambique/Malawi

The present structure of the electricity sector is also characterised by large consumption of electricity in the mining sector in Zambia and Zimbabwe, while consumption in the domestic sector is among the lowest in the world. To alleviate the energy situation for the rural population several member States have given rural electrification and construction of small hydropower plant high priority. However, implementation of these projects has often been hampered by financial problems among the different electricity utilities.

STRATEGY FOR THE NEXT FIVE YEARS

In order to reach the overall objectives the following sector strategies have been identified and will be given priority in the

next five years.

1. Better Utilization of the Existing Electricity System
Due to the large surplus in generating capacity it will be an important task to work for a better utilisation of the electricity system rather than adding new capacity to it. New capital investments must be carefully timed not to come in line before demand can properly justify the investment.
In some regions attention should be given to installation of new capacity to reduce dependence on South Africa.
The five year strategy calls for a strengthening of regional co-operation in the field of electricity through:
   - interconnection of the national electrical networks or grid sections to guarantee a rational utilisation of the region's energy resources.
   - establishment of coordinated water management agreements, in particular on the Zambezi River and its tributaries, in order to facilitate implementation of new schemes in the future as well as reduce generating costs in existing system.
   - preparation of electricity Master-Plans. In this context close cooperation with the authorities in the member States will be necessary.

2. Cooperation Between Electricity Utilities
The Seminar on cooperation between Electricity Utilities in the SADCC region held in Harare in December 1984 gave a first opportunity for an exchange of information on technologies among member States and with external agencies. Following the experiences gained at this seminar, consideration will be given to the establishment of a forum whereby electricity utilities might meet together, discuss common problems and new projects, exchange ideas and transfer know-how and information. In its initial phase this could be based on annual conferences or seminars. At a later stage the creation of a SADCC electricity utility organisation might be a possibility.

3. Rural Electrification
A main task for SADCC is to improve the living standards of the population and in particular for people in the rural and semiurban areas. In this context rural electrification is of particular importance. Rural electrification has also been identified as an area where a substitution for woodfuel might be found. The construction of small-scale hydropower plants could further alleviate present dependence on petroleum imports to operate remote diesel generators.
Based on information from each country, special programmes for rural electrification will be prepared. These programmes will identify priority regions in each country and evaluate the most convenient supply source for each region

from an economic, technical and ecological point of view. According to the considerations and guidelines given in these programmes, SADCC will promote electricity projects in the rural areas even if they are of a national character. The following projects will be relevant in this context:

- construction of new or upgrading of existing transmission lines to rural areas;
- construction of small scale hydro power plants for local supply;
- promotion of the introduction of new technologies based on electricity in rural and semi-urban households.

4. Hydropower Development in Lesotho
Lesotho, today almost 100 per cent dependent on imported electricity from South Africa, is considering indigenous hydropower resources and harnessing of these as an important step towards self-sufficiency. In this context they are evaluating two large scale hydropower plants which will, if implemented, considerably alleviate the situation and might even make Lesotho a net exporter of electricity for several years. SADCC will support efforts made by Lesotho to lessen its dependence on South Africa through the constuction of small or large scale hydropower plants. In this regard special attention should be paid to the Oxbow Multipurpose project (3.3.4).

5. Electricity Database in TAU
In the next five year period T.A.U will, in connection with the project Information Coordination System(0.0.5.), work to strengthen relations with the electricity utilities in the member States in order to establish a comprehensive database for the electricity sector. A fruitful two-way communication between T.A.U and the utilities is crucial in this context.

5.5. New and Renewable Sources of Energy

STATUS
The new and renewable energy sources (NRSE) comprise direct applications of solar energy, wind, geothermal energy and utilization of biomass for producing gas, ethanol and methanol.

SADCC has identified new and renewable energy sources as an important element in the development of long term strategies as means to reduce the pressure on traditional energy sources, improve living conditions in remote areas through provision of electricity, and contribute to agricultural and industrial development.

However, the introduction of solar and wind technologies to Southern Africa has been slower than in other parts of the developing world such as India, West Africa and Latin America. So

far, in SADCC it has been restricted to solar heating and drying systems and wind powered mechanical devices such as water pumps.

Available data is scarce concerning the use of NRSE in the SADCC region. There are, however, a number of ongoing experiments and pilot studies on a national level, often in connection with the universities. Research has been concentrated on solar systems and experiments with production of biogas. For example, in Lesotho 22 pilot/demonstration biogas digesters have been developed.

Ethanol is currently being produced from biological wastes in Zimbabwe (40 mill. per year) and Malawi, and is being considered in Zambia. The ethanol is added to gasoline. Methanol can also be used in this way, though its use is relatively difficult. The possibility of blending ethanol with diesel will be investigated.

In a SADCC context two projects on new and renewable energy are being implemented, a Solar Eenergy Pilot Project (4.0.3) and a Wind Power Pilot Project (4.0.4).

These projects include the collection of existing experiences in these fields within SADCC. A further survey of these experiences will be an important part of the five years strategy.

STRATEGIES FOR THE NEXT FIVE YEARS

The proposed strategies in the new and renewable energy sector are consistent with the overall objectives of reducing petroleum imports and fuelwood consumption by substitution for these energy sources. Because the technologies are new, the emphasis in the short term will be to increase knowledge and to undertake experiments and pilot studies. The following points will be given priority in the SADCC region:

1) Survey of experiences and expertise existing in the region.

2) Establishment of a SADCC NRSE Research Centre, preferably in connection with one of the existing centres or universities working in this field.

3) Establishment of contacts with other regions of the world (for example with India) with similar energy problems in order to secure a transfer of technologies.

4) Support existing and new pilot projects as required on solar energy and biogas and support the introduction of these technologies.

5) Investigate the potential for geothermal energy within the SADCC region.

The consideration of existing experience will lead to more specific proposals for new projects in this field. But already at this stage the solar and biogas technologies appear promising.

Exchange of experiences is a main issue in the field of new and renewable sources of energy. A SADCC NRSE Research Center would coordinate this information exchange in the region. NRSE will be considered in regional energy planning as it is anticipated that the relative importance of these new technologies will increase in the future.

5.6. Woodfuel

STATUS

One of the most crucial problems the SADCC member States are facing today is the depletion of forests, which in the long run can contribute to erosion and drought.

At present the situation is characterized by woodfuel shortages affecting a substantial portion of the populated rural areas, deforestation for charcoal supply around urban areas, and acute but limited local shortages of woodfuel.

The Luanda Woodfuel Seminar in October 1983 recognised the seriousness of the woodfuel situation, its long term consequences for the ecological system and the negative way it affects the population which is dependent on woodfuel supplies. A series of actions were recommended which require joint efforts from both the Forestry and the Energy Sectors.

The main recommendations of the seminar are:

A) For rural areas:
- Agro-forestry measures
- Better Utilization of Natural Forests
- Village and family plantations
- Improved stoves programme.

B) For urban areas:
- Improved use of natural forests
- Industrial plantation
- Wood as a cash crop
- Improved stoves programme
- Briquetting of agro-industrial residues
- Other alternative fuels.

The proposal for a five year strategy in this sector is in accordance with these recommendations.

Good knowledge of the current situation is a prerequisite for effective actions. In this connection the series of woodfuel projects have been funded (projects 5.0.1 - 5.0.5). These projects include surveys, evaluation of experiences and some pilot projects (for example improved stoves etc.). One major SADCC fuelwood project ,Blantyre City Fuelwood (5.4.1), has also been funded.

The scope for substitution of woodfuel by other energy sources is limited in the short run, in particular in the rural areas. The same concerns conservation efforts (like the introduction of improved stoves). One reason for this is the sociological barriers to be overcome when introducing new technologies. The project Investigation into Local Customs and Potential Acceptability of New Technology in Rural Communities (4.6.1) is designed to improve our understanding of these factors.

Several of the projects in the woodfuel sector comprise measures both in the Energy and in the Forestry Sectors. To guide the cooperation between these two sectors a proposed Memorandum of Understanding between the Energy and the Forestry has been formulated.

A Regional Tree Planting Programme has been proposed with the purpose of increasing people's awareness of trees as a precious resource.

STRATEGY FOR THE NEXT FIVE YEARS

In accordance with the overall objective of reducing the depletion of woodfuel resources and the general strategies of energy conservation, development of indigenous reserves and substitution, the following strategies will be implemented:

1) Afforestation programmes

2) Development and introduction of more efficient wood consuming devices (stoves)

3) Programmes for substituting fuelwood and charcoal by other energy sources like coal, gas, small scale hydropower and new and renewable energy methods.

To implement these strategies it will be necessary to generate pilot studies and pilot installations. Woodfuel strategies will also have an important place in the work with regional energy master plans.

As mentioned, experiences show that the introduction of new technologies is a slow and difficult process, especially in rural areas. This limits possibilities for conservation and for substitution efforts in the woodfuel sector the short term. Measures to improve the rural fuelwood balance must therefore primarily concentrate on the supply side.

Feasibility studies (from areas other than SADCC) have found small-scale agro-forestry and local woodlots to be the most attractive types of projects rather than large scale forest plantations. Perhaps most important in this context is the fact that the small scale projects comprise more of the traditional sustainable resource management systems with which many communities are already familiar.

This conclusion has important implications for the role of projects and programmes in this sector. Such programmes must be oriented towards those who collect and use the woodfuel, particuly women.

Even if the conservation and substitution approach fails to achieve significant results in the rural areas during the first five years, it is crucial to get started. In urban areas where a large part of the population also uses fuelwood or charcoal, there should be some scope for substitution even in a short term. Forest depletion is most severe in the vicinity of population concentrations.

The necessity of cooperation among the Energy, Forestry and Agricultural Sectors will be maintained. Integrated programmes and projects comprising measures on both the forestry supply and woodfuel demand side are required.

Finally, the role of training should be mentioned also in the woodfuel context. This aspect concerns both the training of technicians to supervise afforestation programmes and conservation and substitution measures, and training of people in general to take care of such measures and the forest resources.

Section II

STATUS OF PROJECTS

PROJECTS IN OVERALL COORDINATION

Project No. 0.0.3
Project title: SUPPORT TO THE ENERGY SECTOR, TECHNICAL AND ADMINISTRATIVE UNIT (TAU)

TAU receives support from: Belgium, Brazil, EEC, Norway and Sweden and UK.

Altogether seven external technicians have joined the Unit in Luanda. The objective is to suplement the Unit with appropriate skills and expertise. The programme should gradually reduce dependence on external assistance.

Project No. 0.0.5
Project title: INFORMATION COORDINATION SYSTEM

The project Organization of a Permanent System of Information and Technical Coordination between SADCC Member States (0.0.5) was presented at the Lusaka Conference in February 1984. The objective of the project is to install in the SADCC Energy Sector Technical and Administrative Unit (TAU) a computerized regional energy database system and planning tool, to aid energy coordination in the Energy Sector.

Implementation of the project is underway.

The project is funded by Norway and Belgium.

Project No. 0.0.6
Project title: SEMINAR ON ENERGY PLANNING

The seminar will be the fourth regional energy seminar held within the context of the SADCC programme. Earlier there have been seminars on Energy and Development (Harare 1982), Woodfuel (Luanda 1983) and on Cooperation between Electricity Utilities in the SADCC Region (Harare 1984). The seminar on energy planning will establish a basis for permanent dialogue between the bodies responsible for energy planning in the SADCC member States and the coordinating unit in Angola.

The budget for the seminar totals USD 52.000. Part funding has been obtained from Norad.

PETROLEUM PROJECTS

Project No. 1.0.1 PHASE 2
Project title: A REGIONAL SADCC OIL SUPPLY STRATEGY

The study was presented during the Lusaka Conference in 1984 under the title Study on Regional Self Sufficiency of Oil Products, Phase 2.

The feasibility study obtained finance from the EEC.
The Terms of Reference have been reformulated. The reason for this reformulation is the changes in the international market for petroleum products. The options open to Southern Africa had to take into account this new context, as well as that of the fundamental uncertainty which characterizes the market.

A restricted invitation to tender has been given with closing date October 1985.

Project No. 1.0.2
Project title: REGIONAL PETROLEUM TRAINING CENTRE.

The petroleum training center is located in Sumbe, Angola.

The project is financed by UNDP and Norad (5.560.000 USD), and Angola.

Six courses are on the current schedule:

- external refinery operators (Mozambique 17 and 9 Tanzanian students)
- training of trainers (Botswana 2, Lesotho 4, Tanzania 2, Angola 1, Swaziland 2 students)
- firefighting (Lesotho 10, Tanzania 2 students)
- electricians (Mozambique 4, Angola 12 students)
- production operations (Angola 15 students)

Project No. 1.4.1
Project title: HYDROCARBON EXPLORATION IN THE MALAWI RIFT VALLEY

The objective is to gain information regarding the hydrocarbon potential in the Malawi Rift Valley. The project includes geophysical investigation and drilling for stratigraphic information.

This project was first presented at the Mbabane Conference 1985.

The project is being reformulated by the Technical and Administ-

rative Unit (T.A.U) and the Geological Survey of the Malawi Government.

The reformulated project will be made available at the Harare Conference in 1986.

Project No. 1.7.1
Project title: TAZAMA PIPELINE. TANZANIA/ZAMBIA

The objective of the project is to continue safe deliveries of crude oil to Zambia through this pipeline. The project comprises necessary maintenance work on the pipeline. The cost of the project is USD 8.250.000.

The project was first presented in Mbabane in 1985.

COAL PROJECTS

Project No. 2.0.1
Project title: COAL EXPORT POTENTIAL STUDY

The project has been withdrawn.

Project No. 2.0.2
Project title: COAL CONVERSION STUDY.

The objective of this study is to establish the various coal conversion techniques which could provide a range of synthetic products suited to the market and investigate the regional coal deposits which would be best placed to supply the industrial conversion units.

The cost has been estimated to USD 889.000 for phase 1, and USD 764.000 for phase 2.

The project was first time presented in Lusaka in 1984 and again in Mbabane in 1985. Parts of this study are included in Investigation into Possible Low-Temperature Carbonisation (LTC) of Coal.(2.2.1)

TOR's will be reformulated taking into account project 2.2.1.

Project No. 2.2.1
Project title: INVESTIGATION INTO POSSIBLE LOW TEMPERATURE CARBONISATION (LTC) AND OTHER CARBONISATION PROCESSES IN THE SADCC REGION.

Phase 1 of the project is a technical coal resource desk study and a market study in order to outline possible conversion processes and products as well as the demand and economic substitution values for these products. This initial study will lead to phase 2 which is a detailed pre-feasibility study including sampling by excavations and drilling followed by specialised analysis and conversion tests.

Cost for phase 1 is USD 101.000 and for phase 2 USD 571.000. Estimated time phase 1 is 6 months and phase 2 is 12 months. EEC is financing this project.

The original project, which was presented in Mbabane in 1985, was intended to investigate LTC carbonisation processes in Botswana. However, the project has been extended to include other coal nations in SADCC and to investigate other carbonisation processes as well.

Project No. 2.4.1
Project title: COAL EXPLORATION AND EVALUATION - MALAWI

This study has the intention of exploring and evaluating all the 13 known coalfields in Malawi over a period of 5 years. The object is to assess the economic potential of the coalfields in an attempt to lessen coal imports to Malawi.

The cost of the study is USD 2 million.

The project was presented in Mbabane in 1985. The project will be reformulated and broken up into discrete phases.

Project No. 2.4.2
Project title: DEVELOPMENT OF COAL ANALYSIS LABORATORY - MALAWI

This project comprises acquisition and development of a laboratory to analyse coal samples, and training of people to operate the laboratory.

The project has been financed.

Project No. 2.4.3
Project title: COAL MINING DEVELOPMENT TRIAL AT LIVINGSTONIA MALAWI

The project will consist of designing an appropriate mining method and mining of 5000 tonnes of coal on a trial basis.
The cost of the project is USD 319.000

Project No. 2.8.1
Project title: INVESTIGATION OF COAL BRIQUETTING - ZAMBIA

Due to the advanced stages of previous investigations, the project has been changed also to include the construction of a pilot plant for coal briquetting, and a market study will be done.

The total cost is USD 1.088.000

The project has funding from NORAD.

Project No. 2.9.1
Project title: COAL STOVES FOR USE IN RURAL AREAS.

This project has been extended to include all coal nations in SADCC. 1400 coal burning stoves will be deployed, followed by studies on economy, impact on deforestation etc. Total cost is estimated at USD 767.000.

The project was presented for the first time in Mbabane in 1985.

