EVALUATION OF NORWEGIAN ASSISTANCE TO THE ENERGY SECTOR OF SADCC COUNTRIES

P R O J E C T P R O F I L E 3:

Z A N Z I B A R R U R A L

E L E C T R I F I C A T I O N P R O J E C T

(R U R A L)

Phil O'Keefe (editor)
Idris Kikula
Dagfinn K. Lysne
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CENTRE FOR DEVELOPMENT AND TECHNOLOGY
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L I S T O F A B B R E V I A T I O N S

FAO	-	Food and Agriculture Organization (of the United Nations)
GDP	-	gross domestic product
GJ	-	gigajoule (= 10^9 joule)
GOT		Government of Tanzania
GWh	-	gigawatthour (= 10^6 KWh)
km	-	kilometre
km^2	-	square kilometre
KV (or kv)	-	kilovolt
KVA	-	kilovolt per amp
KW (or kW)	-	kilowatt
KWh (or kWh)	-	kilowatthour
lt	-	low tension
m^3	-	cubic metre
MJ	-	megajoule (= 10^6 joule)
MW	-	megawatt (= 10^3 KW)
MWh	-	megawatthour (= 10^3 KWh)
NARSE	-	New and Renewable Sources of Energy
NOK	-	Norwegian Kroner
NORAD	-	Norwegian Agency for International Development
NVE	-	Norwegian Water Resources and Energy Administration
RUREL	-	Rural Electrification Project Zanzibar
SADCC	-	Southern African Development Coordination Conference
SFPC	-	State Fuel and Power Corporation (of Zanzibar)
t	-	tonne

TANELEC	-	Tanzania Electrical Goods Manufacturing Company Ltd. (in Arusha)
TANESCO	-	Tanzania Electrical Supply Company
TShs	-	Tanzanian Shilling
TWh	-	terawatthour (= 10^{12} kilowatthour)
US$	-	U.S. Dollar

3. ZANZIBAR

3.1 Background and objectives of the project

Zanzibar is composed of two sister islands, Unguja (Zanzibar) and Pemba. Unguja occupies and area of 1660 km^2, while Pemba has an area of 980 km^2. The total population of Zanzibar is about 700,000 of whom some 200,000 live in Zanzibar Town. As for Tanzania Mainland, woodfuel is the predominant household energy source also on Zanzibar. Of the total energy consumed, woodfuel provides 90%, petroleum products 6%, hydroelectricity (from the Mainland) 4%, whereas coal and gas contribute negligible amounts of energy.

The basic objectives of Zanzibar's energy policy are:

- to develop and utilise indigenous energy resources such as hydropower (from the Mainland) and new and renewable energies to the greatest extent possible;
- to arrest woodfuel depletion by supporting appropriate land management practices and more efficient woodfuel utilisation technologies;
- to promote energy conservation measures by reducing wasteful practices and increasing efficiency in energy conservation and consumption; and
- to strengthen and rationalise the energy supply infrastructure in order to minimise energy delivery cost.

In 1987, the Zanzibar power distribution system was connected to the Mainland grid by a 132 KV submarine cable terminating at Mtoni Substation on Zanzibar. The cable which was laid by the Norwegian company Standard Telefon & Kabelfabrikk, was financed by a supplier's credit. Maximum transmission capacity of the cable is 45 MW. The present maximum load is about 9 MW. During the next 10 years, the maximum load is expected to increase up to 15 MW for the Unguja Island.

On May 14th 1986, the government of Norway and Tanzania signed an agreement regarding implementation of an electricity transmission and distribution project in rural Unguja at a budgeted forex cost of NOK 15.2 mill. On 24th June 1988, the two governments signed an addendum to the 1986-agreement on a phase II of the project, with a budgeted forex cost of NOK 21.5 mill.
The objective of the project was to support the rural electrification programme of Zanzibar which has been formulated as follows:

- Organised and reliable electricity supply to improve and extend the water service of the islands, comprising domestic water supply and irrigation schemes (especially rice irrigation);
- electricity supply to clinics and health centres in the districts; and
- reduce dependence on supply of diesel fuel and diesel engine spare parts.

Also some agro-industries should benefit from the early stage of the distribution installations. Later, domestic and industrial (especially cottage industry) electricity consumption should be connected to the distribution system. These future extensions of consumption should therefore be included in the dimensioning of the system.

Training of local manpower, both technicians and on-the-job training of construction workers, formed an important component of the project objectives.

Both Phase I and II of the project were restricted to the Unguja Island.

According to the agreements, the State Fuel and Power Corporation (SFPC) of Zanzibar should be the implementing agency, with the Norwegian company NOREMCO A/S as contractor. NOREMCO should be contractually responsible to Norway for the execution of its

services. To this effect, NORAD and NOREMCO signed separate contracts dated 13.08.85 (Phase I) and 06.04.88 (Phase II).

3.2. Project implementation

3.2.1. Project organisation

The implementation of phase 1 of the Rural Electrification Project (RUREL) commenced immediately after the signing of the Bilateral Agreement between Norway and Tanzania (Zanzibar) in June -86 and was completed in time for the official inauguration to take place on Revolution Day January 10, 1988.

All works have been done by staff and manpower from SFPC under the management of A/S NOREMCO Construction. Under the contract, NOREMCO has provided the project manager and required experts, procured materials and equipment, and organised shipments.

Under a sub-agreement with NOREMCO, the Norwegian Line Contractor A/S Linjebygg has provided the experts required for implementation of the construction programme.

Under the project manager, SFPC appointed 2 assistant project managers, one to be responsible for the fieldwork and one to be responsible for administration and design work. Further the staff was divided in various teams which under their foreman were designated to execute their specific part of the total job, as surveying, bushclearing, transport, pole erection, stores, etc.

Details of the organisation can be seen in the organisation chart, figure 3.2.1.

