Sida Evaluation 97/24

Swedish Support to Tanzania's Power Sector

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Executive Summary

The Evaluation

Sweden has contributed to the development of Tanzania's power sector since 1967, with a heavy emphasis on supporting the building of hydro-electric power stations. While this support has been given to Tanzania in co-operation with the World Bank, NORAD, Finnida and other donor organisations, it is fair to say that Sweden has been a major actor in the Tanzanian power sector over the past 30 years.

The present evaluation of this support is the only one which has been commissioned, with the exception of a brief review and assessment carried out in 1981. It is intended to synthesise lessons learned over the past 30 years and provide a basis upon which current and future decisions can be made.

The evaluation focuses on the Swedish contributions and is, thus, not an evaluation of the overall performance of the energy sector in Tanzania. The Swedish assistance is reviewed in terms of:

- relevance of projects carried out, in relation both to the needs of Tanzania and the Swedish goals and guidelines for energy assistance
- planning and the timely and economic completion of projects,
- their current condition and contribution to the national energy supply,
- the environmental and socio-economic impacts of power plant and dam construction in the surrounding geographical area.

Some discussion is made of the effects of Swedish support on the policy and regulatory framework and institutions/organisations within the electric power sector. There is also a discussion of who has benefited from the Swedish energy assistance.

The Energy Sector in Tanzania

Despite the significant build-up of hydropower installations, 92% of the energy consumption in Tanzania comes from woodfuel, 7% from petroleum and 1% from electricity. While Swedish assistance has been instrumental in building up the electric power generation capacity, the demand for electricity, both for residential and commercial use, is relatively low. Poverty, continuing dependence on raw material exports and the sluggish development of the industrial sector are contributing factors keeping the demand at relatively low levels.

TANESCO, the Government owned power company, is responsible for power generation, transmission and distribution on the mainland. The electric power system has a total installed capacity of 571 MW and is based primarily on hydro power generation, 377 MW. The main hydro power plants are Kidatu (200 MW), Mtera (80 MW) and Pangani (66 MW).

Swedish support to Tanzania's Power Sector

The total Swedish support to Tanzania's power sector (from 1967 and including fiscal year 1994/95) amounted to 726 MSEK in current prices. To this sum should be added additional instalments for Pangani and also the Swedish commitment to the projects within the Power VI scheme. This, then, makes a grand total of approximately 1 000 MSEK in current prices, which amounts to about 20% of the total costs for projects with Swedish Support.

Swedish support has been given to the construction of dams and hydroelectric power plants at the following locations: Kidatu (Phase I, 1970-75, Phase II, 1977-1981, and Rehabilitation Phase 1, 1991-92), Mtera (Phase III, 1984-1988), and Pangani (Redevelopment 1989-1994). Support is currently being given to the construction of a hydroelectric power installation at lower Kihansi.

In addition Swedish support was used to obtain and install 2 of the 4 new gas turbines at Ubungo, Dar es Salaam in 1994.

In terms of power generation, Sweden has support hydro-power projects which have resulted in an installed capacity of 346 MW and an average generation of about 2000 GWh/year.

Main Conclusions

1. The projects carried out with Swedish assistance have, with a few minor exceptions, been completed on schedule and as budgeted. The plants at Mtera and Pangani Falls are functioning well. The plant at Kidatu is in poor condition and the rehabilitation carried out as well as that which is planned for the coming years is inadequate. This is serious, given that Kidatu is responsible for roughly half of the total electricity supply in Tanzania.

2. The plants at Mtera and Pangani are running well, perhaps in part because they are newer than the Kidatu Plant. The plant at Pangani has only been running for a little over one year. Serious attention should be paid to maintenance and spare parts for all of the installations, as timely maintenance and repair could reduce the need for costly rehabilitation at a later stage. This should be the responsibility, however, of TANESCO and the Government of Tanzania.

3. There is, in general, insufficient attention paid to long-term reservoir management in the Mtera/Kidatu system. While it is not possible to say definitively what the lower water and inflow levels at Mtera are caused by, it is certain that the resource is not being managed in a way which will avoid the need for load shedding in the near future. One alternative is to increase the generation capacity (which is being done), however it is clear that there is room for more sound and well thought out management strategies for the existing plants and reservoirs.

4. The level of technology for power plant operation has become increasingly modern. There has been no discussion of the pros and cons of computerised control and maintenance systems in the new designs.

5. None of the power plants or dams financed under the Swedish assistance can be said to have had major negative environmental impact. In spite of the lack of EIAs carried out in the earlier projects, the surrounding environment has been relatively well-documented and the serious environmental problems in the areas are not related to the power plant (i.e. brush fires, expansion of livestock and agriculture, spread of aquatic weeds).

6. Nor have there been serious socio-economic impacts on the surrounding population, primarily because there were so few displaced persons as a result of the installations. One exception to this generally benign pattern is the increased incidence of malaria in the Mtera area. Efforts to enhance the benefits of the power plant and water reservoirs to the local population have become increasingly serious over time

7. Energy assistance has followed the Sida policy guidelines as they have evolved over the past 30 years, including the increasing emphasis on the timely study of potential environmental impact. The emphasis on construction of new power generation facilities, which has been the primary activity supported by Sida, is *not*, however, in line with the most recent guidelines from 1995 and 1996. These more recent guidelines put a greater emphasis on institutional development, support to energy efficiency, environment and the development of a legal and regulatory framework. Future assistance will, then, have to shift away from construction if it is to be in line with the new guidelines.

8. There is a great need of restructuring of the power sector in Tanzania and in combination with that an institutional and competence strengthening of TANESCO which will enable TANESCO to develop as an independent company and also generate enough funds for operating the power system in a proper way.

General Recommendations

1. If the future Swedish energy assistance shall be in line with the guidelines from 1996, there should be a reduction in supporting generation and an increase in support to, among others, institutions (including TANESCO) and NGOs within the energy sector, rural electrification, DSM and other energy efficiency activities and on the whole, to activities directed to poor people and women.

2. More emphasis should be given to maintenance and rehabilitation of the existing hydropower plants, rather than on the construction of new ones. The wisdom of investing in new installations if TANESCO is unable to maintain existing plants should be called into question and the causes of poor maintenance analysed.

3. More resources should be focused on training and building up management capacity at TANESCO to maintain and manage the existing installations before funds are committed to building new installations. The existence of an appropriate and functioning legal and regulatory framework should be a precondition to any future support. One way of encouraging this is to require greater local participation in the investment costs.

4. The inflow rate and sources for Mtera reservoir should be determined in a thorough scientific investigation carried out by a team of scientists not connected to any actor in the conflict over water rights and water usage in the Mtera basin. This should be part of a larger attempt to devise a long-term management strategy for reservoir resources in the national system of hydro-electric installations.

5. In addition to an overall strategy for managing the hydro-electric resources, it is necessary to have a more efficiently integrated overall management system. Specifically, the use of thermal power needs to be planned in a long-term manner and production capacity extended.

6. The pros and cons of computerised control systems should be considered in future planning of power stations.

7. There are a number of specific recommendations regarding follow-up and missing pieces of information regarding environmental impact, however by far the most important measure is to allocate sufficient resources for early EIAs that have some chance of affecting projects while they are still in the design phase.

8. In the Kihansi project, (and other generation projects) take care of lessons learned from Pangani, mainly the need of close follow ups of mitigative measures concerning socio-economics impacts and also ensure that other conditions laid down by Sida are fulfilled.

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3 March 1997

Evaluation of the Swedish Support to Tanzania's Power Sector

Table of Content **Page**

Evaluation of the Swedish Support to Tanzania´s Power Sector

1. Introduction

1.1 Background

Sweden has contributed to the development of Tanzania´s power sector since 1967. Apart from a brief review and assessment carried out 1981, the Swedish assistance to the sector has never been subject to a thorough evaluation. Considering Sweden's position as a major donor since the late sixties within the power sector, and the current growing need of heavy investments in the country, an evaluation is now necessary. Sida has therefore decided to undertake an evaluation of the Swedish support over the years to Tanzania´s power sector.

In order to increase the effectiveness of the work of the evaluation team, a preparatory desk study, designed to provide an overview of all of the documentation available, was carried out prior to the fielding of the evaluation team, Appendix I.

1.2 Evaluation Mission Approach

In Appendix II the Terms of Reference for the evaluation are enclosed. In ToR the objectives of the evaluation are stated as:

i) To facilitate updated and improved informed decisions regarding strategies and investments on the part of the concerned bodies, actors and decision makers in Tanzania and Sweden, through in creased knowledge of the power sector and its needs, and any "lessons learned" that may be identified from projects assisted by Sweden

ii) To account for the results and the effects of the Swedish assistance to the sector.

The questions to be answered in the Terms of Reference are grouped in following sections:
- General aspects
- Economical aspects

- Technical aspects
- Institutional and competence development
- Environmental aspects
- Gender/poverty aspects
- Conclusions
- Lessons learned and recommendation for future co-operation

The Evaluation team has carried out the mission in the following phases:

- Analysis of documents available in Sweden and Tanzania, Appendix iV

- Visit to Tanzania with meetings and interviews with representatives of the Ministry of Energy and Minerals (MEM), TANESCO and Sida in Dar es Salaam, together with site visits to power plants built with Swedish contributions and on-site interviews with concerned managers and staff, Appendix III.

- Writing of draft report and complementary collection of facts and analysis

The evaluation has been accomplished during October - December 1996.

1.3 The Evaluation Team

The evaluation was conducted by a team of three independent consultants, namely Mr **Elon Dahlström**, economist, B. A. team leader (Elon Dahlström Verksamhetsutveckling AB); Ms **Melinda Cuellar**, M.Sc. agricultural/environmental economist (ORGUT CONSULTING AB); and Mr **Hans Peterson**, M.Sc. electrical engineer (Swedish S-E Asian Power Consulting AB).

1.4 Method of Evaluation

The team has carried out the analyses and structured the report on the basis of three distinct levels:

1. Project level (Chapters 4-6)
At this level the team has analysed Swedish supported projects in relation to the relevance and importance of the Swedish contribution. This analysis was structured using the following evaluation components as a starting point:

Relevance of the project
Preparation and Planning
Outputs, technical and economic

Efficiency in project execution
Impacts
Sustainability of the project
Evaluation of the project

The power system is a bridge to the next level which consists of generation and transmission lines. The analysis of this system is presented in chapter 7.