Funding is provided by the EEC.

ELECTRICITY PROJECTS

Project No. 3.0.1

Project title: RURAL ELECTRIFICATION, PILOT PROJECT

This project will be reformulated and broken up into its constituent parts and Terms of Reference will be drawn up for the new projects.

Project No. 3.0.2
Project title: SPECIALISED TRAINING IN THE FIELD OF ELECTRICAL POWER.

One of the major problems facing the development of the electricity sector is the lack of trained and qualified personnel within the region. The objectives of this study project are:

- to identify training needs for electric utilities personnel.
- to formulate a training programme taking into account the existing facilities in the region.

The project cost is USD 150.000.

This project received financial support from the E.E.C at the

Lusaka Conference in 1984.

A restricted tender will be opened at the end of September 1985. The study will start in January 1986 and be completed by August of the same year.

Project No. 3.0.3
Project title: MAINTENANCE OF MECHANICAL EQUIPMENT IN POWER STATIONS. PREFEASIBILITY STUDY

The study aims at assessing the present maintenance costs of power station mechanical equipment in all SADCC member countries, and will propose measures to reduce the related foreign exchange expenditure. The total estimated cost of the study is USD 150.000.

The project was presented in Mbabane in 1985 and attracted interest from Sweden and EEC.

EEC has been requested to finance a first phase.

Project No. 3.1.1
Project title: FLOW MEASUREMENT ON HIGH ZAMBEZI. ANGOLA

The objective of the project which was presented in Lusaka in 1984is to ensure adequate supply of hydrological information to the authorities for power generation on the Zambezi River.

The project will be reformulated to include Angola, Zambia, Botswana, Zimbabwe and Mozambique.

Project No. 3.1.2
Project title: INTERCONNECTION OF THE NORTHERN, CENTRAL AND SOUTHERN ELECTRICITY GRID. ANGOLA

The study will develop in three phases; design, survey and production of tender documents for an interconnection of the three presently unconnected electricity supply systems in Angola. In addition, the possibility of interconnection with the Namibian system will be considered.

Total cost for the study has been estimated at USD 450.000.

The project was first presented in Mbabane in 1985 and attracted interest from Brazil, Norway and Portugal.

Contacts were made with those coumtries in order to define the practical modalities and the methodology for developing the project.

Project No. 3.1.3
Project title: COMPLETION OF THE GOVE HYDROELECTRIC DEVELOPMENT ANGOLA

This project has two stages. The first stage is a study on the generation and transmission facilities in the central power system, with special emphasis on using the existing Gove dam for hydroelectric production purposes. The second stage comprises engineering , tendering and work supervision.

The estimated cost for the study is USD 2 million.

This project is being dealt with jointly with project 3.1.2.

Project No. 3.2.1
Project title: INTERCONNECTION OF THE BOTSWANA AND ZIMBABWE GRIDS. FEASIBILITY STUDY.

The objective of the study is to evaluate the technical and economical viability of interconnecting the two national grids.

The cost of the study is USD 360.000.

Financial commitment for this project was assured by Canada at the Lusaka Conference in 1984.

A prefeasibility study has been completed.

Project No. 3.2.2
Project title: BOTSWANA/ZIMBABWE OR ZAMBIA COOPERATION.

The objective of this study is to evaluate the technical and economical viability of connecting the two small villages, Kazane and Kazungula, in northern Botswana to the national grids in Zambia or Zimbabwe. The cost of the study is USD 70.000.

The project was presented in Lusaka in 1984 and financial commitment was assured by Canada.

The project is implemented jointly with project 3.2.1.

Project No. 3.2.3
Project title: CONNECTION OF SEROWE, PALAPYE AND MAHALAPYE TO THE NATIONAL GRID. BOTSWANA

This project, which was presented in Mbabane in 1985, has secured funding from Denmark.

Project No. 3.3.1
Project title: DEVELOPMENT OF SMALL HYDROPOWER FACILITIES AT MANTSONYANE AND SEMONGKONG, LESOTHO

This project comprises construction of two small hydropower plants in Lesotho. The Mantsonyane plant (2 MW) will be connected to the national grid while Semongkong (180 KW) will supply a local grid.

The project was presented in Mbabane in 1985. Total costs are USD 7.4 million.
Financing is provided by NORAD and preparatory work has started.

Project No. 3.3.2
Project title: 33 kv SUBTRANSMISSION NETWORK DEVELOPMENT, LESOTHO

The objective of the project is improvement of the 33 kv transmission system in Lesotho as a basis for further electrification in the country. The project comprises construction of 7 new substations, approximately 180 km of 33 kv transmission lines and one regional control centre. The cost of the project is estimated to be between USD 2.6 and 4 million.

The project was presented in Mbabane in 1985 and attracted finance from Norway and Sweden, and construction work is expected to start early 1986.

Project No. 3.4.1
Project title: MALAWI/MOZAMBIQUE ELECTRICITY SUPPLY IN THE EASTERN AND WESTERN BORDER REGIONS.

The objective of the project is to supply three villages in Mozambique with electricity from the Malawi grid. The villages are located near the eastern and western border with Malawi, far from the national grid in Mozambique, and are not likely to be connected to it in the future.

The total construction costs are USD 1.726 million.

The project was presented in Mbabane in 1985 and attracted interest from Canada, Norway and the EEC. Mozambique and Malawi have requested financing from Norway.

Implementation will start in early 1986.

Project No. 3.4.2
Project title: SMALLL HYDROPOWER PROJECTS IN MALAWI

The project comprises construction of hydropower plants at Karonga town and for the Chilumba/Chitimba/Livingstonia area both of which are in the northern part of Malawi. This area is currently supplied by a diesel generator and is not likely to be connected to the national grid in the near future. The total cost is USD 4.25 million.

The Karonga element of the project was first presented in Mbabane. The Chilumba/Chitimba/Livingstonia component is being presented for the first time.

Project No. 3.5.1
Project title: ZIMBABWE-MOZAMBIQUE ELECTRICITY SUPPLY COOPERATION IN THE CENTRAL AND SOUTHERN BORDER REGIONS.

The objective of the project is to increase co-operation in the electricity sector between Mutare region in Zimbabwe and Manica province in Mozambique by upgrading existing transmission lines and substations. Phase 1 of the project will increase the capacity of Mutare substation from the current 15 MW to 40 MW which is also the capacity of the existing transmission line between Zimbabwe and Mozambique. Phase 2 comprises a feasibility study on a new transmission line (60 MW) between the two countries. The cost of these two phases is USD 0.7 million.

The project was presented in Maseru in 1983 and funding from NORAD has been secured.

The project is closely related to project 3.5.4 Mavuzi hydropower project, presented in Mbabane in 1985. The two projects will be implemented together.

Project No. 3.5.2
Project title: MOZAMBIQUE/SWAZILAND CO-OPERATION MASTERPLAN FOR THE ELECTRICITY SUPPLY OF SWAZILAND AND SOUTHERN MOZAMBIQUE.

The aim of the project is to identify and appraise, in technical and economical terms, the alternative sources of electricity supply for the whole of Swaziland and southern Mozambique, and to design a master plan based on the interconnection of their grids. The cost of this study is USD 0.624 million.

The project was presented in Lusaka in 1984 and financial commitment was assured by Canada. The project is implemented together with project 3.2.1 and 3.2.2.

Project No. 3.5.3
Project title: CORUMANE HYDROPOWER PROJECT. MOZAMBIQUE.

This project comprises construction of a power plant in connection with the existing Corumane Dam some 140 km from Maputo. A feasibility study has indicated that a 14 MW plant is economic. Total cost is USD 10.95 million.

The project was presented in Mbabane in 1985. Both Norway and Sweden expressed interest, and Mozambique is preparing a more comprehensive project presentation to be submitted to NORAD and SIDA.

Project No. 3.5.4
Project title: MAWUZI HYDROPOWER PROJECT. MOZAMBIQUE

This is a study on possible future export of electric power from Mavuzi hydropower plant in Manica province in Mozambique to Zimbabwe. Both existing production facilities, possible extensions of them, and the market will be evaluated. The cost of the study is USD 0.72 million.

The project was presented in Mbabane in 1985 and has obtained finance from NORAD.

The project is closely related to the reinforcement of transmission lines between the Manica province and the Mutare region in Zimbabwe (project 3.5.1). The two projects will be implemented together.

Project No. 3.5.5
Project title: MOZAMBIQUE-MALAWI INTERCONNECTION OF ELECTRICITY SUPPLIES.

This project consists of a study of the feasibility of a transmission line which would carry power generated at Cahora Bassa to Malawi, and thereafter to the north eastern part of Mozambique. A number of towns along the line could be connected to the national grid of Mozambique, and power exchanges with Malawi could take place with the construction of this line. The cost of the study is USD 100.000.

The project was presented in Mbabane in 1985 and has obtained finance from SIDA.

Project No. 3.5.6
Project title: PEQUENOS LIMBOMBOS HYDROPOWER PROJECT. MOZAMBIQUE

The project is currently withdrawn.

Project No. 3.7.1
Project title: MALAGARASI HYDROPOWER PROJECT. TANZANIA

The project comprises the complete construction of a 7.6 MW hydroelectric scheme in the Kigoma region of the country. Transmission lines, substations and consultancy services for engineering and supervision are also included in the project. Total capital cost is USD 30 million.

The project was first presented in Mbabane in 1985.

Project No. 3.7.2
Project title: SUNDA FALLS POWER PLANT. TANZANIA

The project comprises the complete construction of a 3 MW hydroelectric scheme in the Tunduru region near the border with Mozambique. Transmission lines, substations and consultancy services for engineering and supervision are also included in the project. The total cost is estimated at USD 5.23 million.

The project was presented in Mbabane in 1985.

The project will be revised to include Mozambique taking into account the possibility of providing for energy needs of Mozambique consumers in the border area.

Project No. 3.7.3
Project title: KIDATU-MOROGORO 220 KV TRANSMISSION LINE. TANZANIA

The project comprises the construction of an approximately 160 km of 220 Kv overhead transmission line from existing Kidatu Power Station to Morogoro Substation. Consultancy services are also included. Total cost is estimated to USD 20 million.

The project was presented in Mbabane in 1985 and attracted interest from the African Development Bank (ADB).

Project No. 3.8.1
Project title: ZAMBIA/MALAWI/TANZANIA INTERCONNECTION.

The objective of this project is to define the long term transmission grid structure in the northeast region of Zambia, including possible interconnections with Malawi and Tanzania. Total cost of the study is USD 465.000.

The project was presented in Lusaka in 1984 and will be financed by NORAD.

Revised T.O.R.s are under preparation after consultations with the parties involved.

Project No. 3.8.2
Project title: KAFUE GORGE POWER PLANT. ZAMBIA

The project comprises a complete upgrading of the turbines and other major components in Kafue Gorge power plant. The project also aims at giving key personnel in ZESCO theoretical and practical training in addition to the maintenance work. Total cost is USD 530.000.

Finance has been secured from NORAD and the project will be implemented shortly.

NEW AND RENEWABLE SOURCES OF ENERGY

Project No. 4.0.2
Project title: ENERGY SAVINGS IN INDUSTRY.

The project is a study which will assess energy use in different industrial sectors in several SADCC countries, and recommend adequate measures to reduce their energy consumption. The cost of the study is USD 6.97 million.

The project was presented in Lusaka in 1984.

Finance has been obtained from CIDA and IDRC. The project will be implemented jointly with project 4.8.2 under the name Energy Conservation Programme. The committed programme amounts to USD 3.2 million.

Project No. 4.0.3
Project title: SOLAR ENERGY PILOT PROJECT.
The aim of the project is to introduce solar energy technology in the region by the creation of demonstration units based on low-powered photovoltaic generators.

The total cost of the project is USD 1.0 million.

The project was presented in Lusaka in 1984. INTER PARES, an NGO from Canada, proposed to undertake a pre-feasibility study (co-financed by CIDA) for both projects 4.0.3. and 4.0.4. The report on the study, comprising recommendationshas been completed. CIDA has been identified as a potential donor for the subsequent phases of the project.

Project No. 4.0.4
Project title: WIND POWER PILOT PROJECT.

The project consists of installing and operating a wind-turbine generator, coupled with a diesel generator, in order to supply a small and remote community with electricity.

The total cost of this project is USD 0.9 million.

The project is implemented jointly with project 4.0.3.

Project No. 4.0.5
Project title: INTEGRATED ENERGY SYSTEMS FOR VILLAGES, BASED ON LOCAL ENERGY SOURCES. FEASIBILITY STUDY

The project is a study in three phases on how to meet the energy needs in typical small villages in the SADCC region based on local energy resources. Phase 1 and 2 will identify the different energy end-use purposes and the supply options, while phase 3 will draw up proposals for pilot projects.

The cost of the study is USD 0.39 million.

The project was first presented in Lusaka in 1984. INTER PARES, a Non Governmental Organisation from Canada has been requested to investigate the possibility of NGOs supporting this project.

Project No. 4.8.1
Project title: ENERGY CONSERVATION PROJECTS, INDENI PETROLEUM REFINERY. ZAMBIA

The project aims at saving energy in the existing Indeni Refinery through installing waste-heat recovery equipment, economisers in the boilers and pre-flash tower in the cru de distillation unit.

The total cost is USD 1.4 million.

Project No. 4.8.2
Project title: ENERGY CONSERVATION IN MINING AND INDUSTRY. ZAMBIA

The project is a study which will assess energy use in mining and other industries and recommend adequate measures to reduce their energy consumption.

The total cost of the study is USD 307.000.

The project was presented in Mbabane in 1985 and attracted interest from Canada, and will be implemented jointly with project 4.0.2.

WOODFUEL PROJECTS

Project No. 5.0.1
Project title: DESIGNING A METHODOLOGY FOR CONDUCTING AN INVENTORY AND A SURVEY OF WOODFUEL ENERGY IN ANY SADCC COUNTRY.

Project No. 5.0.2
Project title: EVALUATION OF THE EXPERIENCE AND PROGRESS MADE IN AGRO-FORESTRY AND COMMUNITY FORESTRY IN SADCC COUNTRIES

Project No. 5.0.3
Project title: EVALUATION OF THE PROBLEMS, PROSPECTS AND POTENTIAL OF URBAN WOOD PLANTATIONS AS SUPPLIERS OF WOODFUEL TO URBAN AREAS.

Project No. 5.0.4
Project title: SELECTION OF SUITABLE AND EFFICIENT WOODBURNING AND CHARCOAL STOVES. PILOT PROJECT

Project No. 5.0.5
Project title: SELECTION OF SUITABLE AND EFFICIENT BRIQUETTING AND PRODUCER GAS TECHNOLOGIES. PILOT PROJECT

After the Lusaka Conference in 1984 these projects were merged into one single project, the purposes of which are as follows:

- To enable the T.A.U./SADCC Energy Sector to guide and support energy authorities in Member States in developing woodfuel energy models that will permit a correct assessment of their country's woodfuel situation. The models will form the basis for effective woodfuel strategies and action programmes with particular attention to:
  - agro forestry programmes
  - urban woodfuel plantations
  - improved stoves programmes
  - energy from agricultural wastes programmes

EEC signed a Financing Agreement in early 1985 for this project which is now entitled; Energy Development- Woodfuel. The project is funded in equal shares by the EEC and the Netherlands and amounts to a total of 900.000 ECU. The project will start in October 1985.

Project No. 5.1.1
Project title: EVALUATION OF THE USE OF WOODFUEL IN ANGOLA

The study shall identify measures to alleviate the woodfuel crisis - with particular reference to urban areas. Terms of Reference for woodfuel projects will be formulated.

The cost of the study is USD 286.500.

The project was presented in Mbabane in 1985 and finance has been secured from EEC. The project will only be implemented after results of projects 5.0.1 - 5.0.5 are available.

Project No. 5.4.1
Project title: BLANTYRE CITY FUELWOOD PROJECT. MALAWI

This project involves the establishment and administration of 64.660 ha of fuelwood plantations.

The total cost is USD 6.54 million.

The project was presented in Mbabane in 1985.

Funding has been obtained from NORAD.

Project No. 5.7.1
Project title: ESTABLISHING A FUELWOOD PLANTATION AT RUVU. TANZANIA

The project comprises a 45.000 ha fuelwood plantation. A study to determine the feasibility of an associated charcoal production is included.

The cost of the project is USD 936.000.

The project was presented in Mbabane in 1985.

Section III

PROJECT DOCUMENTATION

PROJECT 0.0.7.

Technical files, data bank and reference library for the SADCC Energy Sector.