In order to supervise the implementation and to ensure that the works were executed according to the objectives of the project, a project group was established. The group includes representa-

tives as follows.:

1.	SFPC	-	General Manager (chairman)
2.	SFPC	-	Operation Manager
3.	MWCE	-	Head Energy Sector
4.	MEP	-	Project Planning Officer
5.	NORAD	-	Senior Project Officer (Project Responsible)
6.	NOREMCO	-	Resident Manager
7.	RURAL/SFPC	-	Ass. project Engineer
8.	RURAL/SFPC	-	Ass. project Engineer
9.	RURAL/SFPC	-	Ass. project Engineer

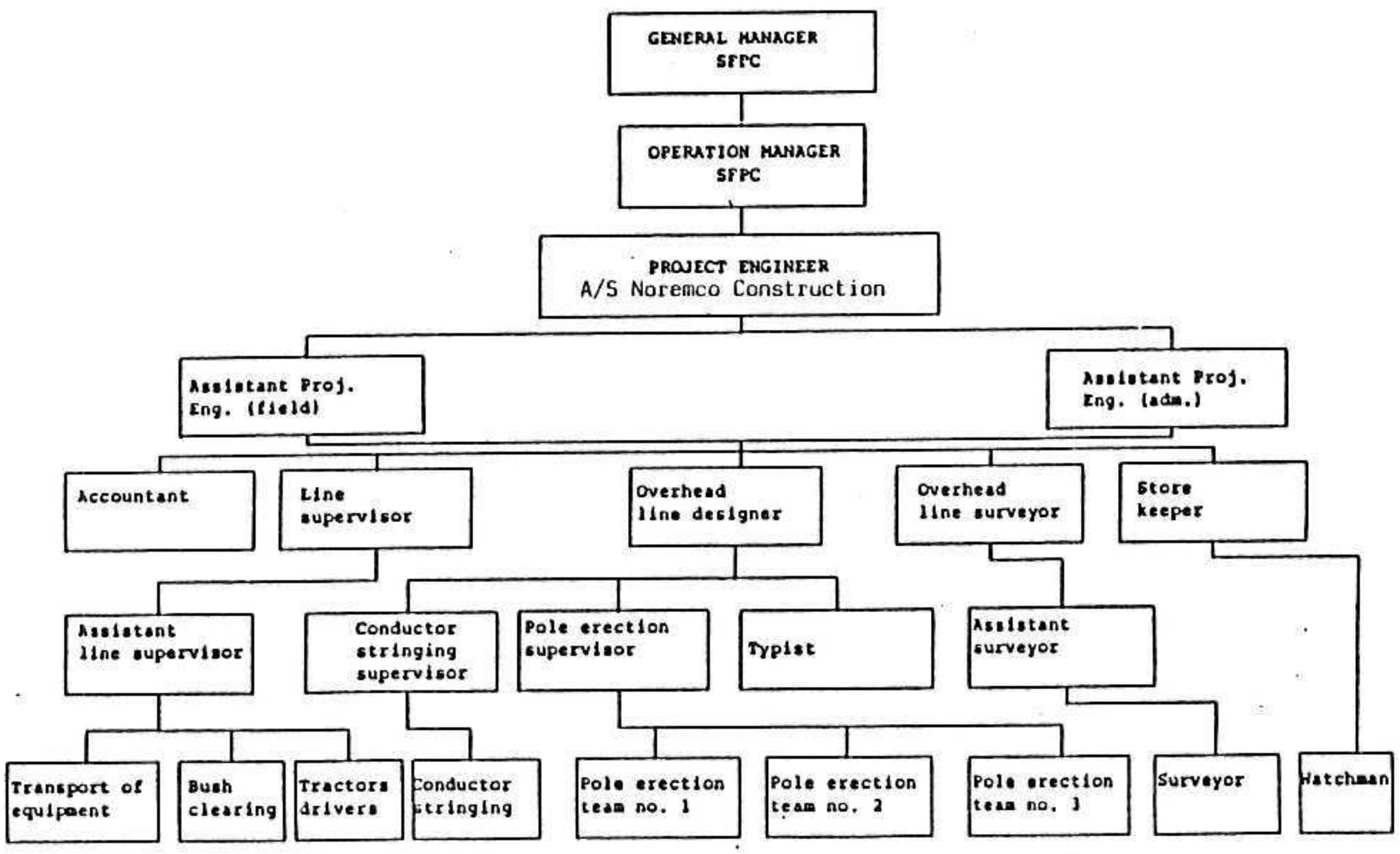

Figure 3.2.1 Organisation chart, RUREL

The project group has had regular meetings and each meeting has been minuted.

The consultant for the project has been The Norwegian Water Resources and Energy Administration (NVE). NORAD/NVE established an advisory group of three persons, two from NVE and one from the Norwegian Society of Chartered Engineers. The advisory group has visited the project once.

3.2.2 Project design and choice of technology

An important basis for the rural electrification project for Zanzibar is the submarine cable from the Mainland of Tanzania. The 132 KV, 45 MW cable commissioned in June 1987 provides ample capacity for expanding the transmission and distribution system throughout Zanzibar and possibly Pemba Island if technically feasible.

The plan for the Phase I of the project was put forward by a senior engineer from NVE after a field visit in 1985 and report submitted early 1986. The plan for Phase I included 65 km of 33 KV overhead lines, the necessary switch stations and step-down transformers.

The progress of work for Phase I was reviewed by the same senior engineer and a plan for a Phase II extension of the programme, with some 160 km of transmission line, was proposed. This programme was again reviewed by the same senior engineer in June 1989, followed by a proposed Phase III programme, including Pemba Island. A request to NORAD was under way when the team visited Zanzibar in November 1989. The existing transmission line system for the town of Zanzibar and the surrounding area consists of 11 and 33 KV lines. Analysis carried out by NVE concluded that 33 KV was the suitable voltage for transmission line coverage of Zanzibar. This choice seems reasonable considering the length of transmission lines to the remote areas, as shown in table 3.2.1.