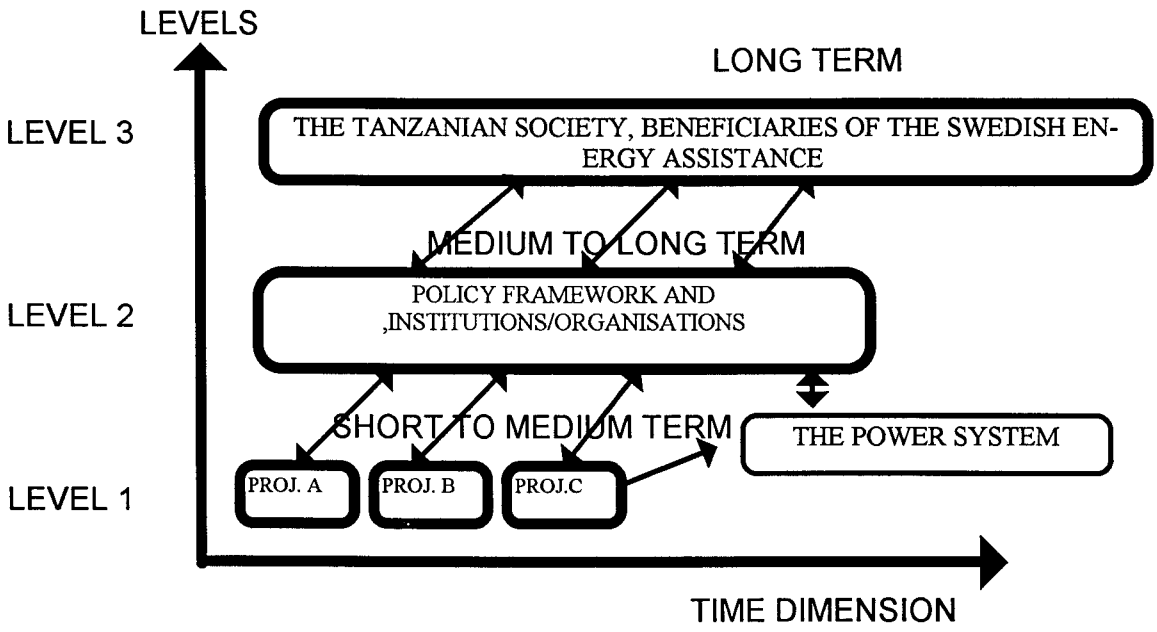
2. The policy and institutional level (Chapters 8-9)
At this level, the team has analysed the effect of Swedish support on the policy and regulatory framework and institutions/organisations within the electric power sector. The institutions concerned are mainly the Government of Tanzania and TANESCO.

3. The overall society (cost-benefit) level (Chapters 10-11)
Here the team has analysed the importance and effect of Swedish support on the Tanzanian society as a whole, including a more specific discussion of who has benefited from the Swedish energy assistance.

Parallel with the analyses on these three levels it is also constructive to have a time dimension.

The analysis model is illustrated in the following figure.

Figure 1



The analyses on these three levels then provide the basis for the conclusions in chapters 12 and also recommendations in chapter 13.

2. Tanzania - Economic Development, Surrounding World

A brief description of Tanzania's economic development during the past 10-15 years is presented in this chapter. An understanding of these changes is important as a general background to the development of the power sector. The relationship between power supply and economic development is, however, not linear. The level of economic development creates demand for electric power, at the same time as economic development is constrained by the supply of electric power.

There are also a number of macroeconomics factors, such as exchange rates and balance of trade, which are important to be able to understand some of the decisions taken concerning the power sector. Measured trends in the GDP have - as we show in chapter 10 - played a dominant role in load forecasting.

2.1 Economic Development

During the 1970's and first half of 1980's, all important sectors of the economy in Tanzania declined. The Government tried to stem the decline through the Structural Adjustment Program (SAP) in 1982. As the SAP did not seem to be enough, the Government launched the more radical Economic Recovery Program (ERP) in 1986.

The background to the ERP was, among other things, the enormous deficit in the trade balance; Tanzania was not able to finance badly needed imports without heavy reliance on grants and loans mainly from the World Bank, IMF and some bilateral donors. The major policy instruments under the ERP were exchange rate adjustments and liberalisation of trade and capital controls. The nominal exchange rate has increased from 32 TSH to the dollar in 1986 to about 600 TSH to the dollar 1996. Inflation rates have hovered around 30% in the 1990's, high by the standards of industrialised countries, but not unusual for a developing economy.

The ERP also included short term measures such as cuts in government expenditures, tax reform and attempts to control inflation through credit restrictions.

To some extent the reforms were successful, at least initially, as can be seen from macroeconomics indicators given in Table 1 below.

Table 1 **Macroeconomics indicators**

	1980	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	(+1996)
GDP, %		3,9	4,9	4,1	4,0	4,5	5,7	3,5	4,2	3,0	3,9	4,7
GDP per capita in current USD	290	270	220	180	140	120	110	100	90	na	na	na
Inflation,%	12,6	28,2	35,0	40,2	18,2	18,4	32,9	29,5	23,5	na	18,0	na
Population mill.	na	na	na	22,4	23	23,6	24,2	24,9	25,5	26,2	26,9	27,6
Prime Deficit as % of GDP	10,4	8,8	4,9	6,3	3,9	4,2	2,3	1,6	8,1	7,7	7,0	

Some trends in the table should be noted:

- The increase in GDP (growth rate) is quite good

- Inflation, while high, is stable and there are some signs of decrease in recent years.

- The fiscal situation has shown promising figures for many years, but the situation has detoriated rapidly from 1993. This is due to both unexpected expenditures and short falls in revenue which, in turn, are the result of a failed tax reform.

Altogether, it seems however as if Tanzania is performing quite well, but it still remains to be seen if it is possible to achieve two of the major objectives - poverty reduction and fiscal restructuring - simultaneously.

2.2 General Factors Influencing Decision-making at TANESCO

This evaluation of the Swedish support to Tanzania's power sector is made keeping in mind the information and opinions existing at the time decisions were made. While not all the thinking and arguments have been documented, there are some historical facts which influenced the decision-making environment.

During 1970's the world met with two oil crises. The first in 1973 illustrated the dependence of the western world on petroleum. The price of oil increased tremendously creating a significant financial surplus in some Arab countries and a significant deficit for many of the petroleum-importing developing countries. It was a common opinion that the dependence on imported petroleum must be reduced as much as possible. This provided the background for the early interest in hydroelectric power.

The second oil crisis occurred in 1979 when the price once more increased significantly. Another important domestic factor for Tanzania was the ERP, discussed above, which increased industrial production but also the demand for and consumption of energy.

The first years of 1990´s the extreme drought of sub Saharan Africa was also a major factor effecting the power sector. This widespread insecurity in regards to water supply was reflected in Tanzania and other countries with concern over the reliability of hydroelectric power.

A domestic event in Tanzania which also must have influenced decision making was the period with load shedding occurring between 1992-95. For whatever the reasons behind the load-shedding, the public pressure for better performance and increased supply of electricity on the part of TANESCO was intense.

3. The Energy Sector in Tanzania

3.1 Energy Resources and Energy Use

Tanzania has substantial and diverse indigenous energy resources, but the extent of exploration is relatively low. In addition to wood resources, the country has substantial coal and offshore natural gas deposits. Any commercially viable petroleum has not yet been discovered. Tanzania's hydroelectric potential is estimated at 3,800 MW. The installed capacity in the electric system is 377 MW hydro and 200 MW thermal.

Approximately 92% of the energy consumption in Tanzania comes from woodfuel, 7% from petroleum and 1% from electricity. In terms of the commercial energy demand, petroleum makes up more than 90% and electricity about 7% of the total demand.

The total energy consumption divided per category shows that households account for about 85%, industry 6%, transport 3%, agriculture 5% and commerce and others for 1% of the total consumption. Figures concerning the use of electricity show that the main users are residential 37%, light commercial 13%, other industrial and commercial 30% (see also section 10.2).

It should be observed that the energy sector in Tanzania (as in other Sub-Saharan African countries) is not an overall comprehensive energy system where resources can be transferred between different parts of the system. In reality, the energy sector in Tanzania consists of a series of separate sub-sectors with - at least in short and medium term - very little potential for trade-offs between them.

3.2 Organisation of the Energy Sector

As in most developing countries, the Government in Tanzania plays a dominant role in establishing and implementing energy policy. The Ministry of Energy and Minerals (MEM) is responsible *inter alia* for the electricity sector, including tariff setting and energy efficiency. Within MEM, the Department of Energy handles energy sector matters.

TANESCO, the wholly Government owned power company, is vertically integrated and is responsible for power generation, transmission and distribution on the mainland. The chairman of the board for TANESCO is appointed by the President, on the Minister's recommendation. Other members of the Board are appointed by the Minister for a three year tenure.

3.3 The Power System

The electric power system in Tanzania is based mainly on hydro power generation. The main plants are Kidatu and Mtera on the Great Ruaha river; and Hale and old and new Pangani on the Pangani river, Appendix V and VI.

Four new gas turbines have been installed at Ubungo, Dar es Salaam with a total capacity of 110 MW. The power plants are connected to a national grid with 220 kV supplying about 96% of the load. There are still a number of smaller towns and villages supplied from local diesel generators.

Both the Great Ruaha and Pangani rivers have good long term reservoirs. A constraining dimension for the expansion of the system is the availability of energy during years with low inflows. As droughts or a number of consecutive dry years are not uncommon in Africa, the system must be dimensioned to withstand these conditions. In addition, peak demand will be constrained during a few years in the near future when units at Kidatu will be taken out of operation for rehabilitation.

TANESCO can control load growth on the interconnected system by advancing or postponing the connection of isolated villages with local generation. They also have a backlog of 15,000 pending applications for connections, out of which 10,000 are in Dar es Salaam.

The interconnected system is controlled from a load dispatch centre in Ubungo outside Dar es Salaam. 24 substations on 220 kV and 132 kV are monitored. From this centre the release of water in Pangani is co-ordinated by the Pangani Water Management Board. The discharge from Mtera reservoir, as well as the amount of thermal power generation, is decided by TANESCO alone

In the control room there are one engineer and one operator per shift. The load has two peaks per day , the first at 11 and a second at 20 hours.