BACKGROUND :
The Energy Sector, SADCC, is coordinated by the Technical and Administrative Unit (TAU) which is established within the Ministry of Energy and Petroleum in the People's Republic of Angola.

TAU is headed by a Regional Coordinator and includes three departments- the Administrative Department, the Technical Department and the Energy Bulletin Department. Total staff amounts to about 40 persons.

The functions of TAU include :

(a) Administrative Department

- Perform administration of regional meetings, seminars and missions
- Circulate general information about energy developments in the SADCC Region
- Assist in contract negotiations and render professional assistance to SADCC Member States
- Produce and distribute financial and other progress reports to donors on matters related to TAU
- Perform general administrative functions in TAU : Accounting, procurement, travel/visas, translation, personnel, office and support functions.

(b) Technical Department

- Acquire and prepare documents necessary for the work in the Energy Sector which comprises : Petroleum, coal, electricity, new and renewable sources of energy, wood fuel, training, regional planning
- Prepare and submit regional development plans and projects
- Recommend measures to optimise facilities and measures to meet energy demands
- Prepare and analyse relevant energy statistics of the region
- Assist in negotiations with cooperating partners and promote regional energy projects
- Establish technical files and energy reference data for the SADCC Region.

(c) Energy Bulletin Department

- Edit, produce and distribute the SADCC Energy Bulletin in English and Portugese
- Translate technical articles from Portugese to English (and vice versa) for publication in Bulletin
- Solicit advertising for the Bulletin from SADCC national and international companies
- Edit and produce special publications as required by TAU (special issues, brochures, documents)

The backbone of all TAU activities is a reliable and updated data base in the Energy Sector.

There is a clear need to improve the energy data base in order to facilitate energy planning. TAU has already embarked on the establishment of an Information Coordination System (Project 0.0.5.)- which is being developed with foreign technical assistance.

As an integral part of energy planning, TAU will survey completed studies and reports of energy-related issues conducted by Member States and external agencies. Proper energy planning also requires an inventory of regionally-based manufacturers of energy equipment, training facilities, research institutions and energy-related periodicals by Member States.

The rapidly increasing number of projects, and the complex and integrated nature of work in the various energy sectors and related SADCC sectors,represent an increasing possibility of overlapping efforts, particularly in the field of collecting basic data.

The establishment of an Energy Data Bank for the SADCC Region will therefore serve many purposes :

- Planning and project work in TAU
- Regional reference for national energy planning in Member States
- Data base and reference for contractors and consultants engaged in SADCC projects
- Reference for cooperating partners and donor agencies
- Reference for other SADCC sectors which require coordination with the Energy Sector : Forestry, Industry, Transport and others.

The amount of data is expected to be large. General background data is required for six energy subsectors.

The regional coverage comprises nine countries, with a population of some 58 million living in a variety of industrial and rural communities.

Background data wil also be required for countries adjacent to the SADCC region with which coordination may occur.

Data concerning other sectors such as transport and communications will also be indicated in the data bank.

The accumulated number of projects in the Energy Sector was 56 by January 1985. Each project requires a file of background information:- project documents, minutes of meetings, contact with donors, revisions and updates.

In non-physical projects where TAU has a key role, all such information shall be readily available to Member Countries and relevant cooperating partners.

The work in the Administrative Department is also to a large extent project related. It is therefore necessary to establish a common basis for the technical and administrative files.

The Energy Bulletin, which aims to inform interested parties about the energy development and policies in SADCC and to publish updates on project and donor activities, should also be integrated in a common file system.

OBJECTIVES :
The short-term objective is to facilitate professional work in TAU and provide a proper base for future development in the project administration.

In the medium term, the project ensures proper handling of the large flux of data which is required in the process of arriving at an energy master plan for the SADCC region.

In the long term the energy data base and reference library may serve Member Countries, cooperating partners, consultants, contractors or any agency dealing with energy matters or related subjects in the region. Time-consuming efforts in collecting the same data and reference time and again will be saved. Moreover, a comprehensive regional data base is a prerequisite for proper planning and definition of effective projects in the Energy Sector.

WORK DESCRIPTION :
Basic elements :

1. The project shall establish a professional file system which shall meet the requirements of the Administrative, Technical and Energy Bulletin Departments in TAU.

2. The files shall be established and made operational in TAU's office facilities in Luanda.

3. The project shall establish an Energy Data Bank and an Energy Reference Data Library for SADCC.

4. The Reference Library shall be established and made operational in TAU's office facilities in Luanda.

IMPLEMENTATION :
TAU is presently working with tentative file systems which are separate for each department. Additional office space which may accommodate the files and reference library is available in temporary facilities.

The project shall be carried out by a consultant who shall make a professional archivist/librarian available to TAU for a period of

1 - 2 years as required. This person will be stationed in Luanda.

1. The work shall start with an evaluation of the detailed requirements for an adequate file system for TAU activities. A file system shall be generated and implemented. Necessary equipment shall be provided by the project. TAU has a system of several small computers (Olivetti M24) which may be applied.

2. The second stage of the work will be to establish formal links and cooperation with an agency outside Angola which has ready access to relevant international data banks in the field of energy and related topics. A survey of data banks and reference systems in the SADCC Region should be performed.

Cooperation with the external agency should provide the following:

- A comprehensive literature survey with relevance to the SADCC Energy Sector

- A quarterly update of new reports/literature in the energy field.

- A means of ordering copies of books and reports for the Energy Reference Library

- A means of running literature surveys on special topics when required.

3. The third stage of the work is to establish a reference library for the SADCC Energy Sector. The library shall be established with an open file and a restricted file as applicable. It is important that the file is complete regarding national energy reports and plans from all Member Countries. Provisions for confidential treatment of such reports shall be made.

The reference library shall be established in conjunction with the TAU offices in Luanda. Office facilities exist. Other physical facilities shall be provided by the project.

4. Training of local personnel shall be provided throughout. Relevant courses for two persons and on-the-job training for another two is envisaged. Relevant courses and required background for the local candidates shall be established at the start of the project.

TIME SCHEDULE :

The first phase should start as early as possible and be fully implemented within the first project year.

The second stage should be started within the first project year and be fully implemented during the first half of the second year.

The third stage shall be implemented during the second project year.

Recurrent budgets should be provided for a period of 5 years to pay for continual services by the external agency and secure continued development of the energy data base.

Courses for local candidates shall start as early as possible to enable the candidates to participate in the implementation of the project.

On-the-job training will occur mostly in TAU, but external training should be considered.

COST ESTIMATE

The following cost estimates represent order of magnitude figures. It is envisaged that detailed and revised cost estimates are worked out as an initial project phase.

Cost categories		Cost USD
1.	Librarians/Archivist 2yrs	90.000
2.	Accomodation Luanda	25.000
3.	Travel expenses	20.000
4.	Filing cabinets and other filing equipment	5.000
5.	Olivetti M24, floppy disc	4)00
6.	Services of external agency for access to international data banks (5 years)	40.000
7.	Survey of data banks and reference systems in the SADCC region	23.000
8.	Establishment of reference library in Luanda	10.000
9.	Training programme for two Angolan nationals	20.000
10.	Administration and "backstopping" services	43.000
11.	Contingency	25.000
	TOTAL USD	305.000

Project 1.5.1

Experimental Centre for compressed natural gas as road transportation fuel, Mozambique.

1. SYNOPSIS

Mozambique at present has to cover all its needs for petroleum products by import. This is causing a heavy strain on the country's balance of payment. Transportation is the largest consuming sector of petroleum products, primarily as gas oil and gasoline.

Natural gas has been found in Mozambique. One of the fields Buzi is only about 25 kms from a major consuming center, the city of Beira. The purpose of the present proposal is to establish an experimental center for the utilization of compressed natural gas, (CNG), as an alternative to liquid fuels in Beira. It is proposed to convert 50 vehicles, mainly diesel-driven. The main elements of the experimental center will be:

- Compressor station at Buzi
- Transport of CNG from Buzi to Beira
- CNG refuelling station in Beira
- Engine conversion center in Beira

Foreign assistance in the form of a consultant with expertise in engine conversion to CNG would be required to implement the project. Provided an early decision is made on the funding of the project the experimental center could start its operations early in 1987. The responsible project authority in Mozambique, the Ministry of Mineral Resources, is applying for funding of the foreign currency costs required for building and initial operations of the center, amounting to U.S. $ 970.000,00.

2. BACKGROUND

At the present time the demand for petroleum products is covered by import. It is a heavy strain on the country's balance of payment, even though imports have been severely restricted in recent years. Transportation is the main consumption sector, and is the only energy consuming sector which could not potentially be converted to the available domestic energy sources, hydroelectric power, coal or wood.

Natural gas was discovered in the country as early as in the mid-1960's, but so far there has been no production. The main field is Pande in the northern part of the Southern Region, about 750 kms from Maputo. The field has not yet been fully explored but proven reserves assessments vary between 20 and 60 billion cubic meters. Other minor fields are Buzi (with reserves estimated at 0.4 to 1 billion cubic meters) and Temane (between 1 and 2 billion m^3) in Inhambane Province, south of Pande. Buzi has the advantage of being close to a major consumption area, about 25 kms from Beira.

The Sofala Province represents 15.8% of the total consumption of petroleum products in the country, 74,795 out of 473,818 tonnes for 1982. Transportation and industry are the main consuming sectors, with approx. 2/3 of the total consumption. Most of these activities in the province are concentrated in the city of Beira and the industrial city of Dondo. Gas oil or diesel represents in total 64% of the consumption of oil products.

In February-May 1985, a study of natural gas demand, transportation and utilization in Mozambique was carried out by Norconsult. This study has been executed on request of the Ministry of Mineral Resources and sponsored by Norad. In this Gas Demand Study a major element was directed towards the possibility of using natural gas as an engine fuel in the form of compressed natural gas. As a part of the overall study the Ministry of Mineral Resources asked for a proposal on a CNG pilot project based in the city of Beira. The city of Beira was chosen due to the closeness to the Buzi gas field. the proposal presented by the Ministry of Mineral Resources in Mozambique- is based on this pilot study report.

3. OBJECTIVE

The objective of the proposed experimental center would be to determine the feasibility and practicability of implementing a large natural gas conversion project in the Tansportation sector in Beira as well as in other provinces in Mozambique. The pilot project should also be of major interest to other SADCC countries where natural gas, but no petroleum in liquid form has been found.

The Beira area is interesting as a major consumption area in the vicinity of a gas field. This will allow for the possibility of implementing an experimental center for CNG utilization in the transportation sector as an alternative to gasoil as well as gasoline at a moderate level of investments.

As several other SADCC countries may have potential for gas discoveries, this project has regional interest as a pilot project.

4. TECHNICAL DESCRIPTION

The experimental center proposed is to deal with 50 converted vehicles. Since diesel fuel is a major fuel to replace, the major part of the vehicles should consist of vehicles equipped with diesel engines, so buses and trucks are chosen.

At this moment there is no pipeline between the gas well at the Buzi field and the city. To provide a refuelling station in the city with gas, the gas has to be compressed at the well. From the well the gas can be transported by trailers loaded with large CNG cylinders. The gas field is separated from the city by two rivers. At the nearest riverside the vehicles will drive onto a ferryboat. From the loading place the boat will travel down the river and a few miles along the coast, into the harbour of Beira and drive onshore on a landing ramp to be constructed.

From the harbour the tractor and trailer will travel into the city to the refuelling station. At the refuelling station the trailer is disconnected and used as a bulk storage for the refuelling station. The tractor will then connect to an empty trailer and return to the well for refuelling this trailer. At the refuelling station a booster compressor is installed to refuel the vehicles.

The refuelling station should be equipped with "quick fill" and with "slow fill" installations. The converted fleet will consist of trucks, passenger cars and city buses. The trucks and passenger cars will use the "quick fill" during the day and the buses will be filled at the "slow fill" during the night.

The vehicles converted will be:
- 30 buses (Type Ikarus)
- 10 trucks (Different types)
- 10 passenger cars (Different types)

Buses from TPU (the Beira public bus company) will be used for the purpose. The experimental center will be located in the center of Beira, where the maintenance workshop of TPU is the most likely location.
The project will be constituted of four different parts:

- compressor station in Buzi, where two single-stage gas-generator driven compressors will refill the CNG cylinders on the trailers.

- compressed natural gas will be transported from Buzi to Beira by three trailers with 2000 Nm^3 capacity and a landing craft (second hand) with a loading capacity of 30 tons.

- CNG refuelling station which will be of a "quick fill" and "slow fill" type enabling refuelling of vehicles in 5 to 10 minutes and overnight during 12 hours respectively.

- Engine conversion center where the conversion units will be installed in the project vehicles.

5. IMPLEMENTATION

Project implementation would start with selection of a consultant with expertise in conversion of gasoline and diesel engines to compressed natural gas, preferrably based on tender. The consultant will assist personnel from MMR in project organisation such as selection of engineering contractor to undertake detailed design, engineering and construction, selection of vehicles, supervision of installation and commissioning of equipment, vehicle conversion and of the compressor station and the refuelling station, supervision of road testing of converted vehicles and finally assist in training of local people.

A period of 14 months has been allowed by MMR for design engineering, procurement, deliveries, construction and equipment conversion after selection of consultant and engineering contractor. This would mean that the experimental phase would start up in the first half of 1987.

6. COST ESTIMATE

The main elements of the costs connected with the establishment of the experimental center are as follows:
(All figures are in thousands of current USD)

Equipment (to be imported)	632
Consultancy costs for project implementation (9 man months plus travel expenses)	156
Consultancy assistance during the initial three months of center operations (6 man months, travel and social expenses)	94
Contingency (10%)	88
Total project cost estimate	970

The equipment costs include auxiliary equipment, spare parts and a freight allowance (15%) for transportation to Beira.

In addition to the above foreign currency costs, local costs will incur for civil works as well as local personnel for erection and operation of the experimental center.

7. FUNDING REQUIREMENTS

The responsible project authority in Mozambique, the Ministry of Mineral Resources, would require the funding of the foreign currency investment costs amounting to 970 thousand USD to build and initiate operations of the experimental centre.

Project 1.5.2

Synthetic liquid fuels production from natural gas feasibility study.

1. SYNOPSIS

Like so many other SADCC countries, Mozambique has been caught in the web of the world wide energy crisis of the 1970's. With no petroleum production of its own, it has been necessary to continue to import crude oil and petroleum products at much higher prices than before. For all SADCC-member states, except Angola, oil import is a heavy burden on the balance of payment.

Mozambique has got petroleum resources in the form of natural gas. The onshore Pande gas field contains natural gas in quantities sufficient to enable the country and the SADCC neighbouring countries to become very much self-sufficient in petroleum energy for the next generation.

An alternative strategy could be visualized in chemical processing of natural gas into synthetic liquid fuels or energy chemicals. These synthetic liquid fuels, like methanol, gasoline and diesel, could substitute for imported oil products in the industrial, power and transportion sectors.

2. BACKGROUND

Since 1981 the Government of the People's Republic of Mozambique has been investigating the possible utilization of natural gas in the Pande gas field.

FLUOR (GB) Limited was commissioned to undertake a detailed feasibility study in order to determine the economics of converting the natural gas to ammonia.

2.1 NATURAL GAS PIPELINE STUDY

FLUOR carried out a separate economic analysis on the pipeline alone in order to determine a suitable delivered cost of natural gas for both a Bazaruto Bay (near the Pande Gas Field) plant site and a location in Maputo.

2.2 STUDY OF NATURAL GAS DEMAND, TRANSPORTATION AND UTILIZATION IN MOZAMBIQUE.

This study was carried out by NORCONSULT with support of NORAD. The scope of this study was to determine the amount of energy which could be substituted by natural gas in the 3 southern provinces South of Save River and in Dondo/Beira area from now until 2 000.

NORCONSULT's study sets out to quantify and discuss more specifically the Southern Region market potential and economics for converting the different energy sectors to natural gas, and the two transportation alternatives available for direct utilization of the gas, namely the pipeline alternative and the LNG alternative. In addition,

the possibility of chemically transforming the gas into some form of synthetic liquid fuel is discussed.

3. OBJECTIVE OF THE STUDY

The overall scope of work of the feasibility study is to analyse the conversion of natural gas into synthetic liquid fuels to supply the SADCC countries. The study can be divided in two phases.