Table 3.2.1 Line sections completed in phase I of RUREL

Sectional description	Length in km.	No. of poles
Mtoni-Mahonda-Donge	21.003	264
Mtoni-Jendele-Ufutuma	22.976	284
Tee off to Bububu Hospital	0.966	17
" " " Chuini Hotel	1.505	21
" " " Kama Camp (JKU)	1.976	26
" " " Mfenesini Pumping St.	0.328	9
" " " Bumbwi Sudi Rice Field*	5.619	76
" " " Mahonda Sugar Factory	0.172	8
" " " Donge Mbiji Pumping St.	0.218	6
" " " Machui Pumping St.	4.993	58
" " " Ubagao Refamatory Camp	2.733	28
" " " Cheju Rice Field*	1.956	24
" " " Mangapwini	0.460	7
Totals	64.905 km	828

* Rice fields cultivated as individual plots, but govt. is to supply water/manage water pumps.

The project has also included some low tension (low voltage) installations, partly outside the original plans, but agreed to by NORAD.

Shortly after the work on the project had started, the Project Engineer and his design staff worked out specifications for materials and equipment in close cooperation with the management of SFPC. A special reference group was established by NVE to advise on the specifications and the procurement of materials and equipment.

The transformers are supplied by TANELEC in Tanzania, a trans-

former factory established in 1981 through NORAD-support. Wood poles of acceptable quality were not available on Zanzibar, in Tanzania or East Africa until late in Phase I of the project. Then the Sao Hill forestry project was given the facilities for producing poles of acceptable quality. Therefore only 250 poles, or less than 30% were purchased locally. The balance was imported from Norway.

Considerable attempts were made to purchase other materials and equipment locally, but these attempts failed; and except for a few items, most of the components are of Norwegian/West European origin.

The team concludes that a good balance between quality considerations and making use of local supplies has been shown in this project."Shopping around" in different countries for the cheapest suppliers could have been an option, but this would have lead to an inconsistent line of components which is very inconvenient to Zanzibar considering spare parts and maintenance.

The scope of choice with respect to alternative technology is really very small for this type of transmission system. The real question is choice of quality.

3.2.3 Implementation and training

Surveying and some preparatory work was started by NOREMCO before the agreement between Norway and Tanzania/Zanzibar was signed in June 1986. From then on progress of work for Phase I has been close to schedule throughout with a maximum of a few weeks deviation from the original time plan. The progress for Phase II has likewise been very close to schedule and is due to be completed by the end of 1990.

As technology transfer was a key point in the terms of reference of this project, training was given special attention. A com-

prehensive training programme was implemented immediately after the work started. This training programme embraced "on the job" training of both workers and staff. The workers were trained in bushclearing, transportation, pole erection, crossarm installation and conductor stringing. The training was aimed at giving the workers a wide understanding of the jobs, both the why and the how to do a particular job, in addition to the pure technical training related to tools, equipment and methods of working.

Later on, installation of transformers and disconnecters, HT cables, metering boards etc. was included in the training programme. The project staff, the engineers and supervisors, were trained in several disciplines like surveying, design, project management and accounting.

Early in 1987 a draft of a training manual was worked out. One expatriate stayed in Zanzibar for a period of two months to assist the project Engineer in this work. In June 1987 a temporary edition was available. This edition was used by the project staff on their own, and suggestions for improvements and extensions have been reported back to the editor, who has updated the manual.

The total staffing of the project has been 60 to 65 people, each of whom has been given training in line with their work. The NVE senior engineer reviewing the project in June 1989, concludes in his report that: "the work (training) both on the planning/design side and on the construction side is being professionally and neatly done". He also points out that the training manual is very good and instructive, though some minor polishing is needed.

The Team, having background themselves in education and training, is very impressed considering the low level of expatriate input in this project and the broad scope of training. The programme has covered training of staff in management and engineering as well as training of technicians and skilled labourers. It should be pointed out that there have been no accidents, thanks to

special emphasis on safety precautions in the training programme. Furthermore, the time plan has been followed and there has been no cost overrun for the Phase I of the project.

3.2.4. Assessment of costs and internal economies of the project

Phase I of the project was completed within 17 months, from September 1986 to January 1988. Table 3.2.2 shows the budgeted and actual costs, respectively, of phase I.

Table 3.2.2. Budgeted and actual costs of phase I NOK '000.

	Budget	Actual	Actual as % of budget
Procurements	8470	10664	126 %
Project design	150	643	429
Project management	210	210	100
Constr. management	1630	1391	85
Travel/subsistence	500	399	80
PTT/Comm.	200	176	88
Insurance	150	45	30
Fuel, Yard, Office	650	663	102
Labour/staff	2400	-	-
Misc.	840	1006	120
Total	15200	15197	100 %

(Sources: Grongstad: Report of 05.08.89, p. 11; and NOREMCO: Zanzibar Rural Electrification Project, Phase I, Final Report, Appendix 3.)

Phase I comprised 64.9 km of 33 KV line including 828 poles with conductors on cross-arms and 16 pole-mounted transformers. The

cost per km of line turned out to be NOK 234,160.-. Although the project included a considerable training component, this figure compares well with international standards. For example, for comparable 33 KV lines on the Mainland, Acres International has estimated total cost per km of line at about US $ 35,000.- or approximately NOK 230,000.-. (Acres International: Review of 1985 Power Sector Development Plan, July 1989, p. 6.8.)

As table 3.2.2 shows, phase I of the project was completed within the budget limits. However, there are marked deviations between some of the budgeted cost components and actual costs. The budget overdraft for Procurement is partly due to higher freight and clearing costs than anticipated, especially between Tanzania and Zanzibar. Moreover, only 250 poles were purchased locally, whereas 600 were imported from Norway. The average price of a pole imported from Norway is about NOK 1700.-, including 15% freight costs, whereas the average price of poles bought from Sao Hill in Tanzania is about NOK 500.-. If Sao Hill Saw Mill had received its impregnation plant in due time to supply the project with all poles, procurement costs of poles for phase I would have been about NOK 700,000.- lower.

It should also be noted that about 70 poles which were included in the costs of phase I were left over in stock and used in phase II of the project.

The budget overdraft of design costs was mainly due to higher costs than estimated in the production of the Training Manual.