4. The Swedish Support to Tanzania's Power Sector

The total Swedish support to Tanzania's Power sector up to fiscal year 94/95 is calculated at 726 MSEK in current prices. To this sum should be added additional instalments for Pangani and also the Swedish commitment connected with the projects within the Power VI scheme. This makes a total of about 1 000 MSEK in current prices which is the total Swedish energy assistance to Tanzania from 1967 and up to the commitment for Power VI.

The sum of the Swedish support to hydro power projects and the gas turbines alone amounts to about 970 MSEK. The residual of 30 MSEK should then be the Swedish support to other studies and programmes within the energy sector as described in section 6 in the Desk Study. While this sum seems to be somewhat underestimated, an exact figure is, unfortunately, not possible to get. It can be assumed, however, that of the total Swedish energy assistance of about 1 000 MSEK in current prices, about 95% has been destined to hydro power projects and the gas turbines and the rest to other studies and programmes.

The total Swedish support to hydro power projects and the gas turbines of about 970 MSEK can be compared with the total costs for these projects of about 4 900 MSEK, all in current prices. The Swedish support to hydro power projects has, accordingly, amounted to about 20% of the total costs.

In terms of power generation, Sweden has supported hydro power projects which have resulted in an installed capacity of 346 MW and a average generation of about 2000 GWh.

It should be emphasised that the above figures are not exact, but they give an indication of the magnitude of different parts of the Swedish energy assistance.

5. Projects with Swedish Support

An survey of all the generation projects is given in Appendix VII.

5.1 Hydro Power Projects

5.1.1 Project selection and planning

TANESCO has had a least cost expansion plan as a basis for their system expansion. The plan has been up-dated regularly, e.g. by ACRES in 1984 and in 1989. In general, the projects from Kidatu Stage 1 up to Pangani have followed a least cost expansion plan. A reasonable certification has been made by TANESCO before the final decision to start a project by comparing different alternatives. In some cases reviews have been requested by a independent consultant.

Each project has been prepared in a pre-investment study and various appraisals by consultants appointed by the donors. The proposed project has been compared with other alternatives to make sure that the correct alternative is chosen.

The deviation from this approach is represented by the installation of the gas turbines, the two first financed by Sweden and the third and fourth by the World Bank. The alternative with gas turbines was selected because of time pressure, probably caused by the turbulence during the load shedding period .

The situation leading up to the years with load shedding could possibly have been studied in a better way by making more frequent system load studies and studies better illustrating the consequences during dry years. But the quality of these system studies has not been reviewed in-depth by the evaluation team as they were not carried out with Sida financing. (They were made by ACRES with financing from the World Bank.)

An more detailed analysis of the developments leading up to the load shedding situation is made in Chapter 7. If the difficulties ahead had been observed at an earlier time it is possible that some preventative measures such as an earlier start of diesel generation, energy saving campaigns or earlier installation of the gas turbines could have been initiated. The hydro power projects have a very long lead time and could probably not help very much. But it should also be pointed out that in a power system under expansion, such as the one in Tanzania, it is important to have a number of already-prepared projects on the shelf. The adjustment to the load growth should be made by varying the starting time for next project.

5.1.2 Efficiency in project implementation

Difficulties in the implementation of the projects are normally reflected in time delays or cost increases. But none of the projects show any significant delay or cost increase. One project, Pangani, was commissioned before time and to costs under budget. The planning for implementation seems thus to have been good.

The main problem which is reported is for Mtera power plant where bad rock necessitated a change of location for tail race gate. This in turn gave a different head for the turbine and caused cavitation. A different runner for the turbine had to be designed and new runners manufactured. The cost increases lead to a dispute about responsibility for the modifications which finally was settled in negotiations. The evaluation team has not tried to evaluate if the settlement was reasonable in terms of contractual responsibility for the situation.

To some extent has international competitive bidding been applied under the World Bank rules. The evaluation of the bids has not been reviewed by the team but neither have the team met any opinion from the interviewed persons saying that more efficient alternatives could have been selected.

One case where it could be possible that the contractor chosen was not the best alternative is for Kidatu. The bidding process and price competition might have contributed to the later development of problems due to problems caused by cost reductions for quality in design and erection. Another case might be the Chinese contractor for Lower Kihansi, who at least initially, caused much trouble with long delays.

From the inspection reports for Kidatu it is concluded that some of the problems are originating from the design of the cooling air for the generators which is carrying coal dust from the exciter to the generator. It was also reported that the exchange and repair of the piston for the guide vanes was not possible to make without removing the concrete where it was supported. As the basic design of such components has been the same for many years it seems unnecessary to have them in a plant built during 1970 by an experienced manufacturer.

5.1.3 Technology level

In the documents for the projects can be seen a number of investigations of different technical solutions for the installations. Examples are the choice between surface or underground plant at Kidatu, location for step up transformers under ground or in the switchyard. The choice between these alternatives are however not made with the background of selecting a technology level most suitable for a developing country like Tanzania. Once the preferred

technical alternative has been decided the prevalent technology for that time is being used.

The projects in Tanzania span over a period of about 25 years. During this time there has been a technical development in many areas which are reflected in the constructed power plants. Prime movers such as turbines and generators are in terms of technology level about the same for all the evaluated power plants.

For the control equipment there is a clear change in the selected technology for the different power plants. In the oldest power plants electro-mechanical relays has been used and in the latest a fully computerised control and protection system has been selected. Electro-mechanical relays can be greased and adjusted by a good technician locally. Later technology is increasing the dependence on the manufacturer.

The local technicians can exchange the electronic cards only. The faulty card must then be sent to the manufacturer for repair. This makes it necessary to have a good stock of exchange cards available on site. It is also necessary to have administrative and financial routines functioning which makes it possible to have a fast repair of the cards. Some of the cards are very expensive. The need for spare parts and funds in hard currency for repair is thus increasing for TANESCO.

The other aspect of the use of the modern computerised system is that it has a lot of knowledge built into it. The system is checking the status more carefully and giving alarm or blocking if things are not normal. So as long as the staff are not choosing to by-pass the alarms but repair or adjust the equipment the reliability will improve. But a prerequisite is of course that the concerned staff has the needed resources and knowledge to do the repair.

The only experience of a fully computerised control system is from Pangani which is coming up for the two year guaranty inspection soon. It is thus too early to come with a conclusion if the correct technology level was chosen.

But as an example of a not correct handling of a computerised system can be mentioned a leaking valve for the breaking system for one unit at Pangani power plant. The automatic start up sequence from the control system was observing the condition and did not start the unit. But the staff knew that the unit could be run anyhow. So the alternative was to start it with manual control from the local panel. When doing this the security built into the computerised control system was lost. The fault will be repaired during the guaranty inspection.

This incident is mentioned here only to illustrate the need for keeping the plant in perfect condition if the benefits from the mo-

dern systems shall be gained. And it can also be taken as an warning that routines and financial resources for maintenance must be reviewed if TANESCO shall benefit from the new technology.

The maintenance problems existing at Kidatu are not related to the technology level. The origin for the problems are cooling air arrangements, leaking hydraulic systems, leaking valves etc. which are related to quality of work and technical design and routine maintenance.

Assessment by the evaluation team
The selection of technology level has been an adjustment to the prevalent technology on the market. This has been the correct decision as there were no reasons for a deviation . But the chosen technology creates a need for having agreements with the manufacturer for delivery and repair of spare parts to be bought with hard currency. This dependence on the manufacturer is higher than for older solutions with discreet components where equivalent parts could be found. As this maintenance must be financed by TANESCO themselves it will increase the importance of having a financially strong and independent company.

5.2 Kidatu Hydro Electric Power Station

For Kidatu power plant Sida has participated in financing of four projects all related to building and rehabilitation of the power plant. Since they are closely related they are dealt with here in the same paragraph.

Stage I (1970-75)
Stage I included the construction of an underground power plant with two generators with a total capacity of 100 MW and a expected output of 580 GWh during the average hydrological year. It necessitated the construction of a regulating dam some 10 km upstream with an adjacent intake for an unlined headrace tunnel down to the power station. The power is transmitted to Ubungo transformer station outside Dar Es Salaam via a 220 kV transmission line.

The regulating dam is a relatively small earth-rockfill structure with a crest length of 350m and a height above the river bottom of about 40m. The storage capacity is 125 Mm3. The reservoir is located in a gorge with steep slopes. The water level is deep and concentrated to a small area.

The project was financed by Sida with 81 MSEK. Other financing organisations who contributed were World Bank and CIDA with a total of 193 MSEK.

Stage II (1977-1981)
In stage II the capacity at Kidatu was upgraded from 100 to 200 MW and the expected output raised to 1,300 GWh during the average year. It became apparent that the reservoir volume at Kidatu was too small to ensure water sufficient to run all four generating units year round. Adequate storage to safeguard the water supply in the dry seasons or ordinary years as well as during very dry years or a series of dry years was constructed about 170 km upstream at Mtera.

The project was financed by Sida with 90 MSEK. The total project cost was 351 MSEK. Other organisation participating in the financing were KfW and the World Bank.

Kidatu rehabilitation Phase I (1991-94)
A fault occurred in one generator at Kidatu in October 1989. The repair was extended into Phase I of a rehabilitation program which included, repair of generator 1, overhaul and change of the excitation systems for all generators and overhaul of turbines 3 and 4.

Kidatu rehabilitation Phase II (future project)
After rehabilitation Phase I, there are still significant rehabilitation needs at the Kidatu power plant. TANESCO signed a contract with Norconsult for inspection and definition of remaining needs for rehabilitation. The result is presented in a report and in a project document submitted to Sida. The total cost for a full rehabilitation amounts to 150 MSEK. The different items are assigned with priorities from 1 to 6. The planned rehabilitation, to cost of 74 MSEK, will only include priorities 1 and 2. This means that repair with priority 3 to 6 will be postponed.

5.2.1 Relevance of the project Kidatu Power Station
The year 1968 when the project was initiated the load was about 250 GWh. The plan to build an power plant with an output of 1300 GWh per year must then be seen in a perspective of creating the conditions for an economic development in the country. With the background of the oil crises which came during 1973 and 1979, but which could not be foreseen when the project was started, the domestic hydro power generation was very beneficial for Tanzania. It protected Tanzania from much of the difficulties which hit other developing countries in the form of financing problems for rising costs for oil import. With this background the project must be considered as very relevant for Tanzania.