3.1 PHASE I

The scope of work of Phase I may be summarised as follows:

3.1.1 Market Analysis (SADCC Countries)

* Statistical information on market size (current and historical).
* Projected demand for liquid fuels (mainly gasoline and diesel).
* Liquid fuels production capacity (existing, under construction and planned), taking into account projected operating efficiency.
* Sources and prices for imported products.
* Current channels of trade and distribution practices.
* Products price forecast.

A similar market analysis is being performed under project 1.0.1 "A Regional SADCC supply strategy for the period 1986 - 2000". The two analyses will be coordinated to prevent overlapping efforts.

3.1.2 Plant Capacity

A range of alternative size liquid fuels production plants must be considered. This will include two or three plant capacities.

* To cover the SADCC market totally or partially.
* To cover the sub-regional market, such as Malawi Mozambique, Swaziland, Tanzania, Zambia, Zimbabwe.3.1.3

3.1.3 Process Technology Evaluation

Examination will be made of the available technologies to produce gasoline and diesel fuel, such as the

* MOBIL - Processes
* HALDOR - TOPSE - Process
* FISCHER - TROPSCH - Process

These will be compared to the conventional methanol alternative.

The objective of this task will not be to recommend a final selection of technology but rather to:

* Make a preliminary selection for purpose of outline design and cost estimates for the process units.
* Identify the impact of ultimate process technology selection on the scope of infrastructure (especially utilities), design and capacity.

3.1.4 Preliminary Site Selection

A preliminary screening of possible location for the project site will be made during the Phase I of the feasibility study.

3.1.5 Definition of Site Study Requirements

Must define the necessary site studies, will prepare detailed terms of references, will indicate the best firms to execute them.

3.1.6 Preliminary Infrastructure Definition

Infrastructure should be presented in technical terms at a preliminary level and summarized in such a form as to be suitable for economic analysis.

3.1.7 Preliminary Cost Estimates

Capital cost estimatesmust be prepared for the major components of the project for each plant capacity and technological process.

The associated operating costs (fixed and variables) must be assesed in a preliminary form suitable for economic analysis.

3.1.8 Preliminary Economic Analysis

Phase I must perform a preliminary economic analysis of the alternatives. This analysis will enable a ranking in broad economic terms of the various alternatives.
The results of Phase I will be:

* Generalised market studies and price forecasts.
* A recommended project scope including specifications of the capacity and location.
* Preliminary assessment of process technology available.
* Preliminary infrastructure definition.
* Associated capital and operating cost estimates.

3.2 PHASE II

Taking as a basis the results of Phase I, Phase II of the feasibility study must investigate the following alternatives:

* Two different plant capacities
* Two technology alternatives
* Two plant site locations

3.2.1 Project Definition

In all the study cases the physical facilities of the total project must be analysed comprising the process plant, all the necessary utilities and offsite units, gas and water gathering facilities, a marine terminal and an associated community.

Separate descriptions of the process plant must be given.

In the discussion of the utility and off-site units a description must be given of:

* Power generation and distribution
* Water supply and treatment
* Product storage
* Effluent treatment
* Instrument air
* Firewater system
* Gas metering
* Plant buildings
* Motorised equipment
* Roadways, lighting
* Miscellaneous
* Interconnecting pipeways
* Boundary fencing
* Site preparation, landscaping
* Sanitary sewage
* Laboratory, maintenance shop

For the infrastructure:

* Gas gathering
  The gas gathering system comprises:
  - Flow lines from the wellheads to a central gas sweetening plant.
  - Gas sweetening plant, gas metering and associated facilities.
  - Gas transmission to the plant.

* Marine facilities
  - Number and type of berths
  - Size and type of shipping
  - Types of berth structure
  - Port infrastructure

* Community
  - Housing requirements
  - Land requirements
  - Utility requirements
  - Health facilities

3.2.2 Capital Cost Estimates

All the capital costs must be presented on a U.S. dollar basis. The total installed costs will include:

* All equipment and material costs
* Transportation and freight insurance
* Construction management, supervision and all construction labour.
* Insurance during construction
* All construction equipment
* Home office support during construction and commissioning

* Set of spare parts including start-up spares
* Expatriate start-up and commissioning team for six months
* Initial charges of catalysts and other consumables

The total installed costs of the various process, utility and offsite units must be split into the following categories:

* Civil/Structural
* Equipment and materials
* Transport
* Erection
* Painting and insulation
* Engineering and fees

3.2.3 Operating Cost Estimates

The annual estimated expenses for operation and maintenance must be split into the following items:

* Manpower
* Feedstocks
* Catalysts and chemicals
* Maintenance

3.2.4 Economic Analysis

The purpose of the economic analysis must be to provide a ranking between the various cases considered, rather than an absolute evaluation of the project's economic viability.

The ranking process must be based on a review of cash flows, the internal rate of return on a full equity basis and the impact on the national balance of payment. In the course of the analysis, the payback period and the net present value for a range of discount rates must be calculated for each of the cases considered.

The sensitivity of the economic performance of these cases must be displayed to variation in the base estimates of such items as:

* The gas price
* Total installed costs
* Product demand in different markets
* Product prices
* Plant utilization
* Duration of construction

Finally, some of the alternatives must be selected for financial analysis to determine the return on equity taking as a basis a realistic financing package.

3.2.5 Project Execution Plan

The following preliminary plans must be developed:

* Preliminary project execution plan for the plant offsites, utilities and infrastructures.
* A bar line chart showing the assumed relationships in time.
* Construction progress curves and contract manpower estimate for the plant, off-sites, utilities and infrastructures.

4. IMPLEMENTATION

4.1 TIMING

The total time to carry out the feasibility study is estimated in one (1) year from the moment that the contract with the Consultant is signed.

The tentative project time table is displayed over leaf.

4.2 TYPE OF CONSULTANTS

This study must be performed by a team of consultants with a large experience in the energy sector and chemical industries consisting of:

* One or two Economists
* One Chemical Engineer
* One Civil Engineer
* One Mechanical Engineer
* One Electrical (power) Engineer

4.3 RESPONSIBILITY FOR THE STUDY

Overall control and coordination of the project will be done through a Steering Committee consisting of representatives from the Donor, the Ministry of Mineral Resources (MMR) and from the Technical and Administrative Unit (TAU). The team of consultants will be represented at Steering Committee meetings, but without a formal vote.

Project implementation is the responsibility of the team of consultants in close cooperation with MMR.

The MMR could appoint part of the technical staff of the Natural Gas utilization Department to work in conjunction with the consultants consisting of:

* One Dr. Nat. Dipl. Eng.; Chemical Engineer
* One Petromechanical Engineer
* One Petrochemical Engineer

5. COST ESTIMATE

5.1 COSTS INCURRED BY CONTRACTOR (U.S. DOLLARS)

A) Salaries

Professional and support services will be charged at standard rates including all provision for compensation, fringe benefits, overheads, general and administrative expenses and profit element.

In summary, the weighting rate is:

Salaries	x	1,30	Fringe benefits
	x	1,45	Overheads
	x	1,20	General and Administrative
	x	1,10	Profit
Salaries	x	2,50	Accumulator factor

Type of Advisor	Rate per Hour	Number of Hours	U.S. $
A	20	1.500	30.000,00
B	18	2.000	36.000,00
C	15	1.750	26.250,00
Secretaries	6	500	3.000,00
		Subtotal	95.250,00
		x Factor 2.5	238.125,00
	Five per cent contingency for inflation.....		11.906,25
		Total	250.031,25

B) Expenses

*	Travel	
	- Air fare and expenses for consultants	10.000,00
	- Air fare and expenses for Govern.empl.	4.000,00
*	Communications	
	- Telephone/telex/postage/air freight/etc.	2.000,00
	- Report production/photocopying	1.500,00
	- Translation	1.000,00
	- Computer costs	1.500,00
	- Training	10.000,00
	Subtotal	30.000,00
	Five per cent contingency for inflation	1.500,00
	Five per cent contingency for other aspects	1.500,00
	Subtotal	33.000,00
*	Subcontractors	17.000,00
	Total	50.000,00

5.2 COSTS INCURRED BY MOZAMBIQUE GOVERNMENT (METICAIS)

A) Salaries

Name	Rate per Month	Number of Months	Meticais
Mario Marques	50.000	2	100.000,00
Rolando Valdivia	40.000	10	400.000,00
Armando Rodrigues	40.000	10	400.000,00
Inacio Bento	40.000	10	400.000,00

2 Specialists - other Ministries	40.000	2		160.000,00
Secretaries	15.000	10		150.000,00
			Subtotal	1610.000,00

B) Expenses

*	Air fare and expenses in Mozambique	1200.000,00
*	Expenses in Maputo (Accomodation, Internal transportation, Office Accomodation, Secretarial Services, Communication facilities, etc.)	300.000,00
	Subtotal	1500.000,00
	Total Meticais	3110.000,00

6. FUNDING REQUIREMENTS

Total Estimated Costs		U.S. $
*	Incurred by contractor	
	- Professional Services	250.000,00
	- Expenses	50.000,00
	Total US $	300.000,00
*	Incurred by Mozambique	
	- Salaries	1610.000,00
	- Expenses	1500.000,00
	Total Meticais	3110.000,00

Project No. 2.4.3

Project title: COAL MINING DEVELOPMENT TRIAL AT LIVINGSTONIA - (MALAWI)

Background

Coal is a small but vital source of energy for Malawi. Currently total demand requirements are met by imports. The Geological Survey estimates some 300.9 million tonnes of coal as being the probable potential of indigenous reserves and 15.6 million tonnes have been indicated which could be exploited to supply the current and future demand.

The occurrence of coal in the Livingstonia area has been known for many years, and some detailed exploration and quantification is being carried out here by the Geological Survey in the 1984 dry season. This is in addition to a bulk sample (+ 1000 tonnes) to be mined for trial by the Coal Users Committee.

Presently, Malawi imports about 75,000 tonnes of coal per year at a high foreign exchange cost. In the late 1970s before the recession, imports were about 100,000 tonnes per year, which is considered to be minimum potential of the current market for coal in Malawi.

It is recognised that to meet the planned production levels, it will be essential to design a mining method which will optimise exploitation, along with limiting mining costs and overheads.

The Government is in the process of forming a Mining Development Investment Agency which will be entrusted with the responsibility for promoting mineral development in joint ventures with interested private investors.

Objectives

This project will lead to commercial mining of coal in Malawi, thus furthering the objective of national self-sufficiency. The following comments define the short-term project objectives:

1. Details of outputs and services. An opportunity will be provided for investors to acquire coal mining know-how.

2. Phasing of project outputs: Mining of a bulk sample (± 1000 tonnes) for test by consumers is to be carried out by the Coal Users Committee in the 1984 dry season. This is likely to be done by the Portland Cement Company on behalf of the association, and in liaison with both the Geological Survey and Department of Mines.

   The Department of Mines' trial mining is essentially aimed at designing the optimum mining method for short and long-term mining of coal resources in Malawi.

3. Expected contribution of project to present knowledge: Local investors have generally been reluctant to invests in the mining of our mineral resources. This project will be a further attempt to encourage them to look at mining as another area into which they can invest.

Work Description

The project basically involves the following main features:

1. To design a coal-mining method which will optimise exploitation along with limiting mining costs and overheads.

2. To mine 5000 tonnes of coal on trial basis.

3. To separate the valuable coal from diluent waste materials as/if required.

After the trial mining, plans will be formulated for long-term exploitation of the coal resources to meet the current and future demand.

Implementation

The mining and processing (washing and/or screening, if necessary) will initially be executed by the Department of Mines, under the supervision of the Chief Mining Engineer.

Cost

The estimated total project cost is approximately USD 385,000, and has been developed as shown below:

Category	Total USD
Buildings	70,000
Other construction	10,500
Plant and vehicles	112,000
Other equipment	21,000
Personal emoluments	24,500
Running expenses	140,000
Special expenditure	7,000
Total	385,000

Funding Requirements

Funding for the entire project cost, USD 385,000, is desired.

Project No. 3.4.2

Project Title: Development of Small Hydropower Projects In Malawi

Background

In its efforts to increase use of indigenous energy resources in order to reduce dependence on imported sources of energy, Malawi is developng the hydroelectric resources on the Middle Shire river for its electricity energy needs. In this regard associated transmission and distribution network is being expanded to reach most centres in the country.

However, other centres may not benefit from the above expansion programme of the interconnected system. Such centres are meanwhile either being supplied from diesel/generator sets or have yet to be supplied in order to service the amenities and improve facilities in the centres by the use of electricity.

In 1981 the UNDP produced a report Evaluation of Small Hydropower Sites in Malawi -(Ref TCD/INT-80-R47/5) in which two sites were identified as having potential for the development of Small Hydropower Schemes. These are as follows:

1. Karonga Small Hydropower Plant

   The above reconnaissance level report revealed that, by using a net head of 75m and a design discharge of 0.8 cub.m/s after the confluence of the North Rukuru River with its tributary river Sere, it should be possible to harness about 500KW with an annual energy content of 2.34Gwh at an average load factor of 60 per cent for supply of electricity to Karonga Township.

2. Chilumba/Chitimba/Livingstonia Small Hydropower Plant

   The above reconnaissance level report revealed that by utilizing a design discharge of 0.09 cub.m/s and a net head of about 272 metres downstream of the Manchewe and Kazichi river confluence, it should be possible to generate about 200 KW with an annual energy production of 1Gwh at an annual load factor of 60 per cent.

Objectives

1. To reduce the quantity of diesel fuel imported into the cuntry. The Karonga diesel station is already costing K180 000 in annual imports of diesel fuel for electricity generation.

2. Provide a cheaper source of energy to rural centres.

3. To improve the living standards of the rural people.

Cost Estimate

1.	Karonga Small Hydropower Project	US$2 500 000
2.	Chilumba/Chitimba/Livingstonia Small Hydropower Project	1 750 000
	TOTAL	US$4 250 000

Funding Requirements

Donor funding is sought for the small hydropower projects for Karonga and Chilumba/Chitimba/Livingstonia of US$4 250 000.

Detailed description for each scheme are attached.

PROJECT NO. 3.4.2.(1)

Project Title: KARONGA SMALL HYDROPOWER PLANT - (MALAWI)

Background

Karonga Town lies in the north of Malawi and has an urban population of approximately 8000. At present is served by a system consisting of two 120 kW diesel generators, 18 km of distribution lines and 19 km of medium voltage transmission line. Power is delivered to 241 customers.

The existing system produces energy at very high costs, as all diesel fuel must be imported to Malawi from external sources, and thereafter transported to Karonga over long distances. Karonga is so isolated that it is not anticipated to be connected to the national grid in the near future.

In 1981 a UNDP report "Evaluation of Small Hydropower Sites in Malawi - TCD/INT-80-R47/5" indicated that a promising site for small hydropower development lies near Karonga. The reconnaissance level report revealed that, by using the net head of 75 m and a design discharge of 0.8 m^3/s, of the location on the North Rukuru River and the Sere River, it should be possible to obtain an annual energy production of approximately 2.6 GWh with the installation of a 500 kW generating facility and an average load factor of 60%.

Objectives

The objectives of this project are:
- to reduce the quantitity of diesel fuel imported to Malawi
- to increase the supply of electric energy, available to Karonga Town
- to reduce the internal Malawi transport of fuel over long distances
- to increase local self-sufficiency.

Work Description

The project will be carried out in two stages.

The first stage will consist of a team of consultants who will travel to the site to undertake the final feasibility evaluation and at the same time, perform the necessary field work for design. Implementation will take place as a second phase.

The project thus consists of the study, design and construction of small hydropwer facilities and the associated 37 km of transmission and distribution line.

Implementation

It is envisaged that the study and design of the Karonga Small Hydropower Project will be carried out by a consultant. The civil work would be carried out by a contractor and the mechanical/electrical equipment would be installed by Electricity Supply Commission of Malawi (ESCOM) staff under the supervision of the supplier. The substation, transmission and distribution lines would be designed and constructed by ESCOM staff.

Cost Estimate

The first stage studies will cost approximately USD 200,000, and the second stage is anticipated to cost about USD 2,300,000 with a total cost of USD 2.5 million.

Funding Requirements

Funding is sough for the entire cost of USD 2.5 million.

Project Title: Chilumba/Chitimba/Livingstonia Small HydroPower Project 3.4.2 (ii)

Background

Chilumba Township in the Northern Region lies on the shores of Lake Malawi about 77 km south of Karonga Town and has, together with the adjoining community centres, a population of about 5 000. Chilumba has a jetty for lake vessels, a growing government complex and there are plans to establish cold storage facilities for processed fish.

In the adjoining centres of Chitimba and Khwawa, irrigation can be developed with provision of electricity.