Regarding insurances, it should be noted that local insurance costs were included in the item Fuel, Yard, Office, which contributed to reducing the cost item insurance below the budget estimate.

The normal wages for workers seconded to NOREMCO by the SFPC were paid by NOREMCO and reimbursed by SFPC. These costs, in local currency, do not enter table 3.2.2 above. In addition, the

workers were paid one hour overtime each day except Fridays, and they were served a meal free of charge 6 days a week. These expenses were not reimbursed by SFPC. To our understanding, they should have been debited the item labour/staff in table 3.2.2. However, NOREMCO included these costs as Miscellaneous costs which resulted in an overdraft of that cost item by 20%, whereas the labour/staff-item was not used.

Overall, we may conclude that the budget was well adhered to and that phase I of the project was implemented in a cost-effective manner.

Phase II of the project commenced in 1988 and is planned to be completed by the end of April 1991. The total budgeted costs of phase II are NOK 25.5 mill., of which NOK 21.5 mill. are forex costs and provided as a grant by NORAD.

Phase II includes 150 km of 33 KV lines and 20 km of low tension (LT) lines with a total of 2250 poles. The total costs of the LT lines is estimated at NOK 800,000.-. Hence the estimated cost per km of 33 KV line is only NOK 170,000.- which may be considered as very low. One reason for the low cost per km for phase II is, no doubt, the effective training of local staff and consequent learning of effect of phase I.

On July 1st, 1989, 870 poles had been erected (implementation rate: 39%), and 52 km of conductor stringing had been carried out (implementation rate: 35%).

At the same date, an amount of NOK 12.6 mill. or 49.4% of total budgeted costs had been spent. The main reason for the difference between financial and physical progress was considerable purchases and accumulation of stocks of materials (mainly poles, insulators and strings), with the result that the financial progress of Procurement reached NOK 9.8 mill. or 62% of the budget per 01.07.89.

It should be noted that physical implementation of phase II was far behind schedule up to August 1988, because of considerable delays in deliveries of poles and line material. However, while waiting for these items to arrive, surveying, designing, bush clearing, and digging/blasting holes for poles went on very well. As the waited-for materials arrived in Zanzibar in August-October 1988, implementation of pole erection and conductor stringing attained a higher speed than planned, due to good planning. At the end of November 1989, pole erection had reached 1170 poles against the planned number of 1225, whereas stringing had reached 77 km, against the planned 92 km.

The impression of the team at our visit in Zanzibar in November 1989 was that implementation was proceeding well. There is good reason to assume that the project will be completed within the planned date (April 1991) and within the planned budget limit.

When phase II is completed, 10 out of the 13 rural water supply schemes in Zanzibar will be run by electricity, while only 3 will be left with diesel generators. According to the Department of Water, the average cost per month for electricity to run a pump is TShs. 186,000.-. On the other hand, the diesel costs, including transport and maintenance, are estimated at more than TShs. 500,000.- to run the same type of pump.

The low cost of running pumps with electricity is to some extent due to a very low tariff for electricity purchased from TANESCO (about 0.20 TSh per KWh). SFPC expects that the tariff will rise considerably in the near future. However, they argued that electricity for water pumping will be much cheaper than diesel also after a tariff increase.

Finally it may be noted that the difference between electricity and diesel costs reflects a foreign exchange saving for Tanzania as a whole.

3.2.5 Project operations

Phase I of the Rural Electrification Project (RUREL), was on schedule from start to finish. The second phase was somewhat behind schedule at the beginning because of a delay in receiving materials. After their arrival, work was stepped up and the project is on schedule in surveying, bush clearing, erection, and almost on schedule for stringing operations.

The greatest contributory factor to the very successful implementation of RUREL in Zanzibar, is the enthusiasm, pride in work, and team spirit shown by all the people concerned with the project. It was difficult to pinpoint one single cause:

- was it due to a special work ethic in Zanzibar? - or -
- the devotion and personal touch of the project engineer?

Or was it simply the way in which the project was managed and implemented. The implementation was carried out like a well-oiled engine. All the factors mentioned above contributed substantially to the efficient running of the project.

In order to ensure smooth implementation of the project, a project group was established from the outset. It was made up of the following:

SFPC	-	General Manager (Chairman)
SFPC	-	Operation Manager
MWCE	-	Head Energy Sector
MEP	-	Project Planning Officer
NORAD	-	Senior Project Officer
NOREMCO	-	Resident Manager
RUREL/Noremco	-	Project Engineer
RUREL/SFPC	-	Assistant Project Engineer

The group meets regularly and each meeting reviews past progress, achievements are briefly outlined and problems are identified.

The operations in the field consist of:

- surveying and designing,
- bush clearing,
- pole erection,
- stringing high tension wires with accompanying step-down transformers, surge regulators etc.

Recently low tension wiring and connections have been provided.

i) Surveying and design

The first phase was undertaken in August 1985 and was carried out by NOREMCO as consultants, who used a team of four surveyors from the project staff supervised by the assistant project manager (field). Surveying for Phase II had to be done by two teams in order to catch up because of the delay in receiving materials. In addition to the engineers the teams also included some unskilled workers.

Before a survey is carried out, the project informs the local party branch leader about the plans. Parallel to the surveying, the trees, crops and even houses which have to be demolished are marked and listed. SFPC is then informed of the need to negotiate for compensation for the loss of property. The survey details are then used to lay down the design for the poles and lines.

ii) Bush clearing and pole erection

Along the alignment of the transmission lines a path of about 10 metres on each side of the line is cleared. Due to dense vegetation, including palm trees, this entails heavy work sometimes using motor-driven chain saws.

A team of 8-10 labourers gets special training, in the technical and safety aspects of cutting down the trees. The project usually uses two teams. In some cases, extra labour is employed from the villages nearby. In the first phase, it was possible to transport labourers to and from the clearing sites but, as the project goes further afield, it has been necessary to set up "camps" in local houses. The labourers get a free mid-day meal and 500 shillings per month which includes a salary plus bonus.

If the labourers have to live in "camps", all the cost of meals and accommodation are met by the project.