5.2.2 Preparation and Planning
Each project has been prepared by a preinvestment study defining the project and forming the basis for the decision by the financing organisation. In many of the studies has also been included a com-

parison of alternative investments. An example is the first choice between investments in Wami or Great Ruaha river.

The preinvestment study from Kidatu stage I includes a description of extensive efforts for collection of hydrological data for the planned project. With the background of the discussions later in appendix VIII about the inflow to Mtera reservoir it should be said that there is no reason for criticising the efforts made to collect the best possible information as a base for the planning.

5.2.4 Efficiency in project execution

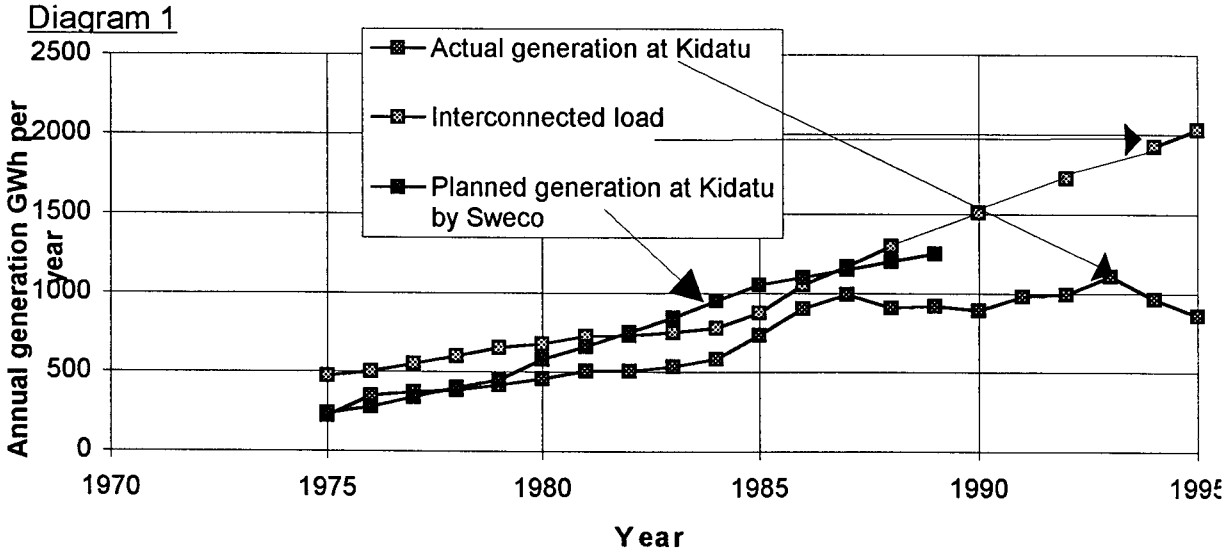
The construction projects have been implemented within planned financial and time limits. For the rehabilitation and repair project there is a extension with 2.5 MSEK. This can not be considered as very severe in a rehabilitation project where often unforeseen costs occur when the work has started.

5.2.5 Evaluation of the project

Generation capacity

The objective of building a power plant with a installed generating capacity of 100 MW in stage I and another 100 MW in stage II has been fulfilled. The generated energy is compared with the planned output in the diagram 1 below. It can be seen that there is a good correspondence during the years 1975-1980. Between 1980 and 1985 the generation is lower than planned. The reason seems to have been the low growth of the load during this period. After 1987 the output has been around 1000 GWh per year and the planned average of 1250 GWh per year has never been reached.

Diagram 1



The explanation for this can be found either in the fault on one of the generators which occurred in October 1989 or in discrepancies in the statistics for the inflows. As the difference is of very big financial value for the project a more detailed analysis can be found

in chapters 7 and in Appendix VIII. The most probable explanation seems to be that the inflows are lower than expected in the pre-investment study.

Maintenance

After the completion of the rehabilitation phase I it was obvious that it remained a need for further rehabilitation. As mentioned above, a review of the condition of the power plant has been made by Norconsult. Even a relative short visit to the plant makes it obvious that there is an urgent need for a major rehabilitation like the Rehabilitation phase II project. There are leakages of oil and water and complaints about coal dust which creates a very bad technical environment for all equipment inside the plant. There is an oil film inside the new cabinets for the excitation system which makes dust stick to the surface.

The upper limit for local purchase by the power plant of spare parts and consumables is 500,000 TSh (about 6,000 SEK). All requests for purchases which include hard currency, must go to the Head Office in Dar Es Salaam. Approval for opening a letter of credit must be obtained from the National Bank.

Examples were shown of requests for spare parts submitted by the power plant in 1994 which had been approved after two years. The Purchase Department at TANESCO has no technical staff and are thus unable to assign priority to requests.

The technical reason for the fault on unit 1 might be related to the design for cooling on the generator. Cooling air is taken from the exciter and thus carrying some amounts of coal dust when it is arriving to the main generator. It is important that this and other observed weaknesses in the original design are eliminated during rehabilitation phase 2

It took two years from the fault occurred until the project with the repair started. As this repair had a pay back period of only 37 days this seems unacceptable. TANESCO could not give any explanation of the reason for this delay.

The very long times for decision making makes it clear that some of the difficulties can be found in the organisation and delegation of authorities to various levels. The time of two years for deciding about the repair is nor acceptable. Even if nobody 1989 was foreseeing the coming load shedding period it is not acceptable to have one generator out of service for such a long time and spill the water. If funds shall be requested from donor organisations like Sida or the World Bank it must be accepted that the preparation time is quite long, if it is not a clear emergency situation. If TANESCO shall be the owner of such big assets as Kidatu it must also have the financial strength to deal with this kind of faults without outside assistance.

If the decision about repair was a question of authority given to TANESCO top management by the Ministry, the question of purchase of minor spare parts and consumables is a question of delegation of authority inside TANESCO.

Training and transfer of technology
During the first phase of Kidatu there was very little transfer of technology. This can be understood as the project was mainly about design and construction of the plant by the contractors. In phase II was included delegation of expatriate staff from Sweden and India to support the operational staff. Ten operators were sent to Kafue Gorge for training during the initial period of operation. Some of them are still working at the power plant. Among the early trainees at Kidatu was the present Director General, Mr Luhanga, and the present power plant director. In Phase II TANESCO was more active and learned a great deal.

Interviews made with the staff during a short visit to the plant indicates that they have good knowledge about their plant and equipment and that the training has been efficient.

5.2.6 The Evaluation Team's Assessment of the Kidatu project

The two construction projects at Kidatu in building a 200 MW power plant for a power company without any previous experience in building, operating and maintaining such installations has been quite successful.

However, the annual average energy output which was planned to be 1250 GWh per year has not been reached. The deficiency of about 300 GWh per year represents a value of about 36 MUSD per year if valued at the cost of gas turbine generation. The statements about unauthorised subtraction of water for irrigation purposes must be clarified by an independent mission.

The rehabilitation project Phase I was a mixture of fault repairing and rehabilitation. It left, however, the plant with a big remaining need of rehabilitation which should be completed as soon as possible. The planned and decided rehabilitation project Phase II is thus necessary. The Phase II rehabilitation will cover only items with priority 1 and 2 while others will be left for the future. This means there will be a pending rehabilitation project Phase III. As the power plant is producing about 50% of the electricity in Tanzania, Kidatu Power Station will be very important for many years in the future. The main installations are in good condition. It should therefor be investigated if additional financial resources can be made available so that the rehabilitation project can be said to have been completed and the responsibility for its performance given back to the power plant management.

The staff at the power plant have received training in operation and maintenance of the power plant. The organisation, routines and resources available for TANESCO and the power plant show some weaknesses which must be addressed. If TANESCO shall be in a position to benefit from the technical and management training it has received it must be financially stronger and more independent in its decision making. The authority to decide about purchase and repair must be closer to the staff which has received to technical training.

Environmental observations and assessment in Great Ruaha River

There were no environmental studies made for the Kidatu project, although substantial information was collected concerning geology, sedimentation, hydrology and other aspects of the physical environment which directly affected the functioning and economic feasibility of the power plant.

Measurements of water quality downstream from the power station were made in the early 1980's (EIA for Stieglers Gorge - RUBADA/ Euroconsult) and indicated some problems, but these have not been followed up. The staff at the power station have no knowledge of water quality measurements having been carried out.

The power plant itself at Kidatu is not in optimal condition and there are oil leakages in the turbine areas. The possibility that these then leak out into the river should be checked, although the amount being leaked does not seem to be enough to have any significant polluting effects.

There are no serious environmental problems in the Kidatu area which can be traced to the existence of the power plant. There is a need to monitor the situation, however, and especially to check water quality downstream from the power station. In the future, the increasing settlement in the Catchment area, with related problems of afforestation and soil degradation, could pose a problem for the dam in terms of sedimentation. Sedimentation levels, as well as temperature, pH, bacteria, heavy metals, etc. could be checked as part of the water quality studies.

Fishing appears to be limited in the reservoir itself but there is fishing being carried out upstream. Some water is being released into the old river bed due to leakages in the dam gates. There are also small tributaries from the surrounding mountain areas which empty into the river bed and contribute towards the maintenance of a steady flow of water. Water hyacinth has not been observed.

Far greater environmental problems in the area are those arising from the extensive burning of large parts of the Catchment area which are covered by Miombo woodlands. These bush fires result

in a decreased number of species, a lessened stability of the eco-system, long term decreasing soil fertility and all of the negative effects of disturbing the vegetative cover and an increased susceptibility of soil erosion and sedimentation.

The fires are started by the local population to eradicate tics and tse tse flies, clear agricultural land, and encourage the growth of fresh grass for grazing. This practice is widespread, thousands of hectares of recently burnt miombo woodlands were observed by the evaluation team in the catchment area, including substantial areas of the Udzlunga National Park.

According to information given to the team an extensive study of socio-economic impacts from the construction of a hydro power station was made at the time for the construction of Kidatu. However, the study has not been published and the evaluation team has thus not observed any documented observations of any kind of socio-economic impacts from Kidatu. From the visit to Kidatu the team could observe that the construction, and then of course the running of the station, has implied an inflow a people and in general a positive economic stimulants to the surrounding areas.