Livingstonia Mission, situated on the Khondowe Plateau and not far from Chilumba, has a population of about 3 000 and it obtains its electricity from a 25KW diesel generating set.

This whole locality, apart from Livingstonia Mission, has not been electrified as yet and there are no immediate plans for its electrification, either by extension of the main grid system or by the installation of a diesel power station, because of the prohibitive costs due to the localities remoteness from the existing grid.

In 1981 a UNDP report Evaluation of Small Hydropower Sites in Malawi (Ref TCD/INT-80-R47/5) indicated that a potential site for small hydropower development lies downstream of Manchewe and Kazichi river confluence (the two rivers join to form Chitimba river). The reconnaissance level report revealed that, by utilising a designed discharge of 0.09 cub.m/sec and a net head of about 272 metres. It should be possible to generate about 200KW by installation of one hydro generating set. The annual energy production is estimated to be about 1.0GWh at an annual average load of 60%.

Objectives

1. To reduce the quantity of diesel fuel imported into the country thereby improving foreign currency reserves.

2. Provide a cheaper source of energy to rural centres.

3. To improve the living standards of the rural people.

4. To increase local self-sufficiency in agricultural products.

Work Description

The project will be carried out in two stages.

The first stage will be a visit to the site by a team of Consultants to undertake the final feasibility study to identify the power station site and perform the necessry field work for design.

The second stage will be the construction and installation of the power station and plant including the distribution lines to the centres.

The project thus consists of the feasibility study, design and construction of the small hydropower plant and the associated 30 km of distribution lines and reticulation in the centres.

Implementation

It is envisaged that the study and design of the Small Hydropower Project would be carried out by a Consultant. The implementation of the civil works should be carried out by a contractor and the mechanical/electrical plant would be installed by Electricity Supply Commission of Malawi (ESCOM) staff under the supervision of the plant supplier. The distribution lines and reticulation would be designed and constructed by ESCOM staff.

Cost Estimate

(a)	Feasibility Study (approximately)	US$150 000
(b)	Implementation	
(i)	Small Hydropower Plant:	
	Civil Works	637 000
	Power Station Plant	318 000
		US$955 000
(ii)	Distribution Lines and Reticulation	320 000
	Distribution Substations	24 000
(iii)	Establishment	US$80 000
	Total (a) and (b)	US$1 529 000
	Contingencies	221 000
	Total	US$1 750 000

Funding Requirements

Funding is sought for the entire project cost estimate of US$1.75 million for the study and implementation of the Chilumba/Chitimba/Livingstonia Small Hydropower Project.

Project No. 3.3.3

Project Title: Expansion of 33/11 kv Network - Third Phase (Lesotho)

Project Background

Lesotho's electrical reticulation system has been developed to link the mains towns which are situated in the lowlands. This system is now being upgraded. For this, the Lesotho Electricity Corporation (L.E.C.) constructed an 88/11kv sub-station in Maseru and is constructing in the first phase of the 33 kv project a transmission line to Teyateyaneng, Roma, Mazenod and the new airport near Mafeteng. The second phase of this project comrpises the extension up to Mohale's Hoek in the South.

In the third phase of the programme which is the subject of this proposal, LEC intends to uprate supplies to the rural towns situated in the lowlands. These comprise Mohale's Hoek, Mafeteng, Morija/Matsieng, and Quthing in the South and Teyateyaneng, Maputsoe, Leribe, and Butha-Buthe in the North.

Project Description

The programme will be achieved as follows:

Southern Area

The present supply within rural township areas and neighbourhoods is obtained by an "add-on" system. This has outlived its usefulness, is expensive to maintain and can offer only a limited and poor quality of supply.

It is now proposed that in each rural town 11kv reticulation is served by an 11kv ring feed system giving greater flexibility and better power flow potentials.

The major areas requiring a ring feed system to support expansion are Mohale's Hoek, Mafeteng and Morija/Matsieng.

It is further proposed that a new 33 kv line of H-pole construction be built from Mohale's Hoek to Quthing. This line to be operated at 11kv until demand in the deep South materialises from development of proposed irrigation projects to the mini-hydro in that area materializes when the line can be uprated to 33kv at minimum expense. At a later stage a 33kv substation will be required at Quthing to Service future planned development.

From the new reticulation and in conjunction with the old 33kv line derated to 11kv it is further proposed to supply power to rural villages for 5klms either side of the existing line. This development will enable rural schools, hospitals, irrigation projects etc. to be

served by electric power,

Northern Area

It is proposed to extend the 33kv system from Teyateyaneng to Maputsoe, Leribe and Butha-Buthe with one 33kv/11kv substation at Maputsoe, and a second 33kv/11kv substation midway between Leribe and Butha-Buthe.

The 11kv reticulation for the Northern rural towns will again consist of a ring system to promote development in the neighbourhoods as planned for the South.

Implementation

The project should commence mid-1986 and is expected to be finalized within a period of two years. Planning and construction will be under the direction of Lesotho Electricity Corporation.

Project Cos

Total project cost expressed in million US$ are estimated as follows

(exchange rate : 1 M = US$0.45):

PROJECT COST ESTIMATE

Million US Dollars

	Local	Foreign	Total
South Area			
Outgoing Mohale's Hoek sub-station	0.02	0.07	0.09
33kv line (M/Hoek/Quthing)	0.24	0.50	0.74
11kv reticulations (M/Hoek, Mafeteng and Morija/Matsieng)	0.20	0.39	0.59
	0.46	0.96	1.42
North Area			
33kv/11kv Maputsoe s/station	0.11	0.34	0.45
33kv Leribe/Butha-Buthe s/station	0.11	0.34	0.45
33kv line	0.36	0.74	1.10
11kv Reticulation	0.27	0.56	0.83
Control Centre	0.09	0.38	0.47
Total	0.94	2.35	3.30
GRAND TOTAL	1.40	3.32	4.72

Project No. 3.3.4

Project Title: Oxbow Multipurpose Project - Final Design (Lesotho)

Project Background

The Oxbow scheme has, for manny years, been identified as having the greatest potential for hydro electric power development in Lesotho. The first studies on the possibility of developing the Oxbow scheme were undertaken in 1955/56 by Ninham Shand and Partners and, as a result, an expanded programme to collect hydrological, topographic and geological data was initiated.

Further studies on the scheme were undertaken by Binnie and Partners in 1971 and by Olivier-Binnie in 1978/79.

Physical Conditions

The project area, most of which lies about 2500m above sea level, has a catchment of about 280 sq.km. The overall geology consists of a layered sequence of gently dipping sedimentary rocks, capped by basalts and intruded by dolerite dykes and sills.

The mean annual temperature is 7.4 degrees C but temperatures below 0 degrees C in winter occur frequently.

Precipation in the project is the highest in the country with a maximum of 1600mm/year. The mean annual rainfall is 1264mm. The mean annual runoff at Oxbow amounts to 4.5 cub.m/s or 142 cub.m. per annum.

Project Description

The envisaged scheme would involve a regulated flow from the reservoir at Oxbow, through a headrace tunnel with about 700m of head to a powerhouse at the foot of Mt. Khatibe near Tlhaka.

The following would constitute the main features of the project:

- A dam located on the Malibamats'o river, about 4 km downstream of the confluence of Tsehlanyane and Tlholohatsi rivers. The confluence of these two rivers together with the natural Oxbow formation on Tlholohatsi river provide a good reservoir site.

- 11km long headrace tunnel located completely within the upper part of the basalt formation from the reservoir to the surge tank.

- 2.7km of steel penstocks from the surge tank to the power house.

- A power house with 54MW installed capacity and 162.4 GWh of energy at a plant factor of 0.33.

- A re-regulating pond or weir after the powerhouse.

- 132 km of transmission lines to the main load centre in Maseru.

Project Costs and Benefits

The total cost of the Oxbow scheme including access roads, civil works, electric mechanical equipment, dam, transmission lines, contingencies, engineering and administration has been estimated at M145.0 million.

The hydropower generated at Oxbow would be used to meet the daily demand peaks, whereas ESCOM power would be used to cover the base load. Since peak power is the more expensive part, the energy from ESCOM would be imported at a lower charge while the benefits of energy generated at Oxbow would be maximised.

Additional benefits would be derived by using the water from the power house for irrigation and domestic water supply in the Hololo Valley.

Present Status of the Project

The African Development Bank has approved a loan of FUA1.25 million to Lesotho Government to finance the feasibility study for the Oxbow project. A short-list of prospective consultants has been drawn, and once it is agreed with ADB, proposals will be invited. The feasibility study will be done in a period of 18 months.

Conclusions

Preliminary calculations show that the Oxbow scheme would be cheaper than any known alternative i.e. thermal powr generation in Lesotho and imported electricity. The project, if implemented, will greatly reduce Lesotho's dependence on imported electrical energy. The project will have very minimal environmental impace due to the sparse population in the project area while it will enhance the undoubted beauty of the Oxbow area.

Funding Requirements

Funding is desired for the total cost of the final design studies to be carried out after finalization of the feasibility study and for the subsequent construction of the Multipurpose Scheme.

PROJECT NO. 3.5.3.

Project Title: CORUMANA HYDROPOWER PROJECT - (MOZAMBIQUE)

Background

It is the aim of the Government of People's Republic of Mozambique to minimize the dependency on electricity energy supplied from the Republic of South Africa.

The southern part of Mozambique, including its capital Maputo, is at present highly dependent on imports from ESCOM in South Africa for its power supply. In accordance with an agreement to supply power from Cahora Bassa I to South Africa, Mozambique will receive 78 MW at a very low price. Until recently, however, little or no power from Cahora Bassa has been available to Mozambique, as the supply to the Apolo substation in South Africa has been unrealiable. This means that approximately 90% of the energy consumed in the Maputo area has been supplied by ESCOM at a price higher that which would have been paid for Cahora Bassa power.

Maputo's thermal power station is kept in reserve in the event of power outage which occurs with relatively high frequency. The installed capacity is 57 MW coal-fired and 46 MW gas-fired.

The annual system consumption is 360 GWh and the load is 66 MW. According to moderate forecasts made by EDM the consumption in southern Mozambique is estimated at 450 GWh in 1985 and 600 GWH in 1990. This corresponds to an annual growth rate of approximately 6%.

The Corumana Power Plant on the Sabie River has been proposed as a source of electric power and energy to the South Energy System in Mozambique. Its distance from Maputo is some 140 Km by road. An earthfill dam is presently under construction at the Corumana site. The main use of the dam will be for irrigation purposes of the arable land around the lower reachers of the Sabie and Incomati Rivers.

The Sabie River is a tributary of the Incomati River. Both rise and flow for most of their length in South Africa territory. At the project site, some 10 Km from the border, the average runoff based on 31 years of records at the border has been estimated at 634 Mm^3, the individual years ranging between a minimum of 80 Mm^3 in 1983 and maximum of 1700 Mm^3 in 1976. The catchmant area at the site is 6310 Km^2.

The June 1984 Feasibility Study concludes that a power plant with a rated capacity of 14.5 MW is a feasible addition to the dam project. The powerhouse will be located above ground at the toe of the dam, between the bottom outlet structure and the spillway. The generating units comprise two Kaplan turbines of 7.25 MW each at 36 m rated head (8.1 MW at HWL). The generators are each rated at 9 MVA.

The selection of the recommended hydropower plant is based on a comparison of alternative sizes of installations ranging from 3.6 MW to 17 MW. The least unit energy cost alternative is achieved with an installed capacity of 4.5 MW requiring an investment of USD 5.9 million. The power station capacity was increased until the incremental cost of generating one more kWh equalled the cost of generation with gas, giving an installed capacity of 14.5 MW and requiring an investment of USD 10.8 million. An additional advantage of choosing a higher installation than 4.5 MW is the increased security of supply should the transmission line from South Africa fail out. The size of the reservoir allows the generation at full capacity for a longer period of time without significant influence on reservoir water level.

The energy cost of the Corumana project at 12% discount rate is US¢ 4.15/kWh and is significantly lower than either of above thermal alternatives. If the Corumana project's output was reduced to firm energy alone, the cost per kWh would be higher than US¢ 5.6/kWh.

The Corumana project may be said to be justified from an economic aspect. Furthermore, assuming the electricity generated at the Corumana plant is sold at a tariff higher than the current high-tension tariff of US¢ 2.94/kWh (MZM 1.67/kWh) as average tariff, the return on capital is adequate (12%) and significantly higher than the prevailing rates of interest in Mozambique. The payback period has been estimated at 6 to 7 years. It is very important to note that funds are already available for electrical interconnection between Corumana and the 110 kV southern networks.

Objective

With this project, Mozambique will materially reduce its dependence on RSA for electricity supply in the southern part of the country. In addition, the domestic reserve generation capacity will improve the system security.

Work Description

This project consists of the construction of an above-ground powerhouse at the toe of Corumana Dam, and the production and installation of the associated electromechanical generation equipment, consisting of two similar units of 7.25 MW Kaplan turbine linked to a generator of 9 MVA capacity. The facility will be integrated with a dam currently under construction as part of an irrigation project.

Feasibility study and design of the power station have already taken place, and final design and production of tender documents are currently underway.

Cost Estimate

The total cost of the hydropower project is estimated at USD 10.95 million and is categorised as follows:

Cost (end 1983 price level)

Civil works	USD 3.44 million
Electromechanical works	USD 7.51 million
TOTAL	USD 10.95 million
Foreign currency component	USD 9.39 million

Funding Requirements

Funding is desired for the complete project costs of USD 10.95 million.

Project No. 3.7.1

Project title: MALAGARASI HYDROPOWER PROJECT - (TANZANIA)

Background

A feasibility study, performed by Norconsult, Norway and financed by NORAD, with the objective of presenting conclusions and results concerning potential hydropower development for supply of the Kigoma Region was presented to TANESCO in August 1983. Several alternatives were studied and a site at Malagarasi River, approximately 60 km southeast of Kigoma and 35 km west of Uvinza, was found to be the most viable economically, taking power market, power transmission, hydrology, geology, and geotechnical aspects into consideration.

The population of Kigoma Region is approximately 750,000. The major urban centre is Kigoma/Ujiji with an approximate population of 80,000. Other main towns are Uvinza, Kasulu and Kibondo. As the main consumers to be served from the project are in the towns of Kigoma, Ujiji, Kasulu and Uvinza, the project will influence locations with an aggregate population of approximately 100,000.

The existing facilities in the region consist of isolated diesel generators located in Kigoma Town and Uvinza. They operate under severe constraints, with respect to both diesel fuel and spare parts for maintenance. As diesel fuel is expensive, electric energy is produced at a relatively high cost under the existing conditions and the lack of a reliable power supply is considered to be an important constraint on the development of the region.

Objectives

The project will ensure a reliable supply of electric power to the towns of Kigoma, Ujiji, Kasulu and Uvinza in the Kigoma Region by developing indigenous hydroelectric potential on the Malagarasi River. The proposed scheme will meet projected load growth up to year 2002 and thereby contribute to the general development of the region.

Description

The project comprises a run-of-the-river development of the rapids along some 4 km of the river. The head being developed is approximately 62 m. A brief description of the project components is given here below.

- The headrace channel intake is located on the south side of the river about 200 m downstream of the gorge, approximately 3.5 km upstream of the powerhouse.

- A low intake weir will be constructed across the river about 200 m downstream of the channel intake. The weir will have a length of about 130 m and a maximum height of 2.5 m.

- The headrace will comprise a headrace channel 7 m wide and 590 m long to be excavated along the southern riverbank, a headrace tunnel intake and a headrace tunnel 3115 m long with a cross-section area of 20 m^2.

- A surge chamber will be provided to ensure hydraulic stability. It will be excavated as a vertical surge shaft, 72 m long with a cross-section area of 15 m^2.

- The penstock connecting the headrace tunnel and surge chamber to the power units in the powerhouse will have a total length of 205 m and a diameter of 3 m. The penstock material will be fine-graded structural steel.

- The powerhouse, a reinforced concrete structure, will be located above ground. The main dimensions will be 27.5 m by 10.5 m/12.5 m in plan and 19 m in maximum height.

- The tailrace channel will be excavated along the course of the small creek which runs near the power station. It will be 6 m wide and 350 m long.

- Two vertical shaft Francis turbines with an output of 3.8 MW each and a rotating speed of 375 rpm.

- Two vertical shaft synchronous generators with a nominal rating of 4.5 MVA.

- 185 km of 33 kV overhead transmission lines with ACSR conductors on wooden poles.