Two teams are also used for pole erection. In Phase I, 828 poles were put up. A great deal of effort was spent in preparatory work such as checking of the land and the poles themselves. In most cases holes were dug with hand tools. However, in rocky areas, drilling and blasting was required. Appropriate equipment was used to put up the poles. Phase II will require the erection of 2210 poles. The work is done by a team of 4 each under a supervisor. Once again the team is trained in the technicalities of setting up the poles as well as ensuring their personal safety and that of others while doing so. So far no accidents have taken place. Technical training also consists of the ability to choose stable slopes and how to support the sides of holes in order to avoid subsidence.

iii) Stringing works

During Phase I, 65 Km. of 33 kv line was stringed. Prior to the start, a small scale demonstration line was erected close to the project offices. This particular training was found to be very useful and there were no problems when the actual work commenced.

iv) Training

As technology transfer was a major objective of the project, training has been given special emphasis. This training programme has consisted of "on-the-job training" in bush clearing, transportation logistics, pole erection, crossarm installation, conductor stringing, laying HT wires etc. Besides technical aspects, the project staff were also trained in management and accounting techniques. Two other components of training were overseas professional training for project engineers and the preparation of a training manual. The staff has consisted of 64 people and there has been a minimum of two staff for each position.

iv) Other activities

Other activities include the transportation of materials to the various teams which is a very important part of the operation in order that work is smoothly implemented. Finally, the project is also involved in the rehabilitation of certain facilities, such as cables and connections for the Mahonda Sugar Factory.

The team endorses the recent evaluation of the work for Phase I which sums up the operation as:

> "Line design routing, alignment and pole erection of the 33V overhead line is impeccable".

Briefly, the planning, execution and training in the project have been excellent.

Recognition of the sensitivity of local feelings is best illustrated by the attention given to informing people about the compulsory demolition of property and the system of compensation For instance, after marking the trees and houses to be demolished, a consultation is arranged between the party branch leaders and officials from SFPC and the Ministry of Water and Construction. After that, four announcements are made over the radio informing the owners about the property that has to be demolished during the construction work.

At each stage, there is an effort to involve the local authorities, the owners, the Ministry of Water and Energy and SFPC. It was not possible for our team to talk to persons who had been compensated, but from speaking to the labourers one had a feeling that the people had no resentment against the project. As one of them put it: "..if there was, the people would have knocked down the poles". Trees that were cut down to clear a path for the electricity poles, were offered as fuelwood to the neighbouring villages. The project was also conscious of the need to utilise local materials as much as possible.

The care taken inparticipatory planning and implementation is also apparent in the working relationship of the staff. For

example, beginning with the NOREMCO, the expatriate project engineer appears to be well integrated into the local scene and is on a first-name basis with many of the senior and middle level personnel in the project. He is also well known and popular among the local Zanzibar city bureaucrats, politicians and businessmen.

The management and operations reflected of the care and meticulous attention given to participatory planning, decision- making, and appropriate technical training on the job. Above all, there was sensitivity to local feelings. This was a project which considered that people and not things and technology, were at the centre of development. The transfer of technology was so well achieved that people with little or no previous experience were doing complicated jobs with ease and enthusiasm.

The organisation of RUREL shows what can be achieved by a sympathetic expatriate working with local staff who are well trained and motivated.

3.3 Role of rural electrification in promoting economic growth

80 per cent of the population live in the rural areas and depend on agriculture for their livelihood. The main emphasis of the government's economic policy is therefore on agriculture. Most of this is produced on small farms where energy, inputs other than manual, are minimal.

However, there are areas where the provision of electricity can have an impact.

a) The fishing industry

Fishing is an important economic activity, with Zanzibar Town being the main market. Most of the fish comes from villages outside Zanzibar Town and therefore transport and storage facilities are critical for the efficiency of the industry. Most of the storage facilities are also located in Zanzibar town,

so if transport is not available, the fish in the outlying villages can, and often does get spoilt. In order to avoid this, the fishermen pay enormously exorbitant transport costs; in many cases the fish gets spoilt because is simply not available, or because, by the time the fish gets to Zanzibar town by bicycle, the Zanzibar Market and the storage facilities are closed (6 pm).

Rural electrification can make a difference. Villagers in Unguja are planning to utilise the newly-installed village connection to the grid by investing collectively in a freezer/ice making machine, so that they can store the fish and avoid spoilage. This example will probably be followed by other villages and should stimulate the entire industry.

b) Irrigation

Small-scale irrigation is an important part of the economic strategy of the government. Rice is the main staple and large quantities have to be imported. The government has embarked on an extension of irrigation schemes for rice cultivation so as to facilitate multiple cropping. Intensification is important because little spare agricultural land is available.

The main constraint on the use of electricity has been the availability of low tension distribution systems. RUREL has accepted irrigation pumping as one of the priority areas for providing electricity and has already provided step-down transformers. The main task of the government, or the aid agencies supporting such schemes, is to provide the materials/ funds for the final connection and internal wiring.

Another crop that is being developed under irrigation is sugar cane. There is a fairly large sugar producing complex known as the Mahonda Sugar Factory. In 1972/73 the factory was able to produce all the sugar requirements for Zanzibar and Pemba based on its own plantations. Power is required for the massive turbines required to produce sugar. The two diesel generators have broken down so frequently that:

on its own plantations. Power is required for the massive turbines required to produce sugar. The two diesel generators have broken down so frequently that:

> as the turbines do not produce enough power the factory was not able to utilise all the sugar cane which then rotted on the ground requiring a major reorganization of the plantations (field interviews).

The factory was linked to the grid in January 1988 and plans are underway to restore production to its previous level of 6000 tons (up from its current 2000 tons), as well as to increase acreage through irrigation from 2000 to 3000 acres. This expansion will have positive effects on output and employment. The factory/plantation complex now employs 600 permanent employees and about 2000 seasonal workers. In addition to sugar, the factory also produces liquor and perfume for export. The economic benefits of providing electricity to this plant are quite clear.