5.3 Mtera Power Plant (1984-1988)

An 80 MW underground power station at Mtera was constructed to take advantage of the head. The water is redischarged into the river bed through an 11 km long tailrace tunnel.

Sida's contribution to the financing of the project was 135.3 MSEK out of a total cost of 245 MUSD. The Swedish contribution was divided on 3.3 MSEK for studies and 132 MSEK for the plant. Other financiers were IDA, KFAED, MCC, KfW and NORAD with a total contribution of equivalent about 1 090 MSEK.

There has been no release of water into the desiccated river bed since 1990. Before that the dam was 'spilled' during the wet season.

Relevance
The development of the consumption on the interconnected grid made it necessary to plan for additional generation capacity. At this time shortly after the second oil crises and with the Mtera dam under construction it was natural to consider a continuation at Mtera.

Preparation and Planning
The project was prepared by a preinvestment study made by Sweco. The study included also the necessary reinforcements and extensions of the transmission system up to the year 1990.

Evaluation
Generation capability
The annual actual generation from the power plant is shown in Appendix VIII, Table 2 and Diagram 1. The values for 1990-1994 are higher than the expected average. But it should then be observed that the discharge of water from the reservoir has been higher than the inflow so that the reservoir from 1993 was left at a very low level as can be seen in Appendix VIII, Diagram 2. The average annual production for 1990-96 is 388 GWh, more than the planned value of 320 GWh. But it is based on seven years only which is a too short period for estimating the average. During this period the reservoir has been emptied. This has increased the average for the seven years with about 105 GWh. If a correction for this is made the average will be 283 GWh which is lower than planned. The calculation of inflows indicates that the actual inflow is lower than expected during the design.

Even if the time for calculation is short there seems be reason to believe that the planned energy output not will be fulfilled. The designed capacity of 84 MW has been reached.

Technical and maintenance evaluation
The power plant is built with technology from a later date than that of Kidatu. One difference in the design is that the step up transformers are placed above ground on request from TANESCO. This has resulted in some problems with monkeys causing flash-overs on the 11 kV bushings.

During construction and initial operation it was observed that there was cavitation in the turbines. A modified runner was designed and all runners were modified including a spare runner. This caused a need to take units out for the replacement and additional costs in the project.

The power plant is in good condition. It is quite clean with the exception of some small oil leakages. The equipment for control and protection is more modern than for Kidatu. Electronic relays are installed. It was observed, however, with some surprise that the plant did not have any computer as a support for operations and maintenance.

The total number of staff at the plant is 182 persons, out of whom 42 are women. Staff reduction are currently under way and the security staff is being reduced. The manager said it is difficult to recruit staff to Mtera. In his opinion he is short of about 10 techni-

cians and has lost staff to private enterprises. There are still about 10 people working at the plant who participated in the construction work. (There was no expatriate staff during the first years of operation.)

The low level of the Mtera Reservoir is a continuing problem in the operations of the power plant. In the opinion of the power plant management the amount of water used for irrigation purposes in the catchment area is perhaps as much as 1/3 of the inflow. If the inflow is around 50 m3/s it should mean something like 10-15 m3/s is taken for irrigation purposes. (This issue is discussed in greater detail below under the heading 'Water Rights and Abstractions in the Catchment Area').

Mtera Dam and Ecosystem

From an environmental point of view, the most extensively studied reservoir in the Tanzanian hydropower system is that at Mtera. These studies are of great interest, mainly because comparable observations over a twenty year period can be made. They are also interesting because the relative lack of human and industrial activity in the area makes it easier to see the direct impact of the reservoir on the ecosystem. While the observations have a significant scientific value, it should be remembered that these studies were primarily carried out to ensure the smooth functioning of the power plant and do not represent an environmental impact analysis in the sense which it is understood in more recent hydropower projects.

Construction of the Mtera dam was finished in late 1980. It is a concrete structure of the buttress type with the crest level at 701.5 masl, about 45 m above the river bottom at maximum height. The total crest length of the dam is about 260 m.

Filling of the reservoir began in December 1980. The full supply level (F.S.L), 698.5 masl, was reached for the first time in April 1984. At this level the reservoir has a surface area of approximately 660 km2 and a volume of 3800 million m3. At minimum supply level (690.0 masl) the area is 200 km2 and the volume is about 600 Mm3.

Water levels in the Mtera reservoir are shown in Appendix VIII, diagram 3. It can be seen that full supply level (or almost) was reach every year between 1985 and 1990 but never during the period 1991 to 1994. Minimum supply level was reached for the first time in December 1994. The level measured 693.78 masl during the time when the evaluation team made its site visit in late October 1996.

Geomorphology and Sedimentation
The reservoir is situated in the centre of a natural sedimentation basin, where in fact a large lake once existed during the period of the geological development of the Rift Valley.

Studies of the sedimentation patterns after 1993 indicate that the relatively low sedimentation rate calculated prior to inundation have proven to be accurate, or higher than the actual sedimentation rates being observed. Most of the sediment yield comes from seasonal streams draining agricultural and grazing land. However, most of this sediment is deposited in low gradient grass plains before reaching the shores of the reservoir. It is estimated that about 0.5 million tons (0.3 -0.7 million m3) per year may influence the live storage capacity. However, it should be remembered that this represents a maximum of 0.00023% of the total live storage capacity on an annual basis. (based on the upper range assumption that the sediment volume is 0.7 million m3)

Limnology and Water Quality
It has been observed that despite the decrease in the size of the reservoir in the 1990's, yields have been steadily increasing and that peak yields are still to be reached. The water quality data reveal no major changes from the preimpoundment levels.

Floating Woody Vegetation and Aquatic Weeds
Close observation in the post-impoundment period has revealed, that no accumulation of debris has occurred at the booms or the spillways of the dam or at the trash racks of the intake to the power station, nor has there been any problems vegetation or weeds.

Wildlife and Birds
To protect the wildlife in the near-by Great Ruaha National Park the Tanzanian parliament established a game controlled area (Lunda Mkwambi) to provide a protected access from Great Ruaha to the reservoir.

Hippos and crocodiles are reportedly frequent and together with elephants, black-faced vervet monkeys and yellow baboons regarded as a nuisance. A decrease in the number of Greater Kudus, Impalas, Zebras, Buffaloes and lions is reported, while the number of giraffes seems to remain unchanged.

Bird fauna changed significantly in the period following impoundment. While the creation of a huge expanse of fresh water has increased the bird species diversity, it is estimated that there has been little positive or negative effect on the resident species.

Land Use and Economic Activity Along the Shorelines
Since many of the economic activities are related to fishing, they are a direct result of the creation of the reservoir and benefits can thus be measured in spite of the scarcity of baseline data.

Only one village (Old Mtera) with 4-500 villagers had to be relocated. The construction phase caused an economic boom and population explosion as people migrated to the area to take advantage of employment possibilities in construction and also fishing opportunities and related commercial and service activities

Thus, while the main activities carried out prior to the creation of the reservoir were pastoralism and agriculture, today the dominant economic activity is fishing, followed by pastoralism, agriculture, formal employment and petty trade.
The ethnic composition of the local population has also changed. Now the Mtera basin houses almost all the ethnic groups found in Tanzania, especially in the fishing villages. One interesting sociological development has been the significant in-migration of female entrepreneurs in fish processing and trading.

In spite of the increasing population of the fishing villages no widespread erosion or overgrazing is visible in the areas surrounding the villages.

TANESCO has made efforts to provide electricity to the fishing villages and investments in chilling equipment for fish have been made. Provision of electricity to the local communities has a potential for stimulating economic development in the area and ensuring local co-operation.

TANESCO now runs three kindergarten for staff children, and also a dispensary which is open to some extent for other people than the staff at the station. There are, however, problems with school after primary school in Mtera, as the secondary school is far away and has no boarding facilities. This fact has obviously a negative effect when recruiting staff to the station and this issue should be paid attention to from TANESCO as there are quite a lot of vacancies in Mtera station staffing.

Water related diseases
Malaria: The measured density of mosquitoes is four times higher in the fishing villages which have developed along the shores of the Mtera reservoir than in those areas pre-impoundment. The prevalence of malaria in the population has doubled (from 23.5% to 50.4%) after flooding. Besides that no problems with other water related diseases.

Water Rights and Abstractions in the Catchment Area
Upstream of the confluence of the Great Ruaha and Little Ruaha Rivers, there exist artificial swamps which some researchers claim retain water that would otherwise flow into the Mtera Reservoir. As a consequence of the swamps so created, more quantities are getting lost through evapotranspiration.

This causes immense problems to downstream users, particularly the hydropower production and an increasingly important issue for the management of the Mtera reservoir is that of the optimal upstream abstractions.

The low level of the reservoir in December 1994 (only 15 cm above minimum) caused disruptions in the power supply and widespread load shedding during 1993-1995. The lack of alternative thermal generation capacity did not allow for proper management of the water shortages early on. While reliable rainfall data is difficult to obtain, it appears that the less than usual levels of precipitation did not account entirely for the low levels of water in the reservoir.

Hydrology reports are conflicting, some say that the abstraction from the rivers where irrigation activity is prevalent (Little Ruaha and Kisigo) is removing less than 5% of the total inflow, however these calculations are based on the water *rights* granted for abstraction, not on actual measurements. TANESCO staff at the power station and reconnaissance studies carried out by TANESCO researchers point to the significance of this abstraction as being much greater, perhaps as much as a third of the total inflow. This volume corresponds roughly to the total inflow of the Little Ruaha River. It should be relatively straightforward to measure the inflow of the Little Ruaha River and illuminate whether or not it contributes to the inflow at Mtera reservoir.

In addition, while the legally mandated abstraction rights and irrigated area is known, there is little or no measurement of the water actually being diverted to irrigation schemes. (For a more detailed discussion of inflow calculations and indications that there may have been some flaws in the calculations made in the original pre-investment study upon which all current estimates are based, see the section dealing with the technical performance of power stations at Kidatu and Mtera.)

In appendix VIII is a calculation of inflows to the reservoir based on the production in Kidatu and Mtera during the years 1990-1995.

5.4 Improvements in the Grid System Voltage

This project consisted of the installation of 3x15 Mvar mechanically switched capacitor banks at Ubungo in order to handle the frequent low voltages in the east part of the Grid System. This project appeared to be very relevant; the output was estimated to give TANESCO further about 85 000 MWh to distribute and sell per year in the area of Dar es Salaam with an yearly increase in income of about 5.1 MUSD. With an investment of about 1.6 MUSD the pay back time was only some months. To this output should also be added the gains for the customers with a more reliable supply of electricity.