- Three 33/11 kV substations in Kigoma, Kasulu and Uvinza, respectively.

Cost Estimate

A cost estimate, based on 1982 price levels, is given here below, broken down according to major components.

	Foreign exchange USD x 10^3	Local currency USD x 10^3	Total
Civil works, including access roads	14,120	2,460	16,580
Electromechanical works	3,730	440	4,170
Transmission lines and substation	4,176	1,691	5,867
Engineering and supervision	2,580	640	3,200
Total	24,606	5,231	29,837

These cost figures include physical contingencies but not price escalation and interest during construction.

Implementation

TANESCO will act as executing agency on behalf of the Government. Malagarasi Hydropower Project is a medium-size project. As such, various concepts for implementation have been considered during the course of the study. The conventional concept consists of a final design phase, a tendering and contract negotiation phase and finally the construction phase. The time schedule for this implementation procedure shows that final design, tendering and mobilisation will take 1½ years, road construction approximately 1 year and power plant construction 2 years; thus totalling 4½ years. This also includes construction of the transmission system.

Financial Requirements

Based on the 4½ year implementation schedule and including price escalation, the project cash requirements have been estimated as follows:

Project cash requirements
USD x 10^6

Year	Foreign	Local	Total
1	0.1	-	0.1
2	3.2	0.6	3.8
3	7.1	1.8	8.9
4	10.6	2.8	13.4
5	11.2	3.2	14.4
	32.2	8.4	40.6

Funding of the entire project is desired. However, local contribution to cover some of the local currency expenses may be subject to negotiations between the Donor and the Government.

Project No. 4.3.1

Project Title: Renewal Energies Development - (Lesotho)

Project Background and Objectives

The basis for this programme is the project Development of Solar Energy and Biogas Production which was started in 1978 and is bieng funded by UNESCO and executed by UNDP. The project is expected to be completed at the end of 1986.

The new project under consideration has the following main objectives:

- Strengthening and intensification of the solar and biogas activities initiated within the UNDP/UNESCO project.

- Dissemination of the biodigesters developed and implemented to more rural areas and utilization of biogas for heating, illumination and electricity generation.

- Further testing of simple solar energy devices and extension of the pertinent research work at the solar laboratory of the National University of Lesotho in Roma.

- Testing and implementation of small windmills suitable under the special circumstances prevailing in Lesotho for electricity production and water pumping.

- Energy conservation measures and demand management in small-scale industries and construction of buildings.

Justification of Project

This project aims at a significant improvement of the energy situation in rural areas and thus at an improvement of the standard of living. Some of the aspects shall be mentioned here:

- The reduction of collection time for firewood and shrubs will lead to an increase in productive activities in agriculture and small-scale industry. Especially women will be independent for other activities.

- The availability of sufficient energy for cooking will improve daily meals and, thus, the health situation.

- Small household-size biodigesters will be promoted for private use and institutions like schools and nurseries will be provided with bigger digesters of the Fry-type allowing the cooking of daily warm meals and lighting in winter months.

- All devices to be introduced are aimed at a very simply construction. Biodigesters need very few imported raw materials and can be completely assembled onsite. Local enterprises have already shown interest in a local mass production for solar collectors. Incentives for local employment (brick-layers, welders) and local industries are to be expected. A preliminary cost estimate of a potential local manufacturer of solar collectors arrives at costs which are hold half of the imported devices.

- Further research work necessary at the University of Roma will increase the experience with the fermentation on biomass and with solar devices.

- The introduction of windmills which is complicated by the frequent appearance of thunderstorms could provide remotely located areas with electricity or water and reduce consumption of costly paraffin. Appropriate technology is to be tested under difficult conditions.

- Extension and dissemination work in the villages could lead to improved cooking and construction methods thus conserving scarce energy sources.

Institutional Framework

The project will be institutionalized within WEMMIN in the newly established Department of Energy. The Renewable Energies Division will be responsible for its supervision and implementation.

Implementation

The project is expected to be finalized within a period of 5 years from 1986 to 1990.

Project Input Required

The Manpower requirements can be specified as follows:
- 8 man/months consultancy services
- 2 supervisors for the whole project period
- 5 full-time workers (builders, welders, plumbers)
- Additional temporary manpower

Other requirements include:
- Construction of a building for the solar laboratory at the National University of Lesotho in Roma.
- Construction of 10 houses to test passive solar heating techniques.
- Solar equipment.
- Two windmills for testing.
- One four-wheel drive vehicle and two motor cycles.

Project Cost

The total cost is estimated at US$749,900 which can be broken down as follows (in thousand US$):

	Local	Foreign	Total
Labour	201.7	67.2	268.9
Material	243.9	22.2	266.1
Equipment	-	146.7	146.7
Sub-Total	445.6	236.1	681.7
10% Contingencies	44.6	23.6	68.2
GRAND TOTAL	490.2	259.7	749.9

Funding Requirements

Funding is requested for the complete project costs of US$749.900.

Project 4.6.1

Project title: Investigation into local customs and potential acceptability of new technology in rural communities.

Background

The rural sector of Swaziland accounts for approximately 80% of the total population. This population relies almost entirely on woodfuel as their energy source. Not surprisingly, given the current 3.6 per cent population growth rate, Swaziland finds its endowment of indigenous forests rapidly diminishing. As population pressures mount, demand for land for food production increases as does demand for woodfuel. In some areas, the level of deforestation is so severe that people now use cowdung or maize stalks for fuel, which then causes the ecological cycle to suffer as natural fertilizers are removed from the ecosystem. Hence it is clear that Swaziland must explore alternative energy sources and conservation techniques appropriate to the rural people. These alternatives must however, not increase Swaziland's dependence on imported petroleum products, as this dependence is already a severe problem that causes a depletion in foreign exchange reserves.

Swaziland currently has a project entitled Women in Development, originally based outside government but now coopted into the Ministry of Agriculture. Women in Development (WID) has to date developed an appropriate technology unit that has experimented with various rural based technologies, including wood stoves, biogas structures, solar water heaters and vegetable dryers. The intent is that rural people attend courses at WID, learn to make the products and then extend their knowledge and skills to their own community.

Unfortunately to date, these technologies are slow to disseminate as the project is small and the amount of background knowledge regarding the viability of those listed products is limited.

Development text books covering the period from the late 1950's to the present are filled with countless examples of case studies where a project failed to account adequately for local customs. This lack of background preparation has led to an enormous waste of resources, both human and material, as projects often self-destruct due to some sociological oversight. In an effort to avoid this error, the Government of Swaziland wishes to conduct an extensive survey and research study to determine the needs and the desires of the rural people. Before embarking on large-scale wood stove projects, solar water heating, biogas or vegetable dehydration projects, it is necessary first to

determine the sociological forces that shape the perceptions of the beneficiaries. This information, although available to a small degree within WID activities, is quite inadequate at this time. Certain models of the four items (stoves, solar water heaters, biogas and vegetable dryers) have been tested but very little is known about their acceptability to rural people on a large scale. The proposed project is hoped to fill this information void.

Objectives

The project shall generate detailed sociological data about typical rural communities where new energy technologies may be introduced. It should identify whether or not people perceive a need or desire for any of the four products: wood stoves, solar water heaters, biogas and vegetable dryers.

The project shall further provide market information and identify the price range within which rural people would be willing to pay for such products. In order to obtain data which may enhance the pilot effect of the study, four different climatic regions shall be surveyed.

Work description

The project is mainly a survey which will be conducted in cooperation with the Ministry of Agriculture, Community Development Office and the Home Economics Section in Swaziland.

In the initial phase a study shall be performed in order to identify sociological factors that would be relevant to the use of the new technologies.

On the basis of this study a detailed programme for the field survey shall be established.

A parallel evaluation of the suitability of the four prescribed technologies shall be made. Modifications or reduction in the number of products to be introduced in the survey shall be made if required.

The field surveys shall:
- identify the range of priorities of rural people;
- assess the cooking and washing and food preparation customs to determine the appropriate models;
- identify the price range acceptable to people for each product;
- identify the optimal model that takes into account all customs and other sociological elements.

The field investigations will include community meetings, individual interviews, demonstrations and limited implementation tests.

Full documentation shall be made from the initial study of governing sociological elements and the assesment of the available technologies.

The field research shall conclude which technologies may be most acceptable in the rural communities and identify which social factors are critical for the acceptance of such technologies.

Implementation

A qualified team of consultants shall supervise the project in cooperation with the Ministry of Agriculture. The team shall include;

- one sociologist (2 - 4 months)
- one appropriate technology engineer (2 - 4 months)
- one specialist on market mechanisms in rural communities (4 - 6 months).

The Ministry of Agriculture will provide the services of one Community Development Officer and one Home Economics Officer to assist in setting up the survey, community meetings and laying the ground work with the chiefs to enable the survey to progress smoothly. In addition the services of the Monitoring and Evaluation Unit will be utilised for conducting the survey.

The Ministry of Natural Resources will provide the use of one truck for the demonstrations in the survey.

Cost Estimate

The following estimates are order of magnitude figures and should be revised after detailed programme formulation.

External costs	USD
Consultant services:	
Approx. 12 man months	48.000
Travels	8.000
Administration and "backstopping" services	10.000
One vehicle for personnel transport	15.000
Contingency	9.000
Total	USD 90.000

Local component
Personnel, administration, office facilities, transport and communication,
Estimated total USD 70.000

Financial requirement
Donor finance is sought for the external cost of the project. USD 90.000.

Project No. 4.8.1

Project title: ENERGY CONSERVATION PROJECTS
INDENI PETROLEUM REFINERY - (ZAMBIA)

Background

The Indeni Refinery was built in 1972/73 by SNAMPROGETTI. It now operates at a 60% capacity, and covers the national market. If more profitably operated the Refinery could be the supplier of parts of Zimbabwe and Malawi as well.

The Indeni Petroleum Refinery was brought on stream in June 1973 prior to the drastic increase in oil prices. The Refinery was designed to minimise capital investment and take advantage of low energy costs. However, with the increase in oil prices, it became necessary to reduce energy consumption as far as possible. Improved housekeeping measures such as elimination of steam leakages and better firing control on furnaces have enabled reduction in fuel consumption.

Objectives

To achieve greater energy savings, three project needs to be implemented:

1. Waste-heat recovery from the hydrodesulphuriser and reformer furnaces.
2. Installation of economisers in the boilers.
3. Installation of a pre-flash tower in the crude distilling unit.

Description of Work

1. Waste-Heat Recovery from Furnaces

Flue gas from the hydrodesulphuriser heater is directed to the convective zone of the reformer heater. A study carried out by AGIP PETROLI shows that it would be possible to obtain 4100 kg/hr steam production at 18.5 atm and 330^{o}C by installing a waste-heat boiler in the convective zone of the reformer heater. Steam production is calculated at 25% excess air. The fuel saving is evaluated assuming the same steam production in a fuel oil-fired boiler with 90% efficiency.

2. Installation of Economisers in the Boilers

The three package boilers installed at the Refinery have provision for economisers. The installation of economisers is estimated to increase the boiler efficiency from the present 82% to 90%.

3. Installation of a Pre-Flash Tower in the Crude Distilling Unit

A pre-flash tower upstream of the heater of the crude distilling unit can reduce the fuel consumption of the heater. Part of the feed (8.45 MT/hr) will vaporise at a lower temperature (170°C) and at 1.5 kg/Cm^2 g pressure. In this way, heating of the vaporised part up to 335°C is avoided and the heat exchange of the liquid feed is improved.

These practical measures are advised in a study by AGIP in 1982, INDENI ENCO STUDY.

Implementation

This project covers practical implementation which can be carried out within 1-2 years.

Cost Estimate

1. Waste-Heat Recovery from Furnaces

The design and supply of equipment is estimated to cost USD 800,000 in foreign exchange including contractor's expenses in supervision of erection. Civil works, project management and erection will be carried out locally at an estimated total cost of USD 200,000. The payout time is estimated at 1.5 years.

2. Installation of Economisers in the Boilers

The foreign exchange cost is estimated at USD 300,000 for the three boilers with USD 30,000 in local cost for civil works, installation and interconnection. The payout time is estimated at 3.3 years.

3. Installation of a Pre-Flash Tower in the Crude Distilling Unit

The design and supply of equipment is estimated to cost USD 300,000 in foreign exchange. The local cost of civil works, project management and erection is estimated at USD 50,000. The payout time is estimated at 1.5 years.

Hence the total costs will be:

		Local USD	Foreign USD
1.	Waste-heat recovery from furnaces	200,000	800,000
2.	Installation of economisers in the boilers	30,000	300,000
3.	Installation of a pre-flash tower in the crude distilling unit	50,000	300,000
	Total	280,000	1,400,000

Financial Requirement

Part of the local costs may be covered by the Refinery or by the Zambian Government.

Project 5.1.2.

HARNESSING THE SEASONAL FLOW RATES OF THE CUROCA, GIRAUL, BERO AND BENTIABA RIVERS TO REFOREST THE RIVERBANKS FOR ENERGY PURPOSES

1. Introduction

In 1980 the total population of Africa was estimated at 400 million inhabitants, 320 million of whom - 80% - are dependent on wood as their chief, or in some cases only, source of energy.

In the People's Republic of Angola, according to 1982 energy consumption data, consumption of ligneous fuels was of the order of 1,663,000 m^3 of wood with an energy equivalent of 72 million GJ as compared to conventional energy consumption of 29.3 million GJ. The percent of wood consumed out of total energy consumption was around 71%.

The African countries that carried out a study of their energy budgets on a national scale concluded that at least for the next few decades ligneous fuels will be called upon to meet 80% of the energy needs. Meanwhile, studies on consumption indicate that natural resources are becoming drastically exhausted and that this fact is already having serious consequences on the degradation of arid and semi-arid lands.

In Angola, namely in the Province of Namibe, a region with arid and semi-arid characteristics, the problem has reached frightening dimensions. This is because the situation was aggravated by the crisis that emerged with the war waged in the province; already limited resources were strained even more to the breaking point.

This project is designated to present and propose implementation of ways to solve the problem of ligneous fuel shortfall in this Angolan province. The solutions can play a decisive role in rehabilitating the province. At the same time, the project will analyse and examine ways of remedying the scarcity prevalent in other SADCC countries that have identical problems, namely in Namibia in the near future.

2. Objectives

The objectives of this project are:

2.1 To establish seasonal flow rates of the Curoca, Garaul, Bero and Bentiaba rivers to facilitate reafforestation of the river banks for fuelwood purposes.

These rivers are in fact "waddies" dug out between seasonal flows.

2.2 To evaluate techniques of irrigation for reforestation in arid and semi-arid regions where the woodfuel crisis is most strongly felt.

2.3 To specifically evaluate the effects of small dams and "chimpacas"(1) for water storage after seasonal flows.

2.4 To restore the energy basis for the rural populations in Namibe.

2.5 To disseminate results to other SADCC countries which face similar problems of water shortage which reduces the potential for effective woodfuel production.

3. Terms of Reference

The project consists in the following:

3.1 Experimental planting of at a total of 800 ha: 320 ha for the Curoca river, 240 ha for the Giraul, 160 ha for the Bero and 80 ha for the Bentiaba, in 200 m wide strips on each of the banks, following the contour lines.

(1) The "chimpacas" referred to are rows of stakes driven into the ground used in the province of Namibe to divert and retain water.

3.2 Studying seasonal flow rates in order to harness them for irrigation in the areas to be reafforested, while reducing the speed of the river currents to use the water in Namibe. The study is necessary in order to build microdams and "chimpacas" that are properly located and sized so that they will not be swept away by the heavy currents during the rainy season.

3.2.1 Planting the 800 ha should be carried out according to a basic, pre-established programme which could be as follows, in its general lines

3.2.1.1 The first year

- Planting 160 ha of trees, namely acacia albida, on the banks of the Bero river choosing the areas least affected by strong currents yet supplied with some water (pools may be dug out in the riverbed).
  Planting should begin on the Bero river since experiments have already been made to screen out less hardly specied near the river, so there is some experience in the area; it is near the city of Namibe which will be able to benefit from the energy source in five years-'time. In the initial phase it would not be dependent on dams being built.
- Study on implementing small dams and chimpacas to harness the seasonal flow rates. Priority would be given to the Curoca river which to our mind is one presenting the fewest difficulties for execution and the greatest

possibilities for harnessing the water.

- Also in the first year experimental lots should be initiated on the banks of all four rivers. Four experimental lots of 2 ha each would be established with quick-growing tropical species: leocaina leococefala, acacia nilotica, prosopis - sp. The central plant nurseries existing in Namibe should be used to provide seedlings for the lots.