Other irrigation activities involve the production of the seedlings of coconuts and citrus fruits.

c) A third type of economic activity that can benefit from rural electrification is tourism. The government is rehabilitating old colonial seaside rest houses built for important government officials, into small hotels with modern facilities. The provision of electricity will facilitate such aspects as pumping water, lighting, refrigeration etc.

Other economic aspects of electrification in the rural areas in Zanzibar will depend on the general development of the island and how this development affects demand. On the supply side, there is plenty of excess power. The potential power supply is 45 MW whereas the average load is 5 MW, or a mere $^{1}/_{9}$ of the potential supply.

3.4 Social aspects

3.4.1 Background

According to the 1988 Population Census, the total population of Zanzibar is 640,578, with 314,864 males and 325,714 females. The main population indicators are summarised in Table 3.4.1.

The high rate of urbanisation has put a strain on the urban amenities. In order to reduce rural-urban migration the government is therefore endeavouring to provide better social services for the rural areas. The greater concentration of people in the countryside, coupled with the smaller area to be covered potentially, makes it easier to provide community services such as piped water, health facilities and schools. A start was made, soon after the Revolution in 1964, to pay more attention to the rural areas. As a result, about 25 per cent of the rural population in Zanzibar have piped water and in some areas, such as Zanzibar West, as much as 43 per cent. Unfortunately, the decline of the clove industry and the poor economic situation has led to a deterioration of services. One of the biggest recent constraints has been the lack of diesel to run machines.

Compared to the mainland there is considerable room for improvements in education. In 1978, literacy rates were 51.6 per cent for males and only 34.8 per cent for females. Only 14.53 per cent of adults had completed the primary education stage. The only sector in which Zanzibar was ahead of the mainland was in secondary education.

Rural housing is generally poor. Only 10 per cent have been constructed of bricks. Most of the houses are of poles and mud plastered or unplastered and the roofs are generally thatched. The poor quality of houses poses problems for electrification as SFPC requires certain standards in wall construction and roofing materials.

Table 3.4.1 Comparative population indicators for Zanzibar

Indicators	Zanzibar	Mainland	Unit of Measure
Population	640,578	22,533,788	persons
Household size	4.7	5.3	persons
Sex ratio	99	99	men per 100 females
Population density	260	26	persons/sq.km
Growth Rate	3.0	2.8	per cent per annum
Urbanisation*	32.55	13.78	per cent of total population
Infant Mortality*	125	137	deaths per 1000 infants per year
Fertility*	7.2	6.5	children per woman

Source: 1988 Population Census, Preliminary Report, Tanzania, Bureau of Statistics, 1989.

* 1978 Population Census, Volume VIII, 1983.

3.4.2 Recent strategies for rural development

The development plan of Zanzibar states that:

> "Rural electrification will extend power facilities to areas where it is most needed for social and industrial development. It is the Government and Party policy to spread town amenities to the rural areas so that the rural population may remain in the District to develop the land. This can best be achieved with the help of electricity. Rural electrification will extend to the remote countryside a convenient source of power and energy and will establish an important element of the development infrastructure".
> (Zanzibar, Five Year Plan, p.4)

The objectives of the development plan are a heritage of the Zanzibar Revolution of 1964. After the Revolution, the first Present of Zanzibar, Abeid Karume, aimed to revolutionise the suburbs of Zanzibar Town and the rural areas by providing these areas with modern housing and amenities. Some of these were indeed built including water pumping stations and piped water, modern flats and houses and hospitals. There was also a concerted attempt to diversify the economy from a reliance on one crop, cloves, to production of other crops, especially food crops. In the past cassava was the major staple, particularly of the poor; the revolutionary government intensified the growing of other staples such as rice and to a lesser extent maize to improve both self-sufficiency and nutrition.

The objectives of the development plan are reflected in RUREL whose aim is "to extend electric power to areas where it was most needed for social and industrial development" (Zanzibar, Rural Electrification Project (RUREL) Phase I. Final Report, p.2).

An unwritten but underlying emphasis is the preference given to the extension of the benefits of electricity to communities, without, at the same time excluding individual houses from getting installations. It was realised by the Zanzibar government, that communities would best be served if electricity was provided for basic services such as water pumps, hospitals and training facilities. A large group of people, irrespective of sex, age or economic status thus benefitted from rural electrification. There are plans to expand electricity use to other basic uses such as in food production through irrigation. Many people should thus benefit directly and indirectly.

In Phase I and II these objectives were translated into providing power for water pumps, hospitals, training camps, irrigation, the provision of cold storage for tree nurseries, and even for industries. The original scheme was to provide high-

tension distribution lines and thus motivate these institutions to apply, and pay for, low tension distribution lines and connections. In some cases, when it became apparent that some institutions did not have the capacity to pay for the low tension connections, the project supplied the materials in order to make rural electrification a reality. In the words of the expatriate project engineer,

> "The high tension lines are only part of the network needed to distribute the electric energy from the power sources to the industries, public institutions and private consumers.. To make the total benefit of the rural electrification project optimal, the project staff would therefore propose to make some reallocation of resources". (Phase II, Progress Report No.. p.4).

To implement this policy, NOK. 800,000 were thus reallocated to 20 km. of low tension wires and accessories.

3.4.3 Current energy use

Woodfuel provides 90 per cent of the current energy used, petroleum 5 percent, and hydroelectricity 4 per cent. The yearly requirement of petroleum products is 10,000 tons, 2/3 of which is used by the transport sector, and the remainder by industrial, agricultural and other sectors.

Unguja (Zanzibar Island) obtains 45 MW of electricity from Kidatu through a submarine cable. However, it uses only 9 MW of this electricity. In Pemba, the main source of electricity is from diesel generators which can supply 4.8 MW but only 1.5 MW is consumed. There is therefore considerable excess power capacity in Pemba and much more in Zanzibar. The government of Zanzibar is therefore anxious to utilise this excess power in order to stimulate development.

3.4.4 Rehabilitation of water supply

The first priority was the provision of electricity to water pumps which used to be run by diesel generators. In most cases the lack of spare parts, poor maintenance and the obsolescence of the machinery had led to pumps operating at very low capacity. For instance, the Mfenesini Pumping Station had not been working for two years before electricity was provided in 1987. At the moment the pump provides water for a rural population of about 16,000 people, using water from 35 public water points. In addition there are about 200 private water users.