However, the evaluation team has observed with some surprise that it took more than two years from the time when problems were identified and well known until measures were taken. This is all the more surprising bearing in mind the relatively minor installations necessary and the obvious yields.

5.5 Pangani Falls Redevelopment Project

Relevance of the project

A pre-feasibility study carried out 1985 concluded that Pangani Falls Redevelopment Project appeared to be feasible. A feasibility study carried out in 1989-1990 concluded that the Pangani Project was the best investment option to meet Tanzania's growing need for electricity energy. One important basis for this conclusion was the quite strong increase in measured load in the interconnected grid system from 1985 to 1990, fully 10% per year. For the future load growth during the 90's the feasibility study from 1990 predicted the same rate in increase, 10-15% per annum.

The urgent need for a new hydro power station as soon as possible was compounded by the fact that TANESCO at that time (1990) had decided not to install new thermal units.

A group of donors from Norway, Finland and Sweden commissioned an appraisal report to be prepared by Swedpower. This study arrived to the same conclusion as the feasibility study mentioned above. This conclusion was based on an analysis of three different load forecast scenarios presented by ACRES in the review of the Sector Development Plan from 1989. The scenarios differed in assumed growth rates of GDP 1988-2020 and then consequently also in growth rate of demand of electricity. Scenario A assumed a growth rate of 4% from 1992, scenario B 3.5% and scenario C 4.5-5.0%.

According to the consultant there were no indicators to support a forecast with a lower growth rate than Scenario A. The consultant also pointed out that the capacity utilised in the industry was (in 1990) still around 30% but could be expected to increase to about 60% in three to four years time. The consultant's view was that Scenario A should be followed as the baseline scenario.

The appraisal report also estimated the available capacity in May 1990 to be only 266 MW from hydro-electric generation compared to installed capacity of 333 MW, depending on that Unit 1 in Kidatu was not in operation. Similarly, the consultant estimated that the *available* capacity from thermal generation was only 30 MW, (compared to an *installed* capacity of 109 MW), due to poor maintenance and lack of fuel.)

Preparation and planning
The environmental and socio-economic consequences of the project were studied and assessed in an early phase of the regular planning process for the construction of the hydro power plant. The conclusion was that these consequences would be limited. The establishment of the Pangani Basin Water Board for water management and a Community Development Programme to be carried out in the surrounding villages were included as project components.

Outputs
The projected output goals for the project as stated in the LFA-matrix in the Project Document have, to a great extent, been met by the actual output from the power station.

The projected firm energy was set to 313 GWh per annum, which can be compared the actual production of 309 Gwh during 1995, the first entire production year at Pangani.

The visit of the evaluation team to Pangani, including an inspection of the station and surrounding areas, the Water Board office, and interviews with managers for operation and maintenance, confirmed the conclusion in the review done 1995, see below, that other project objectives had also been met.

Technology transfer and training programmes have been very extensive and very successful. These programmes still appear to be functioning well, according to the team´s observations at the station. Routines for operation and maintenance have been established and function well.

Efficiency in project execution
The project was executed in a very professional way according to the 1995 Review: the station was commissioned in mid December 1994, 3-4 months ahead of scheduled time and well within the budget.

Evaluation of the project
An Independent Review was carried out by Swedpower in 1995. The conclusions from the review were very positive with some few exceptions:

- The monitoring undertaken of the socio-economic impacts had been fragmented and superficial. The socio-economic impacts discovered and mitigated were, how ever, relatively minor and had been handled in a satisfactory way.

- The PULIS activities were organised and implemented too late to satisfy the objectives and scope described in the Project Document.

- The gender or equality dimension was nowhere explicit in either the Environmental and Socio-Economic Monitoring and Mitigation or in the PULIS activities.

The team's observations of the follow-ups from September 1995 up to October 1996 show that the monitoring has been improved. From these follow-ups it can be noted that the Community Development Programme on the whole has had many positive and sustainable effects in the villages.

The final completion report has not yet been issued; however it will be submitted by the end of 1996 or early 1997.

Environmental Impacts

The Pangani river basin is relatively small in the Tanzanian context (42,200 km2), but, in contrast to the other major hydroelectric installations at Kidatu and Mtera, is located in an economically developed and populated area with substantial alternative demand for the water resource and significant shoreline activities with a degradation/pollution potential. The more significant water users in the area include the Tanganyika Planting Company (sugar estate), Lower Moshi Irrigation Scheme, Nyumba ya Mungu Power station (8 MW), Hale Power Station (21 MW), Old Pangani falls (15 MW), New Pangani Falls (66 MW) and a number of abstractions for commercial and industrial uses.

Sida support has been directed to the redevelopment of a modern hydro-electric power plant in the vicinity of two existing hydro-electric stations (Hale and Old Pangani), one of which has been in existence since the 1930's and already caused the drying up of the original Pangani Falls. Thus, the only major environmental change brought about by the redevelopment project is the drying up of a 2.5 km stretch of the Pangani river.

Environmental Impact Studies

The Pangani Falls Redevelopment Project itself was being discussed as early as 1986. Preliminary investigations in 1989 revealed no social or environmental impacts so adverse that the project should be halted and this is also the reason given for confining subsequent studies to the so-called DIZ (Direct Impact Zone). The initial investigations were carried out mainly by specialists from the University of Dar es Salaam. These, then, were edited by an environmental scientist from a separate (neither IVO nor Norplan) consultancy firm and the conclusions synthesised into an EIS by a specialist from Norconsult.

An Environmental Impact Statement (EIS) was produced in 1990, in connection with the technical and economic studies carried out between 1988 and 1990. Later, in 1994, an Environmental Impact Analysis was produced based on research carried out between

1991 and 1994 by six members of the staff of the University of Dar es Salaam and seven staff from Norconsult (Tanzania) Limited's environmental and socio-economic services section.

Later (in 1995), this EIA was strongly criticised by an independent review financed by Sida and carried out by SwedPower. (see below). Environmental Monitoring Reports have been produced by Norconsult staff in 1995 and 1996.

Environmental Problems Associated with the Project

The initial EIS (1990) did not cover aquatic ecology nor orinthology. Nor did it identify any rare or endangered plant species in the riverine forests. The African Violet, *Saintpaulia tongwensis*, (identified by later reports as a rare species needing conservation measures) is not mentioned in the checklist of vegetation in the project area included as an appendix to the EIS. The Black and White Colobus monkeys whose habitat would be affected were predicted to move to other areas and thus adapt to the changes.

Most of the negative affects of the project and reported in the EIS were those associated with the building phase. The independent review in 1995 reported that the pollution caused by poor management of the construction sites had been mitigated. A summary inspection of the facilities by the Evaluation Team indicated that tree planting and other landscaping and clean up measures recommended by the EIA have been carried out.

The African Violet

The problems of the destruction of riparian forest habitat and the threat to the rare and endemic *Saintpaulia tongwensis* is an interesting one to follow in the project documentation. The plant was not even mentioned as existing in the area in the appendices to the original EIS. The 1994 EIA confirmed its existence, its rarity, and its endemic habitat as that of the riparian forests near Pangani falls where the ground and air moisture levels were affected by the river diversion necessary for the power plant.

Great efforts were made to locate areas with similar microclimatic (including latitudinal range, temperature range and species composition) and soil conditions and a number of plants were transplanted to new habitats such as Kwamgumi and Sigi. (see table below)

Table 2

Location	District	Number of Plants		Percent
		Feb.-95	June 1995	Surviving
Pango la Chui (Original site)	Korogwe	100	130	130
Ngelezi Forest	Korogwe	15	15	100
New Power Station	Korogwe	15	15	100
Kwamgumi Forest	Tanga	37	8	22
Sigi River Forest	Muheza	33	10	30
All five sites	Region	200	178	89

Some plants were transplanted to adjacent forests with slightly different conditions. It is striking that those transplanted to similar habitats have done poorly, those moved to a nearby forest have done somewhat better and that those which were left in their original site have developed thickened stems to adapt to the decrease in moisture and are flourishing.

A recent (1995) study of the transplanted *S. Tongwensis* recommended that monitoring be carried out to detect hybridisation of the transplanted violets with other species of Saintpaulia as such an outcome would necessitate killing the transplanted violets and the hybrids. Financiers of these activities can hope that the transplanted violets die before they hybridise.

Water Hyacinth

The presence of Water Hyacinth, *Eichhornia crassipes*, was noted prior to the hydroelectric redevelopment project, however the creation of a small (1 Mm3) headpond adjacent to the intake of the new power station has created an environment where this noxious weed flourishes. There are a number of undesirable effects of the weed in aquatic environments, but it is also a potential impediment to water flow into the intake gates of the power plant so that TANESCO is highly motivated to remove the weed as quickly as possible. It has been reported that the weed covered the entire surface of the headpond at one point, however, with daily manual extraction activities, it was observed only along the shorelines when the evaluation team made a site visit.

Water Pollution

One of the more serious side effects of the construction phase has been the unforeseen pollution of the desiccated stretch of river by explosive waste disposal at the tunnel access and the current leaching of chemicals from the rock spoils and fill near the tunnel access and crusher sites. The tunnel access waste was slurry, fuel and hundreds of litres of dirty oil spilt on the ground and into pit la-

trines during the early stages of the project. (This practice was later stopped)

The contamination is noticeable in a small area, where bacteriological slime and oil slicks are observable. However, the water quality parameters above the headrace and downstream of the tailrace are virtually identical, which points to the probability that the significant local contamination does not create a serious downstream impact.

Here it is of utmost importance to continue monitoring water quality, in spite of the fact that the Independent Reviews (SwedPower) have repeatedly recommended that this activity be discontinued.

Problems with the EIA for Pangani Redevelopment

The use of EIAs in project planning is a relatively new phenomenon, and lessons of how to best implement them is an experience being gained in the 1990's. The EIA carried out in connection with Pangani has had a number of shortcomings which can contribute to this pool of lessons learned.

The intention to incorporate environmental considerations into the planning process for Pangani Redevelopment was present, however this was carried out with uncertain funding and hasty field research towards the end of the planning phase (1989). The initial EIS pointed to a number of areas which needed further study, however there was no time for this to be done before the project began to be implemented.