3.2.1.2 The second, third and fourth years

- In each of these years 160 ha of trees should be planted, corresponding to 80 on the Curoca river and 80 on the Giraul.
  At the end of the three year period 240 ha of trees will have been planted on each of the two rivers.
- Also during this period construction of dams and "chimpacas" should be implemented based on the studies that were carried out during the first year. If the studies carried out for this project prove viable they should be used as a basis to guarantee funding of dam and "chimpaca" construction during this period.

3.2.1.3 The fifth year

During this year 80 ha of trees should be planted on the banks of the Curoca river and 80 ha on the Bentiaba. Construction of micro-dams and "chimpacas" should also be concluded on the four rivers.

3.3 Plant Nurseries

Plant nurseries should be established in each of the planting areas.

We suggest the following:

Bero river	2 ha	300,000 plants/year
Curoca river	1 ha	150,000 plants/year
Giraul river	1 ha	150,000 plants/year
Bentiaba river	1 ha	150,000 plants/year

According to the basic programme presented in point 3.2.1., these nurseries will be capable of supplying the proposed plantations and any replacement planting that has to be done.

The nurseries should be established on flat land and be protected from the prevailing winds, they also should meet the existing

standards with respect to addition of fertilizers, sterilization and handling of plants.

The present nursery in the city of Namibe should be extended and equipped so that it may function as a central plant nursery to provide plants for the experimental lots and later as a back-up nursery for replacement planting in the plantations.

3.4 The Plantations

Trees should be planted in contour lines according to the terrain's natural relief. For ligneous fuels to be utilized within a period of five years the spacing should be 2.5 x 2.5 m. The species will reseed itself.

3.5 Energy Utilization

Trees will first be thinned out selectively during the fifth year by felling the twisted ones if their growth is under par. In the first year the energy yield is estimated to attain around 1,600 steres of wood with possible conversion into charcoal amounting to around 220 tons. The planted areas could be extended using irrigation water provided by the dams, thus increasing the energy potential.

4. Budget Estimate

Planting 800 ha of trees nn the banks of the four rivers	USD 550,000
Study on h rnessing the seasonal flow rates of the four rivers	USD 100,000
Total	USD 650,000

Project No. 5.3.1

Project Title: Wood/Charcoal Stoves Development and Dissemination Project (Lesotho)

Project Background

The project will continue the work of the former Renewable Energy Technology (RET) Project and a current stoves project which is known as the Energy Initiatives for Africa (EIA) Subproject. The Appropriate Technology Section (ATS) of the Ministry of Co-operatives and Rural Development is responsible for both projects.

The RET Project, which ended in March 1984, developed and began initial dissemination of several improved stoves whilst the EIA Subproject continues with widespread dissemination of some of the stoves. This project will end in September 1986.

The stoves which were developed by the RET Project are of basically two kinds (a) the simple very low cost stove made out of local materials (the 'stone' paola or brazier) and (b) the comparatively complex metal stove which is also relatively costly. No stove was developed in between except the retained heat cooker which is really not a stove. The gap is filled in by imported paraffin stoves, LPG stoves and traditional paolas. These stoves, although more convenient, are not used regularly in the rural areas because of the high cost of paraffin and gas. A slot therefore exists between the low cost stone 'paola' and the relatively expensive metal stove. This gap could be filled by at least one locally made stove.

Bearing this in mind it seems advisable to work as closely as possible with what the people are used to cooking with. For instance the traditional 'paola'. The advantages of this stove over the current ATS stoves is that it is portable, not expensive and durable when compared to the stone 'paola' in particular. When looks at 'successful' efficient stove dissemination efforts in other parts of the world (especially Africa) one will notice that these are single-pot stoves very similar to the traditional paola but much more fuel-efficient (as much as 100% more). The RET Project did develop a few designs of more efficient 'paolas' but these where not considered ready for dissemination because (a) their efficiency was not much higer than that of the traditional 'paola' (b) they were costlier and (c) their durability was the same or lower than that of the traditional 'paola'. But now the ATS staff have identified successful single pot stoves which could be modified to suit local fuels and cooking habits.

The project will aim at developing and disseminating such a stove. Unlike in the case of the RET Project where stoves were meant for dung and shrubs the stove will be designed to use wood and charcoal because it is believed that these should be the most abundant fuels in the rural areas in the future. In addition the project will continue with the current stove dissemination efforts.

Project Objectives

The objectives of the project are as follows:-

(a) Promotion of energy conservation in the rural homes by introduction of improved stoves.
(b) Establishment of small-scale industries for the production of stoves.
(c) Improvement of rural productivity by freeing income and time which are used to purchase or gather fuel.
(d) Dissemination of the results of the programme to other SADCC member States.

Description of Work

1. Development

As far as development work is concerned the project will carry on from where the RET Project stopped with R & D on the metal paola (or single-pot stove). All the positive characteristics of the RET designs will be scrutinized for further development. Then other designs which are successful in other parts of Africa will be studied and used in coming up with a suitable design for Lesotho. The stove will be designed for production by local artisans rather than established metal-fabrication companies. An intensive field test will be implemented at the end of the development phase. The field test will determine among other things the marketabiliy of the stove. Widespread dissemination will then follows.

2. Dissemination

The dissemination strategy for the stove will be similar to the one being followed by the ATS now for the current range of stoves, that is,

(i) Train producers
(ii) Demonstrate stove to different population strata.
(iii) Distribute pamphlets, leaflets, etc. about the stove.
(iv) Launch a radio program.
(v) Follow-up on producers and users to assist them in problems that might have cropped up.

However since the current dissemination project (EIA Subproject) will end in a year's time (September 1986) the new project should also carry on the dissemination work which is going on now. This will ensure that those people who like the current stoves are not left without any stoves to make or buy.

3. Implementation

The project will be implemented by the ATS which has staff conversant with stove development and dissemination. The project is envisaged to have a duration of two years beginning in October 1986 or, at the latest, April 1987.

Project Cost

Financial resources will be required for the following items:

Item		Cost (L.Maloti)	US Doll Equiv. (US$1=M2.00)
(a)	Laboratory equipment	10,000	
(b)	Media Materials	40,000	
(c)	Construction Materials	20,000	
(d)	Staffing (new)	40,000	
(e)	Transport (one new vehicle plus its maintenance)	40,000	
(f)	Other expenses	20,000	
	Subtotal	M170,000	$85,000
(g)	ATS staff (already hired)	50,000	
(h)	Office running costs	15,000	
(l)	Transport (one old vehicle, maintenance and fuel).	24,000	
	Subtotal	M89,000	$44,500
	Overall Total	M259,000	$129,500

All costs will be incurred locally.

The Government should supply, through ATS, office and laboratory space.

Funding

External funding amounting to US$85,000(M170,000) is required for the implementation of this project. The Government of Lesotho should supply the rest (M89,000 or US$44,500).

Benefits

In general, at the end of the project, a large percentage of the rural Basotho should be aware of energy conservation measures and possess an energy saving device. The stove(s) which will be disseminated are meant to replace the open fire and the traditional 'paola'.

There should be training artisans who will carry on with the production of the stove(s) and even improve it with little assistance from the ATS.

The ATS will have in place staff who are experienced and skilled in stove design, development and dissemination. The section can then tackle any other energy technology dissemination (notably biogas, solar water heaters and energy-efficient housing.

Project No. 5.6.1

Project Title: Reafforestation in the Eastern part of Swaziland and Southern Mozambique

Background

Over the past 50 years the indigenous forest area has diminished alarmingly. Man and his activities have been responsible for the reduction of indigenous forest resources through:

- overstocking of livestock;
- excessive burning of the veld during dry winter;
- introduction of extensive agricultural and forest estates;
- over-exploitation of the forest resource to provide firewood and building poles aggravated by population increase;
- prospecting for minerals;
- physical infrastructural development.

The steady disappearance of the indigenous forests has resulted in socio-economic problems, ranging from acute fuel-wood shortage to serious environmental degradation.

Although Swaziland has very advanced man-made forests, most of the plantations are private owned and export-orientated. They provide very little of the firewood needed for domestic purposes, because they are far from the major population centres and they produce large size wood unsuitable for stoves used in the rural areas. Additionally, the forest legislation protects them from free collection of firewood. Other energy sources are not likely to compete with firewood, although conclusive statistics on firewood consumption pattern in both Mozambique and Swaziland is lacking. It is estimated that between one metres cubed and 3 metres cubed of wood (firewood and building poles) are consumed by every family per annum.

Electricity is used mainly in the industrial sector and for lighting in towns. It is non-existent in rural areas. Paraffin is used for lighting in rural areas.

In this particular area where the indigenous forest is thorny and difficult to gather wome and children spend 14 hours a week gathering firewood at distances ranging between 3-6 km from their homesteads. This practice culminates in socio-economic problems like delayed entry of children at school, low agricultural productivity and inability of women to participate in other income generating activities. Men also have to travel long distances looking for building poles to erect their homesteads.

The effects of inadequate supply of firewood goes further when rural women are forced to use the gathered firewood sparingly and thus food is not properly cooked and gastro-intestinal ailments increase

particularly among infants. Mothers must then spend considerable time with their infants, getting treatment, instead of doing some productive work at home. In aggregate, work productivity of the nation is reduced. Afforestation of catchment areas on Lubombo plateau and regulation of river flow will not only reduce floods in Swaziland but will also regulate the flow of rivers lowstream in Mozambique before the rivers enter Indian Ocean.

Objectives

This Project will:

1. Establish a secure source of firewood and building poles, creating rural employment through production and sale of charcoal and surplus firewood as well as protect catchment areas of Lubombo plateau area Swaziland and Mozambique.

2. Improve agricultural production and handcraft production by relieving the women the burden of collecting firewood.

3. Allow the release of children to attend school at an appropriate age rather than be used for collecting firewood.

Programme of Action

A. Mobilization of local communities under local leadership to educate them about the socio-economic features of the project and stimulate interest for the participation.

B. Establishment and management of a total of 400 hectares of fuel lots ranging from below 1 hectare to 10 hectares throughout Mpolonjeni/Tikhuba R.D.A. This will be based on afforestation rate of 60 ha/annum, using mainly eucalyptus on a technical rotation of 7 years o verage to cater for at least 1400 homesteads. Individual farmers will be encouraged to plant trees around their gardens to provide firewood.

C. Proper management of remaining patches of indigenous forest on selection harvesting so that they play a supplementary role in providing firewood and protecting fragile land particularly on the Lubombo escarpment.

D. Establishment and management of income generating activities like charcoal production, sale of firewood and building poles to other areas of the country (in case of surplus), wood carving and other handcraft activities.

E. Establishment of at least 10 species/provenance trials on lowveld and Lumbombo plateau, bordeirng Swaziland and the Republic of Mozambique.

F. Training forestry staff, other general extension workers and local communities about social forestry in both countries.

G. Provision of capital inputs like housing, vehicles, charcoal kilns, chainsaws and taking into account of recurrent expenditure like personnel expenditure, fuel and contingency.

Implementation

This pilot project proposal will cover a five year period initially, given the usually long gestation period required for a forestry crop. The rotation period will be assumed to be 7 years, with some species managed on coppice rotation after the first harvesting.

The pilot project will be implementted by the two Governments through their Ministries of Agriculture and Energy.

Estimate Cost for the Project for Both Swaziland and Mozambique

Category	Cost
1. Buildings	
A. Storeroom	75,000
2. Other Construction	
A. Nursery	30,000
3. Water and Electricity	15,000
4. Plant and vehicles	
A. 2 x 4wd Toyota	30,000
B. 2 x Tractor	40,000
C. 2 x Trailer	4,000
D. 2 x motor cyles	3,000
5. Fuel	90,000
6. Extension and Training	30,000
7. Personnel Emoluments	150,000
8. Materials	30,000
9. Contingency	43,000
TOTAL COST	US$ 540,000

Project No. 5.7.1

Project title: ESTABLISHING A FUELWOOD PLANTATION AT RUVU - (TANZANIA)

Background

Forest resources in Tanzania are currently being exploited beyond their sustainable yield. In order to ease the pressures on the forests a fuelwood plantation has been proposed at Ruvu. The plantation would supply the coastal area and Dar es Salaam in particular. The existing facilities of the experimental station would be utilised, and trees with known survival rates for that area would be planted.

The products could be sold either as fuelwood or converted to charcoal. The usefulness of the project does not depend on which market is chosen at this point, since minimum time until the first harvest will be 6 years. In the meantime different options for marketing the wood will be investigated.

The project is capable of providing energy at the same or less cost to the consumer as the present system, at the same time as reforestation is achieved.

Given the pressures for clearing forests for agriculture the net effect of withdrawing semi-forested land such as the proposed area, may be that existing forests are turned into fields. In this particular case there are sound reasons for the location, but there may still be areas within Ruvu that should be selectively planted. Existing forest, even if it is of a low productive variety, should not be cleared to make room for the fuelwood plantation.

The documentation available does not provide a clear basis for deciding that the area is suitable for large-scale plantation with the assumed yield. Before a final decision is made the results of trials begun in 1981 should be assessed so as to get a firm basis for the calculations of forest economy.

Objectives

The main objective is to reduce deforestation in Tanzania.

The plantation is expected to yield at least 12 m^3 dry wood per year per ha, with 7200 m^3 to be harvested after 6 years.

The plantation together with the marketing and final conversion chosen should aim at yielding energy at a cost which is less than the current 860 TZS/GJ to final consumers. Rough calculations indicate that direct use of fuelwood in improved, but cheap stoves may give an energy cost below 500 TZS/GJ. If the best available combustion technology was to be used, energy costs to the final consumer would sink below 200 TZS/GJ.

Even if the lower range of cost targets is not met the project should be counted as a success if it breaks even at the same time as forest cover is increased. This is equivalent to having a free reforestation programme. The break-even point is currently at 860 TZS/GJ to final consumers via the production of charcoal. In the evaluation of the programme one should ensure that no existing forested area has been lost, even if the varieties concerned have a lower yield.

The plantation is so small compared with the fuelwood and charcoal markets that no significant social benefits should be expected whichever product range is chosen. If the wood is sold as charcoal without improving stoves at the consumer side, the economy of the project does not allow any lowering of the energy prices. Income distribution effects will be long term, and must follow from the experiences gained in this project.

There will be beneficial effects on local employment, but this should not be designated as one of the prime objectives of the project. It is far more important that personnel gains experience that can be applied elsewhere. Given that the site is chosen due to its existing experimental plantation and infrastructure, it should not be expected that this project will contribute to the general infrastructure of the area.

Work Description

An area between the north and south Ruvu forest reserves is proposed as a fuelwood plantation. Given the long maturing times of such a plantation it is proposed that the investment be spread over 6 years. From the 6th year onwards the project should generate enough income to replant as well as slowly expand.

Of the total area of 67,000 ha, a future fuelwood plantation of 45,000 ha is envisaged. The economic plans envisage the use of seedlings of Cassia siamea, but the results of current trials will be taken into consideration when choosing stock. It is proposed that 100 ha be planted each year for 6 years to give a total area of 600 ha financed by development funds. This will require an investment of TZS 1.8 million per year spread over 9 years, with a total expenditure of TZS 10.8 million from first seed to last harvest. The steady state yield is estimated to be 7200 m^3/year.

The programme will be run by a specially appointed manager, who will be integrated into the Tanzanian administrative structure, locally and nationally. Management costs as well as equipment maintenance have been included in the budget as an overhead of 30% of direct establishment costs. The choice of site and scope for the project is for the express purpose of avoiding purchase of new equipment and establishment of new administrative structures in this exploratory phase.

Due to the importance of the concept and the long time lags involved, the project should be periodically assessed so that experiences can be brought to bear in other geographical eras. These expenses will not be debited the project account, but should be carried by the Donor. They are however assessed as part of the total cost to the Donor.

Implementation

Project implementation will be undertaken by the Division of Forestry. The schedule of establishment will be as follows:

Year 0	100 ha taken up and planted
Year 1	100 ha taken up, 100 ha maintained
Year 2	100 ha taken up, 200 ha maintained
Year 3	100 ha taken up, 300 ha maintained
Year 4	100 ha taken up, 400 ha maintained, marketing prepared
Year 5	100 ha taken up, 500 ha maintained, marketing ready
Year 6	100 ha harvested and replanted, 600 ha maintained
Year 7	100 ha cycled, 600 ha maintained, expansion considered.

Forestry staff and available labourers are already at work at the site. From the Donor country side one Liaison Officer will be needed for approximately 3 months a year. Analysis work should be performed within a similar framework.