In total, between Phase I and Phase II, electricity was provided to 12 pumping stations. The team was able to visit several such places (see Table 3.4.2). The equipment at Gamba had not been working for 4 years because of lack of power.

There are also other benefits than simply obtaining an adequate water supply. The availability of pumped water in stands reduces the work-load of women. In Mfenesini Village, for instance, there are stands every 400 km. About 200 private water users have piped water in the house. It is true that the provision of electricity to the village in itself would not have eased the burden of collecting water from distant sources or assured clean water were it not for the pumps and pipeline already installed. However, it does provide a cheap and reliable source of power to operate a service that benefits entire villages. Piped water also stimulates increased production. For example, Mfenesini village has already started a chicken farm and increased vegetable production.

Table 3.4.2 Capacity and persons served by selected stations

Mfenesini Pump Station	16,000 persons	45,000 l/hour 12 hours/day
Chaani	9,000 persons	50,000 l/hour 12 hours/day
Machui	20,000 persons	n.a.
Gamba	900 persons	n.a.
Donge Mbiji	12,000 persons	50,000 l/hour 12 hours/day

Source: Field Data (November 1989)

Finally, electricity has brought other savings including financial ones. Diesel generators are difficult to maintain and are susceptible to frequent breakdowns requiring the replacement of parts. Diesel itself is very expensive. For instance, the Mfenesini Pumping Station required about 600,000 - 700,000 shillings a month to cover the costs of diesel, oil, transport and maintenance. Electricity to work the pump for 12 hours/day works out at 186,000 shillings per month (field interview).

3.4.5 Training and education

Electricity has also helped training institutions. In December 1987, the National Training Camp at Kama, was connected to the main grid. The camp trains about 250 girls for one year in sewing, mechanical repairs, furniture-making and livestock keeping. The girls are secondary school leavers and the training is aimed at equipping young women to undertake income-generating activities. The provision of electricity helps the camp in pumping water, lighting houses and maintaining the chicken project.

In addition to Kama, only two other institutional facilities are mentioned, namely Upenja JKU and Mahonda School, but it is possible that all the 50 villages when provided with electricity could hold evening classes, run equipment etc.

3.4.6 Health services

A total of 15 hospitals have been connected to the electricity grid. No statistics are available about the total number of people served; the following intonation is based on one of the hospitals which the evaluation team were able to visit.

The Kivunge regional hospital is a small hospital with 30 beds, plus maternity facilities, with two ante-natal and six post-natal beds. It has facilities for such operations like appendicitis, caesareans and hernia. It has about 200 - 300 out-patients per day. It also has laboratories and a dental unit. Electricity is used for lighting and laboratories, and can also be used for water pumping. However, it also has a solar system for pumping water.

3.4.7 Overview of services provided for institutions

The use of electricity in institutions as illustrated above is basic to the physical and social welfare of the people. Other related services available include cold storage for fishing villages, maize mills, and at the Manyama tree nursery.

3.4.8 Individual consumers

Although the emphasis of RUREL is on community services, there is also an awareness of the possible benefits of connections to individual houses. For the present, electricity is unlikely to be used for cooking, but there is great interest in being

connected to the grid for lighting, running fridges and operating radios. Electricity is also supposed to be a cheaper fuel than others. One individual fisherman, Mr. Elias Hamisi, in Chwaka, on the east coast of the island, who was the first to be connected, claimed that electricity cost him 230 shillings per month for lighting while Kerosene used to cost him 600 shillings. The installation fee was 15,000 shillings and the wiring came to an additional 8,000, but he thinks that it was worth this sum, because of the convenience and savings from electricity. As a bonus for being the first client, a reconditioned meter was installed for him, free of charge, by NOREMCO and SFPC. This item would have cost him an additional 6,000 shillings.

According to Mr. Hamisi, electricity for cooking is not feasible for him - a two plate cooker costs about 26,000 shillings. Therefore, he would rather use firewood, which he claimed was not a problem.

In all, about 35 houses had already prepared themselves (wiring, meters, etc) for connection. The village chairman, endorsed the desire of the people for electricity. The potential demand is sizeable. There are 225 households, 7 regular shops in addition to the many small "hoteli" (no stars) and tea-shops. In this basically rural village, about 10 per cent have already committed themselves to electricity, as the Chairman said for, "<u>starehe zaidi</u>", which simply means for, "greater convenience".

3.4.9 <u>Gender aspects</u>

As on the mainland, rural women predominate in agricultural and domestic work. Rice cultivation is the women's main occupation. It is almost a year round activity, and given the high rainfall, the rice areas are turned into swamps during the planting and

weeding seasons, making the agricultural work very difficult. Some households also have a small plot of clove trees but this crop is always considered to be the man's crop. Women's cash income is therefore based on the sale of surplus food, especially rice.

There are a few rural projects or industries with a permanent female labour force. They are mostly taken on as "unskilled" labour. In the sugar industry, for instance, women are employed as weeders and cutters. In the rice irrigation schemes supported by the FAO, women are employed as weeders and bird chasers. In activities which are traditionally considered as "women's tasks" such as planting, weeding, women can exceed men in employment. For instance in the Manyama nursery 60 per cent of the workers were women, mainly involved in raising seedlings and taking care of the young seedlings prior to transplanting.

Besides undertaking most of the food production, women also spend their spare hours on such work as mat-weaving, rope-making, cap-embroidering, making baskets and cooking foodstuffs such as buns known as mandaazi.

3.5 Benefits of Rural electrification to Women

The project staff total 64 including the labourers. Among the permanent staff of 10 that were undergoing training, only two were women. One was being trained in technical aspects such as the profiling of transmission line routes, instruments and methods, map reading, designing of power line structure, etc. The other was a secretary, and she was not undergoing any training. Presumably she was already trained in secretarial duties. Given the lower level of education of women and the general reluctance of a predominantly Muslim society to allow women to work in public places, the proportion of women on the permanent staff is commendable.