The more comprehensive EIA document produced in 1994, while understandably more ambitious than the EIS, also had a number of shortcomings. Baseline studies and inventories of plant and animal life have been piecemeal and slow to be completed. The Independent Review criticised the lack of systematic mapping and information on hydrology, climate, vegetation, land use, soils and physiographic features. It also highlighted the lack of a discussion of land use and water conflicts.

The follow-up activities appear to be a shared responsibility between local authorities (PBWB for water quality), the University of Dar es Salaam, the National Environment Management Council (NEMC), and the implementing consultant. The follow-up reporting has been carried out for about two years now and it is rather early to analyse if this is a workable system. The rather prominent role of the implementing consultant, how-ever, does raise issues of the impartiality and long term institutionalisation of these assessments.

The Evaluation Team´s Assessment of Pangani

Against the background of the strong growth in measured load during the end of the 1980´s, a new hydro power station at Pangani Falls appeared at that time (1991) to be a wise investment.

Perhaps Sida in this situation also should have done a closer evaluation of the investment in Pangani as compared with investments in improved capacity in the already existing generation plants.

The project was, with exception for some shortcomings concerning EIAs, thoroughly prepared and planned, the project was professionally executed, well ahead of schedule and below budget. The projected economical and technical outputs have been or will most likely be met. The transfer of technology and training have been extensive and successful.

The Community Development Programme in connection with construction of the power plant was, to some extent, overly ambitious, but many of the planned activities were organised and implemented too late. Moreover, the team wishes to point out that the gender/equality dimension was not satisfactory handled in the Community Development Program in connection with the construction of Pangani Power Station.

Some experiences and lessons learned from the planning and implementation of the Community Development Program and the PULIS-activities:

- Some activities started during construction period have not been fulfilled after project completion, mainly because of lack of funding from the local and central governments and little participation on the part of the villagers.

- A community development programme like this should be worked out together with the local and central governments and have their full support.

- These bodies should also be committed to fulfil activities after the construction period.

- The concerned villagers should be mobilised in early phases of the programme.

- A Community Development Programme should be on a level where it is possible to fulfil the activities started after the completion of the station

Some environmentally disturbing activities took place during the construction but were then taken care of. There has been a lack of systematic mapping and information on hydrology, climate, vegetation, land use, soils and physiographic features. The Review from 1995 also highlighted the lack of discussion of land use and water conflicts. This issue is very important and the Evaluation Team wants to stress that the Water Office Board pays attention to this issue and collaborates with the local users of water.

The environmental impacts of the project have, on the whole, been quite benign and the Team can not see any overwhelming problems in the near future.

In summary, the evaluation team makes the assessment that Pangani is, to a great extent, a successful project.

5.6 Dar es Salaam Gas Turbine Project

The project includes the planning and installation of two gasturbines of type GT10 at Ubungo outside Dar es Salaam. It also includes an operation management contract for the units up to 1997.

The gasturbines were financed by Sida with 206 MSEK. Other donors were NORAD and WB. The operation management contract is financed by Sida

Relevance of the project
The project was initiated as an emergency project to relieve the problems caused by the load shedding situation. The next planned expansion in hydro power generation after Mtera was Pangani which was planned for 1995. TANESCO met with difficulties of supplying the load after 1990 because of the high loadgrowth and the low inflow to the Mtera reservoir. The only existing alternative for fast reinforcement of generation capacity was, then, gas turbines

The justification of the installation was made by Acres under a contract with the World Bank.

Preparation and planning
The project was initiated 1992 and completed in very short time. Two gas turbines with a capacity of 18.5 MW each were commissioned in 1994. Two units with a capacity of 35 MW each, financed by the World Bank, have also been installed on the same site. These were commissioned at the end of 1995.

Outputs
The planned capacity has been reached and the units are available for generation. These units have currently produced 196 GWh and thus considerably reduced the need for necessary future load shedding due to too little hydro power generation.

An operation management contract has been signed with SwedPower up to July 1997. SwedPower has eight persons at the site. For the Swedish gas turbines there is a three year maintenance contract with the manufacturer.

The annual values for generation with the two Sida financed turbines are:

Table 3

	Values in GWh		
Month	**1994**	**1995**	**1996**
Jan.	0	10.63	11.49
Feb.	0	13.76	13.24
March	0	15.79	8.11
April	0	14.27	0
May	0	5.02	0
June	0	8.96	0
July	5.41	0	0
Aug.	6.79	0	0
Sept.	8.85	0	0
Oct.	13.30	0	
Nov.	21.65	25.45	
Dec.	22.12	(63.18?)	

(Received value for Dec 95 must be incorrect)

The generation during 1996 was stopped due to a dispute between TANESCO and the Government about import tax for the fuel.

For the operation management project this is going on and it can not yet be decided if the objectives will be reached. The value of the presence of the Swedish staff has been reduced due to the long stop of the generators. During this period training has been given to staff.

Evaluation

The project was initiated as an emergency project to relieve the situation with load shedding caused by high load growth, low inflows to the reservoirs and the shutdown of one unit at Kidatu. The short installation time was essential and was achieved.

At the time the team visited Ubungo all units were shut down due to the dispute between TANESCO and the Ministry of Finance about taxes for fuel. The generators had been stopped for about six months.

The Swedish team in the operation management project continued with its programme to train local Tanzanian staff but so far with slow progress, mostly due to the culture of top-down decision-making and little individual responsibility at lower levels within the TANESCO.

An unstable 33 kV net for the supply of local power to the Gas Turbines caused disturbances in the Gas Turbines. The supply will be changed from the 33 kV network to the generator itself.

Only small funds were available for spare parts or regular maintenance works.

Financial and economic sustainability

An issue of major importance for the operational situation is the relation between the production costs for the diesel generators and the average price to the customers for sold energy. The cost for diesel generation is about 14 USc/ kWh and for the gas turbine generation about 12 USc/kWh. The average price for sold power was 5-8 USc/kWh and with new tariffs from November 1995 could come up to 8.5 USc/kWh.

A decision by TANESCO to run the thermal generation means first of all that they must have enough liquidity to buy the fuel and second, that they will make a considerable loss on the generation. This situation makes it of course more interesting for TANESCO to manage the balance through load shedding. The cost for fuel to run all four units at full capacity at Ubungo amounts to about 300,000 USD per 24 hours. Fuel is purchased in local currency by TANESCO.

The question of price relation is still valid today when the tariffs have been increased to about 8.5 USc/kWh. The tariffs are according to TANESCO based on generation costs during a typical year. So the costs for generation from the gas turbine should be reflected in the price to the customers. This is however not eliminating the problems when the dry year really is there. If it shall be possible for TANESCO to use the gas turbines as a generation resource during dry years the financial situation must be resolved.

TANESCO must be given the possibility to accumulate sufficient funds during wet and normal years so that they are able to buy the necessary fuel during the dry years. During the previous load shedding period TANESCO received assistance to pay for the fuel from Nordic donor countries. But such help cannot be a normal solution for TANESCO to avoid load shedding in the future. Donor assistance will only be made available after the problems have occurred and then, will be provided with some delay.

This situation is the background for our recommendation to make a financial simulation of the company before the approval is given for the financing of the continued expansion program for generation.

Tanzania has proven fields with natural gas near the Songo Songo island. There are plans for a pipeline to bring the gas up to Dar Es Salaam. The Sida financed turbines are prepared for gas operation. When gas will become available, the cost for generation will be reduced and the economy for the gas turbines will improve considerably. The plans for gas operation were also considered in Sida's decision to finance the project as a positive factor. But so far no fixed date is given for the pipeline. In the power VI appraisal re-

port by the World Bank is mentioned (para 3.18) " gas turbines are expected to burn Songo Songo gas at the beginning of next decade." The evaluation team did not receive any more exact information about the plans.

Environmental impacts

Included in the Ubungo substation are the four gas turbines and a unit with five diesel generators, of which three were operational when the team visited the site October 22.

The site is located by a major intersection in the northern industrial area, with heavy traffic passing by, and across from the National Grid Control Centre.

At the time of the initial construction of the Ubungo Thermal Power Plant in 1963 no environmental impact assessment was carried out, nor was this done when the first gas turbine was installed in 1973. The Ubungo area has always been earmarked for industrial development and is located on the outskirts of the city of Dar es Salaam.

However, during the extension of the Ubungo Power Plant in 1993, Stockholm Energi conducted an assessment of environment and health impacts. With the addition of four turbines as part of the "emergency power programme" and the expected additional stress on the environment an update of this previous assessment was carried out by Agra Earth and Environment (AEE) to investigate the environmental problems of the existing power plant before the additional 75 MW capacity was installed.

Plant personnel (SwedPower) indicated that measurements have been made of the air emissions but that there were no results yet available.

The turbines are run on jet fuel, which is relatively clean compared to other fuels. They are located in an area of heavy traffic, which probably does more to contribute to the level of air pollution than do the turbines. The turbines are used for power production at periods during the year when the water level at hydropower plants is low and demand cannot be met by hydropower alone. The turbine generated power is more expensive to produce and thus TANESCO is motivated to use the relatively cleaner hydropower. The turbines are being used to replace diesel generators, which are a far less environmentally friendly alternative.

Given their status as 'back-up' power sources, their location and the fact that they replace existing diesel generators, the use of the turbines represents no serious environmental hazard.

5.7 Lower Kihansi

Relevance

The load forecast given in the "Review of 1985 Power Sector Development Plan", July 1989, stated that the demand would increase from actual demand of 1300 Gwh in 1988 to about 1800 Gwh in the year 1995 and to about 2550 Gwh in the year 2000. The review lists a number of projects according to unit energy cost, the first is Pangani Falls Redevelopment and the second is Lower Kihansi. The load forecast also stated that Pangani would be fully utilised once the station is commissioned.

The Lower Kihansi Project Document, May 1995, points out that there is a significant risk of load shedding if no new hydro power projects after Pangani are on stream as early as possible. This document also points out that, because of the extensive load shedding 1992-1994, it is very difficult to make any good future projection. No appraisal of the different forecasts compared to measured load is given in the project document.

Sida´s "Insatspromemoria 1995-05-03, Stöd till energiprogrammet Power VI i Tanzania" was the basis for Sida´s proposal to the Swedish government to come to an agreement with the government of Tanzania about support to Lower Kihansi. In this document it is stated that at that time (1995) the fast increasing demand of energy will lead to a deficit in energy supply in the years 1999-2000 when the hydro power station in Lower Kihansi is projected to be commissioned.