Year 0 will require approximately 3 man-years for 100 ha, expanding to about 40 man-years when the entire area is being concurrently worked.

The plantation will prepare a progress report each year, in addition there will be a monitoring report from the Liaison Officer.

Cost Estimate

The investment per hectare was estimated in January 1984. Allowing for 10% inflation the afforestation should require some TZS 18,000 per ha. The investment for one new field would be required over a period of 3 years with the bulk of the expenditure occurring in the first year. A small maintenance expenditure will be incurred for 3 years after the initial establishment until harvesting at year 6. All expenses concerning the plantation have been included but they have not been discounted to give the present value.

Further expenditure will occur with harvesting, converting and marketing the wood. It is proposed that this phase of operations be studied separately and these costs are not included here.

A suitable area for this phase of the project would be 100 ha/year, leading to a steady state area of 600 ha after 6 years. The average steady state cost of this will be TZS 1.8 million. Due to the time profile of the expenditure, investment will continue for 9 years after year 0, but total expenditure for 600 ha brought up to a steady state yield of 7200 m^3, is estimated to be TZS 10.8 million.

All the expenditure excepting the expatriate personnel contribution will be in Tanzania.

In addition there will be same management costs estimated at TZS 100,000 per year.

The cost of a Liaison Officer for 3 months a year will be approximately USD 40,000 per year.

In the second or the third year of the plantation programme two separate studies are envisaged.

1. A feasibility study to determine the need and profitability of charcoal production associated with the plantation at a total cost of USD 80,000.

2. A market study and market plan for sale and distribution of wood-fuel from the plantations at a cost of USD 120,000.

Hence the total cost estimated is as follows:

	TZS	USD
Establishing Kuvu fuelwood plantation	10.8 million	
Administration	0.9 million	
Liaison Officer		270,000
Feasibility study and charcoal production		80,000
Market study and market plan		120,000
Total	11.7 million	470,000

Funding

The total needs for funds will be TZS 11.7 million in local currency and an additional USD 470,000 in foreign currency. This is approximately equal to a total cost of USD 936,000.

ANNEXES

SUMMARY STATUS OF PROJECTS, ENERGY SECTOR SADCC

PROJECT NUMBER	PROJECT TITLE	COST TOTAL US$ MILLION	COST FOREIGN US$ MILLION	FUNDING SECURED US$ MILLION	COMMENTS
0.0.1	Study on Regional Energy Situation and Prospects	-	-	-	Completed, financed by Belgium
0.0.2	Seminar on Energy Development in Southern Africa: Opportunities and Constraints	0.270	0.270	0.270	Completed, financed by SIDA
0.0.3	Support to the Energy Sector Technical and Administrative Unit	4.300 + Angolan contribution	4.300	4.300	Assistance under implementation from Norway, EEC, Belgium, Brazil, France, Portugal, Canada, U.K.
0.0.4	Energy Bulletin	0.205	0.205	0.205	Under implementation

PROJECT NUMBER	PROJECT TITLE	COST TOTAL US$ MILLION	COST FOREIGN US$ MILLION	FUNDING SECURED US$ MILLION	COMMENTS
0.0.5	Information Coordination System	200	200	200	Financing secured from Norway and Belguim
0.0.6	Energy Planning Seminar	0.052	0.052	0.052	Completed November, 1985: Funding from NORAD
1.0.1	Study on Regional self sufficiency in the supply of oil products				
	Phase 1	0.553	0.553	0.553	Completed.
	Phase 2	0.341	0.341	0.341	Under implementation: Funding from EEC.
1.0.2	Regional Petroleum Development Centre	8.330	5.560	8.330	Under implementation Funding from NORAD and UNDP
1.4.1	Hydrocarbon Exploration in the Malawi Rift Valley	1.514	1.514	-	TOR is being reformulated
1.7.1	Rehabilitation of Tazama Pipeline	8.250	8.250	-	Possible funding by Italy

PROJECT NUMBER	PROJECT TITLE	COST TOTAL US$ MILLION	COST FOREIGN US$ MILLION	FUNDING SECURED US$ MILLION	COMMENTS
2.0.1	Coal Export Potential Study	-	-	-	Withdrawn
2.0.2	Coal Conversion Study				
	Phase 1	-	-	-	New TORs will be reformulated, taking into account project 2.2.1 (below)
	Phase 2	-	-	-	
2.2.1	Investigation into possible low-temperature carbonisation (LTC) of Coal				
	Phase 1	0.101	0.101	0.101	Funding secured from EEC.
	Phase 2	0.571	0.571	0.571	
2.4.1	Coal Exploration and Evaluation, Malawi	2.000	1.620	-	Project to be reformulated and divided into phases
2.4.2	Development of Analysis Laboratory	0.290	0.290	0.290	Funding secured

PROJECT NUMBER	PROJECT TITLE	COST TOTAL US$ MILLION	COST FOREIGN US$ MILLION	FUNDING SECURED US$ MILLION	COMMENTS
2.4.3	Coal Mining Development Trial at Livingstonia, Malawi	0.390	0.390	-	To be presented at Harare Conference
2.8.1	Investigation of Coal Briqueting	1.088	1.088	1.088	Funding from Norway details being negotiated
2.9.1	Coal stoves for use in rural areas	767	767	767	Funding by EEC
3.0.1	Rural Electrification	-	-	-	TORs under revision
3.0.2	Specialised Training in the Fields of Electric Power	0.150	0.150	0.150	Funding by EEC
3.0.3	Maintenance of Mechanical Equipment in Power Stations	0.150	0.150	0.150	Funding by EEC for first phase
3.1.1	Flow measurements on the Zambezi River in Angola	-	-	-	TORs under revision
3.1.2	Interconnection of the Northern-Southern and Central Electricity Supply System, Angola	0.450	0.450	-	Interest from Brazil, NORAD, Italy and Portugal

PROJECT NUMBER	PROJECT TITLE	COST TOTAL US$ MILLION	COST FOREIGN US$ MILLION	FUNDING SECURED US$ MILLION	COMMENTS
3.1.3	Completion of the Gove Hydro-Electric Development	2.000	2.000	-	Interest from Brazil, NORAD, Italy and Portugal
3.2.1	Interconnection of the Botswana and Zimbabwe Grids	0.360	0.360	0.360	Funding by CIDA. Under implementation.
3.2.2	Botswana/Zambia or Zimbabwe Corporation	0.07	0.07	0.07	Funding by CIDA. Feasibility study completed
3.2.3	Connection of Serome Palapye and Nahalapy to the National Grid	2.150	2.150	2.150	Funding by DANIDA
3.3.1	Development of small hydropower facilities at Nantsonyone and Semonhong, Lesotho	7.400	7.400	7.400	Funding by NORAD.
3.3.2	33 KV subtransmission network development	2.600-4.000	2.600-4.000	2.600-4.000	Funding by NORAD and SIDA
3.3.3	Expansion of 33 KV Network - Third phase	4.720	3.320	-	To be presented at Harare Conference
3.3.4	Oxbow Multipurpose Project - Final Design	55.000	55.000	-	To be presented at Harare Conference

PROJECT NUMBER	PROJECT TITLE	COST TOTAL US$ MILLION	COST FOREIGN US$ MILLION	FUNDING SECURED US$ MILLION	COMMENTS
3.4.1	Malawi-Mozambique Electricity Supply in the Eastern and Western border regions	2.230	2.230	2.230	Funding by NORAD
3.4.2	Small hydro-power Projects in Malawi	4.250	4.250	-	To be presented to the Harare Conference
3.5.1	Zimbabwe-Mozambique Electricity Supply Corporation in the Central, Southern Border	0.700	0.700	0.700	Funding by NORAD
3.5.2	Mozambique/Swaziland Cooperation Masterplan for the Electricity Supply of Swaziland and Southern Mozambique	0.624	0.624	0.624	Funding by CIDA
3.5.3	Corumane Hydropower Project	10.950	10.950	-	To be presentated at Harare Conference
3.5.4	Navuzi Hydropower Project	0.720	0.720	2.720	Funding by NORAD

PROJECT NUMBER	PROJECT TITLE	COST TOTAL US$ MILLION	COST FOREIGN US$ MILLION	FUNDING SECURED US$ MILLION	COMMENTS
3.5.5	Mozambique/Malawi Interconnection of Electricity Supply	0.100	0.100	0.100	Funding by SIDA
3.5.6	Pequenos Limbombos Hydropower Project, Mozambique	-	-	-	Withdrawn
3.7.1	Malagarasi Hydropower	30.000	30.000	-	To be presented at Harare Conference
3.7.2	Sunda Falls Power Plant	5.230	5.230	-	To be presented at Harare Conference
3.7.3	Kidatu Morogoru 220KV transmission line	20.000	20.000	-	Interest from ADB
3.8.1	Zambia/Malawi/ Tanzania Interconnection	0.465	0.465	0.465	Funding by NORAD
3.8.2	Kafue Gorge Power Plant	0.530	0.530	0.530	Funding by NORAD
4.0.1	Seminar on Woodfuel	0.110	0.110	0.110	Completed October 1983 financed by Angola and EEC

PROJECT NUMBER	PROJECT TITLE	COST TOTAL US$ MILLION	COST FOREIGN US$ MILLION	FUNDING SECURED US$ MILLION	COMMENTS
4.0.2	Energy Saving in Industry	6.970	6.970	3.200	Funding by CIDA
4.0.3	Solar Energy Pilot Project	1.000	1.000	0.075	Pre-feasibility study under implementation by Interpares of Canada
4.0.4	Wind Power Pilot Project	0.900	0.900	0.075	Pre-feasibility study under implementation by Interpares of Canada
4.0.5	Integrated Energy Systems for villages, based on local Energy Sources	0.390	0.390		Funding by Interpares of Canada
4.3.1	Renewable Energies Development	0.750	0.750	-	To be presented at Harare Conference
4.8.1	Energy Conservation	1.400	1.400	-	To be presented at Harare Conference
4.8.2	Energy Conservation in Mining and Industry	-	-	-	Funding included with 4.0.2 by CIDA

PROJECT NUMBER	PROJECT TITLE	COST TOTAL US$ MILLION	COST FOREIGN US$ MILLION	FUNDING SECURED US$ MILLION	COMMENTS
5.0.1	Designing a Methodology for Conducting an Inventory and a Survey of Woodfuel Energy in any SADCC Country	0.210	0.210	0.210	Awaiting draft work programme for the projects - EEC and Holland
5.0.2	Evaluation of the experience and progress made in Agro-Forestry in SADCC Countries	0.285	0.285	0.285	Awaiting draft work programme EEC and Holland
5.0.3	Evaluation of the problems, prospects and potential of urban wood plantations as suppliers of woodfuel to the urban areas	0.135	0.135	0.135	Awaiting draft work programme EEC and Holland
5.0.4	Selection of suitable and efficient woodburning and charcoal-burning stoves	0.350	0.350	0.350	Awaiting draft work programme EEC and Holland

PROJECT NUMBER	PROJECT TITLE	COST TOTAL US$ MILLION	COST FOREIGN US$ MILLION	FUNDING SECURED US$ MILLION	COMMENTS
5.0.5	Selections of suitable and efficient briquetting and produces gas technologies	0.380	0.380	0.380	Funding by EEC and Holland
5.1.1	Evaluation of the use of woodfuel in Angola	0.287	0.287	0.287	Funding by EEC
5.3.1	Wood/Charcoal stoves Development and Dissemination Project	0.130	0.085	-	To be presented at Harare Conference
5.4.1	Blantyre City Fuelwood Project	6.540	6.540	6.540	Funding from NORAD
5.6.1	Reafforestation on the Eastern Part of Swaziland and Southern Mozambique	0.540	0.540	-	To be presented at Harare Conference
5.7.1	Establishing a fuel-wood Plantation at RUVU	0.936	0.936	-	To be presented at Harare Conference

ANNEX B

SADCC ENERGY: STATISTICAL INFORMATION

The tables in this paragraph are mainly based on data on energy production, supply and consumption acquired by the SADCC Energy Sector, TAU, during missions to the Member States in July and August 1985. Key data up to the year 1984 have been collected by energy balance forms distributed to the Member States.

TABLE 1. Production of commercial energy sources in the SADCC Region 1980 and 1984.

	1980	1984
Primary energy		
Coal. Mill. t	4.7	4.2
Crude oil. Mill. t	6.8	10.4
Natural gas. Bill. m3	1	2.3
Hydropower. TWh	26.0	15.5
Secondary energy		
Oil products. Mill. t	2.9	2.3
Thermal power. TWh	1.7	2.4

Table 1 shows the production of commercial energy in 1980 and 1984. The reduction in hydropower production of more than 10 TWh is due to the breakdown of the production at Cahora Bassa. In 1980, about 11 TWh was produced here and exported to R.S.A. The more than 20% reduction in production of refinery products was mainly due to the decrease in production at the Matola refinery in Mozambique

TABLE 2. Final energy consumption in SADCC 1980 and 1984

	1980	1984
Coal. Mill. t	3.5	3.0
Oil products. Mill. t	3.1	3.0
Electricity. TWh	16.0	16.8
Woodfuel (incl. charcoal). Mill. m3	86.5	100.2

The consumption of other traditional fuels (bagasse, dung etc.) should be added (about 50 PJ)

Table 2 shows the final regional consumption of energy in 1980 and 1984. Coal and oil used as input in thermal power plants have been deducted from the figures. The figures on coal consumption include coal for coking (about 1 mill. tons)

TABLE 3. Final energy consumption in SADCC 1980 and 1984 expressed in PJ.

	1980	1984	
	PJ	PJ	Percent
Commercial energy sources:			
Coal	102.3	87.5	6.0
Oil products	131.7	127.1	8.7
Electricity	57.5	60.3	4.1
Traditional fuels (mainly wood):	1034.5	1190.7	81.2
Total	1326.0	1465.6	100.0

Table 4. Imports/Exports of energy in SADCC Countries 1984

Country	Energy source	Imports	Exports	Unit
Angola	Crude oil	0	9000	1000 t
	Oil products	10	500	"
Botswana	Coal	40 (1983)	-	"
	Oil products	150 (1983)	-	"
	Electricity	160 (1983)	-	GWh
Lesotho	Coal	80 (1983)	-	1000 t
	Oil products	70	-	"
	Electricity	120	-	GWh
Malawi	Coal	40	-	1000 t
	Oil products	100	-	"
Mozambique	Coal	80	20	"
	Crude oil	100	-	"
	Oil products	230	40	"
	Electricity	280	-	GWh
Swaziland	Coal	n.a.	n.a.	1000 t
	Oil products	90 (1983)	-	"
	Electricity	250	-	GWh
Tanzania	Crude oil	690	-	1000 t
	Oil products	160	150	"
Zambia	Crude oil	650	-	"
	Oil products	-	10	"
	Electricity	-	3110	GWh
Zimbabwe	Coal	-	130	1000 t
	Oil products	570	40	"
	Electricity	3110	-	GWh

TABLE 5. The relationship between net petroleum imports (PI) and total imports and exports. Percent

Country	Year	PI/Total imports	PI/Total exports
Botswana	1982	14	21
Lesotho	1981	9	88
Malawi	1983	13	17
Mozambique	1984	<18	n.a.(high)
Swaziland	1982	15	25
Tanzania	1982	26	66
Zambia	1982	21	18
Zimbabwe	1983	14	14

The figures are based on the latest available statistics.

TABLE 6. Woodfuel consumption and population in the SADCC Countries 1984.

Country	Consumption of woot	Population	Per capita consumption
	Mill. m3	Mill.	m3
Angola	5.0	7.8	0.6
Botswana	1.2	1.1	1.1
Lesotho	0.5	1.5	0.3
Malawi	11.1	6.9	1.6
Mozambique	20.5	13.5	1.5
Swaziland	0.9	0.6	1.5
Tanzania	40.2	21.0	1.9
Zambia	7.9	6.4	1.2
Zimbabwe	12.9	8.4	1.5
Total	100.2	67.2	1.5

The wood consumption figures for 1980 stem from the Luanda woodfuel seminar which took place in October 1983. Some of the 1984 figures have been estimated on the basis of these figures, some have been provided recently by the SADCC Member States.

TABLE 7. SADCC Energy Reserves

Renewable resources:	
Hydropower	214 TWh (annual firm power)
Woodfuel	n.a.
Non-renewable resources:	
Coal	6400 Mill. t
Crude oil	250 Mill. t
Natural gas	100 Bill. m3