Among the outdoor teams there were no women at all. Given the hard work involved, societal taboos and the rural women's heavy household commitments, it is not surprising that there were no women in these teams. It would also have been hard to expect women to live in camps like the male labourers.

However, RUREL has brought benefits in other ways. The emphasis on the electrification of community services, such as water supply, health facilities and maize mills has benefitted women who are mostly responsible for collecting water, taking children to the health centres and de-husking rice. In addition, the provision of rural electricity has improved some of the training facilities for women, eg the Kama JKT for girls where about 250 girls are undergoing training in skills to make themselves self-reliant economically, and at the Manyama tree nursery, where 60 per cent of the workers are women. The rehabilitation of the Mahonda Sugar Factory and the electrification of the irrigation schemes will provide increased employment opportunities as these economic ventures expand. The long-term benefits are difficult to predict because they are contingent on the improvement not only of the economic situation but also on women's access to education, as well as attitudinal change in a predominantly Moslem society.

Rural electrification will not relieve the majority of the rural women of the task of having to collect fuelwood in the foreseeable future. Even in the towns, the most popular source of fuel for cooking is charcoal. In the rural areas it is wood. About 10 per cent of the households will benefit from electric lighting and possibly not having to buy battery cells for their radio. However, all this may change if the economic situation improves, and/or the price of fuelwood and charcoal becomes exorbitant.

3.6 The project's implications for the environment and land use

This discussion on the project's implication for the environment and land use will be centered around three main points, namely:

a) The impact of the transmission lines on the environment and land use,
b) The impact of anticipated energy switch on environment,
c) The impact of power supply on general land use.

We will discuss below the above points.

3.6.1 The impact of transmission lines on the environment

Observations during the field trips showed clearly that the impact of transmission lines on the environment was negligible apart, of course, from the slight change to the landscape. This negligible impact could mainly be accounted for by the existing land use/cover types of the island, and also to the small width of the land cleared for the transmission lines.

For most of the areas the transmission lines pass through agricultural land planted with coconuts, cassava, rice, mango trees, bananas, clove trees etc. This, of course, means that the project has incurred expenses in compensation for the crops cleared to give way to the power lines. Where the line passes through non-agricultural land it is mainly through bushland areas which are not suitable for agriculture due to shallow and stony soils. Where tree crops are cleared they are replaced by small crop plants like sweet potatoes, rice, cassava etc.

3.6.2 The impact of the anticipated energy switch on the environment

The policy of the Zanzibar government is to electrify all rural areas, among other reasons to reduce the rate of deforestation. It is expected, therefore, that the rural electrification project will lead to an energy switch from woodfuels to electricity. But this is unlikely to take place on a large enough scale to have an impact on the environment. The main constraints are financial, both in terms of installations and the purchase of the electrical appliances. During the visit to Chakwa Village, it was established that the costs of wiring a three room house as from May 1989 was 15,000 shillings. This excludes the cost of meters which are sold at between 6,000 to 8,000 shillings. These costs may not be affordable by everybody. Furthermore, the electrical appliances are not available at affordable prices to low income people. Fortunately the government realises this problem and one official remarked that the government will look into ways of making the electrical installations and appliances affordable to the rural population. Thus the impact of the anticipated energy switch on the environment cannot be immediate even if serious efforts are made to overcome the prevailing problems. It will have to take some time, for the adoption of innovations does not materialise overnight.

On the other hand, diesel-generated power for water pumps, hospitals, irrigation, coconut projects, factories (eg Mahonda Sugar Factory), and many other institutions will soon be replaced by hydropower, thus reducing the level of air pollution. These connections are given priority. Although air pollution has not been a problem so far, it was bound to occur and it is better to take precautions. The power supply is expected to cut down diesel use by 80 per cent. Ten out of thirteen water stations were expected to be connected to power by the end of 1989.

3.6.3 The impact of power supply on the general land use

We have mentioned above that rice irrigation and coconut projects are a the priority for power connections. It is therefore expected that power connections will stimulate the expansion of large scale agricultural activities.

Power supply has also improved seed storage facilities for nurseries. For example, the Munyanyu Tree Nursery which is government owned and supported by FINNIDA has been connected to power sources and the seed storage chamber is fully operational. This facility will hopefully contribute to afforestation schemes.

3.7 Conclusion

Among the projects that were visited and which were meant to bring about rural electrification, RUREL in Zanzibar, is the only one that really addresses itself to bringing electricity to rural areas. The rural electrification projects in Mozambique, for instance, are only concerned with small towns.

RUREL has been implemented in a very costeffective way and according to implementation plans. The learning effects for local staff and workers during implementation have been considerable.

One of the striking features of rural electrification in Zanzibar is that it was calculated to maximise the benefit of the masses, without ignoring the needs of individual consumers. This was achieved by giving priority to supplying electricity to the public services and small industries.

The project staff were sympathetic to the overall policy of the

Zanzibar government, and sensitive to the needs of the workers as well the local people, and therefore were flexible in their approach. They made it their business to be innovative.

There has been a real effort to use local resources, institutions and procurements. For instance, poles for the first phase were mostly obtained from Norway. However, later on a treatment plant to impregnate poles was given to the Sao Hill Forestry project, in Iringa, Tanzania. In Phase II, most of the poles have come from this local source.

Cooperation between government/local staff and expatriates, together with sensitivity to the issues and problems that are inevitable in such projects, meant that the project was solution-oriented.

The use of electricity for such basic services as pumping water, use in hospitals and schools meant that it served a large number of people irrespective of their status.

While women have not benefitted directly in terms of employment, the use of electricity for public services has made women the main beneficiaries of rural electricity in Zanzibar. The availability of credit to women would help a great deal.

Electricity is now being used for increasing productivity, as is evident in the chicken-raising project, irrigation schemes and small-scale industries. This will mean that by raising incomes people will be able to afford to pay for power.

The substitution from diesel to electricity has definitely brought financial savings and other benefits, including foreign exchange savings to Tanzania.