In neither of the documents above is there any appraisal of different load forecasts compared to actual demand.

In the "Insatspromemoria 1995-05-03" it is stated that the prime target group for the lower Kihansi Project is the industrial sector in Tanzania. This document also gives a very clear account of possible risks connected with the project.

A load forecast comparison is presented in the "Feasibility Studies for New Hydropower", 1996, by SwedPower/Norconsult. From this it can be seen that most of the load forecasts have, to a great extent, over-estimated the future energy demand. The measured load 1995 of 1460 GWh should thus be compared to the forecast of 1811 GWh in the review of the power sector plan, see above.

Preparation and planning

The Lower Kihansi project has been thoroughly reviewed and appraised from technical and economical perspectives. The basis for the decision to build Lower Kihansi also contained considerations concerning the environmental and socio-economic impacts from constructing and running the power station.

In the decision-making process regarding support to the project, however, Sida and NORAD made the assessment that the environmental and socio-economic consequences from the project had not been investigated enough. Sida therefore laid down certain conditions concerning further investigations and considerations in these matters connected with the Swedish support to the project. One condition for Swedish support to the project is, then, that the financing and the implementation of the Community Development Programme is guaranteed. Both Sida and NORAD have come to the conclusion that environmental and socio-economic consequences from the project would be possible to take care of if these matters were paid proper attention to from the beginning of the project.

However, the evaluation team has observed that this has not been done. From the "Agreement for Consultancy Services in Respect of Socio-economic Follow-up" financed by Sida, it can be read (Appendix A, page 31) that mitigation measures through strengthen local institutions to be able to manage changes, will not be possible because so much has already happened/been changed. It is also stated that further delay would imperil the prospects of meaningful mitigation.

During 1995 and 1996 extensive investigations concerning the environmental issues have been made and also ambitious programmes for mitigative measures concerning both environmental and socio-economic impacts have been presented. Sida personnel from the Swedish embassy have also to some extent taken active part in designing the Community Development Programme.

Outputs

As the project is on-going we only give the projected objectives and outputs here.

In the Project Document May 1995, the sector objective is given as follows: "increased power availability and improved power supply reliability." Indicators that this objective will be achieved are degree of load shedding before and after commissioning and power availability on the grid.

Project objectives include efficient water management and catchment management plan. The project outputs are: 180 MW power plant with transmission lines, TANESCO staff trained in Operation & Management, TANESCO staff trained in plant design and construction and O & M routines established.

Monitoring/follow-ups and Evaluation of the project

The donors group has established a close monitoring and follow-up of the construction of the project and the consequences to surrounding environment and the local population. Every quarter of

the year TANESCO presents a Quarterly Progress Report which is discussed at the donors semi-annual meetings on site in Kihansi.

Environmental impacts from Lower Kihansi Hydropower Project

The Lower Kihansi hydropower project is the first of the Sida supported hydroelectric power projects where site selection was preceded by environmental studies. A preliminary environmental study was carried out in 1983/84 by NORCONSULT on behalf of RUBADA as part of the Rufiji Basin Hydropower Masterplan.

This RUBADA study ranked the Kihansi project as the first choice in terms of suitability and hydropower potential, and did not identify any serious adverse impacts in connection with its development.

When the project was decided upon in principle, JICA (Japan) financed "Studies on environment and compensation" were carried out in 1990 as part of the full feasibility study. These studies were based on the EIA guidelines and checklist developed by the Asian Development Bank and identified a number of negative impacts and corresponding mitigation measures. The overall recommendation was to go ahead with the project.

During the process of soliciting funds for the project, the World Bank noted some deficiencies in the JICA/EPDC feasibility study particularly in regards to stakeholder consultations and the inventory of flora/fauna affected by the project. Consequently TANESCO commissioned EKONO ENERGY (Finland) to produce a new EIA, which was financed by the Nordic Development Fund, in 1991. This report, "Environmental assessment of the Kihansi Hydroelectric Project" reported negative impacts, and recommended mitigation measures and a monitoring program. This environmental assessment also came out in favour of going ahead with the project.

The World Bank did its own environmental assessment, following internal guidelines, which included a critical review of the JICA/EPDC and EKONO ENERGY studies.

The latest in this series of EIAs (NORPLAN, "Lower Kihansi Hydropower Project: Environmental Assessment, December 1995) was initiated by some of the participating donors in order to have a detailed environmental study to complement and verify earlier studies and to function as a follow-up of recommendations and mitigation measures. This study was conducted during the construction phase of the project.

Major recommendations in all of the above studies have been identical.

The Evaluation Team's assessment of the Lower Kihansi Project

As in the case of the Pangani project, the Lower Kihansi project has been preceded by studies and appraisals concerning the economic and technical aspects of the project. While the project area has been studied in great detail for a number of years, there seems to be a discrepancy between the format and results of these studies and the formal requirements for EIA within the different financing organisations.

The question if Lower Kihansi is a relevant hydro power project is not possible to give a definite answer on now, it depends i. a. on the economic growth and also on the availability of the other hydro power stations, then mainly Kidatu. It should also be noted that so far have the decisions to construct the earlier hydro power stations been based on exaggerated load forecasts. So perhaps lower Kihansi will not be of that great relevance when it is commissioned 1999, but the team's opinion is that in the long run Lower Kihansi will be an important part of the power generating system in Tanzania and thus contribute to the economic growth in the country.

Sida should, nevertheless in the teams opinion have undertaken a more thorough appraisal and evaluation of the load forecasts which were the basis for the Lower Kihansi project.

The Team finds it positive that Sida has to a certain extent taken into consideration the experiences and lessons learned from Pangani in the appraisal of Kihansi. One expression of this is the conditions which have been connected with the Swedish support. Another is the active participating from Sida personnel in the monitoring and follow-up of the execution of the project, including the environmental and Community Development Programmes. But, the team is on the other hand critical to that the lesson from Pangani concerning the need for starting up the Community Development Programme very early, has not in a properly way been transferred to Kihansi.

The conclusion of the assessment of Lower Kihansi as seen as a hydro power project, is that this on-going project complies to (a certain) extent to Sida's new guidelines for energy assistance.

5.9 A Summarised Evaluation of Generation Projects.

In general the projects have been successful and implemented according to plans and without major environmental impact.

One aspect of the planning process which could have received more emphasis is that of the financial aspects for the company TANESCO. There are difficulties reported with funds and delivery

times for spare parts which, at least in Kidatu, have a direct impact on the condition of the power plant. Another similar issue is the funds for purchase of fuel for the gas turbines. The planning for each project has been good but the planning for building a company has been neglected. This is now hopefully being rectified in some of the projects with World Bank financing for structural reinforcement.

The costs for generation vary a great deal with the availability of water for hydro power generation. It is not sufficient that TANESCO has technical possibilities to generate with oil based units. It must also have the financial resources to pay for the fuel if this is to be the policy. TANESCO must be able to create funds during good years which can be used during dry years. In a hydro power based system the decision to start thermal generation must be taken long before the reservoirs are emptied.

Training of personal has been well taken care of by TANESCO. At first project expatriate staff were working as supervisors at Kidatu. For later projects TANESCO has transferred experienced staff from older plants to new ones. The cost for expatriates has thus been reduced.

Environmental Aspects

General

The purpose of carrying out Environmental Impact Analyses (EIAs) is to ensure that the development options under consideration are environmentally sound and sustainable and that any negative environmental consequences are recognised early in the project cycle and taken into account in project design and implementation.

In the Sida-supported projects during the 90's in the Tanzanian energy sector, the goal of ensuring the timely inclusion of EIA results into the project cycle has not been achieved to a full extent. On the other hand, the quality and comprehensiveness of the environmental studies in connection with hydroelectric power development has been steadily improving since the first projects began when, it must be remembered, the concept of the EIA did not exist. Environmental assessments of thermal power development have been hastily implemented and are superficial in nature.

Site selection for hydroelectric power plants has been carried out without much regard to the potential environmental impact, but rather based on technical and economic considerations. On the other hand, the overall environmental impact of these installations and their concomitant reservoirs and desiccated river beds has been relatively benign. In very broad terms, the reservoir and river diversion at Kidatu has had a very minor impact on the surrounding

ecology and the huge reservoir at Mtera has had a net positive effect on the ecology and human activities in the surrounding area.

The environmental impacts of the Pangani redevelopment project are more complicated to analyse. The hydroelectric installation is located in an area of relatively high population density, with agricultural and industrial development in the catchment area which both demand water and create pollution problems. The existence of local habitats for rare and endemic plant and animal life also distinguish it from Mtera/Kidatu. The actual impact of the power plant, however, has been less dramatic than expected and mitigation measures have been implemented.

The Lower Kihansi Hydropower Project is the latest in the series of Sida-supported projects and has had a very high ambition level in collecting baseline data and proposing mitigating measures. The project is located in a catchment area which has been studied for the past 20 years because of its potential for hydroelectric development.

Specific Environmental Impacts of the Sida support to the Tanzanian Energy Sector

In general, the types of environment impact associated with the power industry can be divided into three major categories:

- pollution, both discharges in air and water, fuel spillage or waste

- major physical changes, dam construction, rerouting of waterways, road construction, disruption of existing ecosystems and changing land use

- electric transmission lines effect on landscape

In addition, most EIAs cover the socio-economic impact of the projects on the local population and the archaeological/cultural values which may be impacted.

The presentation of the EIA, then, is generally divided into two phases, the environmental impacts of the construction phase and those of the operational phase. During the construction phase the impact is often severe, but temporary, if appropriate mitigation measures are undertaken. Of greater concern are the long-run effects of the operational phase. It is important to collect detailed and comprehensive information in a baseline phase, so that these long-run effects can be accurately monitored.

The various power projects supported by Sida follow a continuum in terms of their use of environmental considerations in the planning phases. While there were no environmental studies as such made for the Kidatu project, a substantial amount of information

was collected as to the geology, sedimentation, and hydrology of the area directly affecting the power plant.

Although the concept of EIA was not in use at the time, the studies of the ecology of the Mtera Reservoir, for example, provide detailed (if not comprehensive) information from the 1980's which has then been followed up throughout the following decades. Many of the long term effects of disrupting the Mtera ecosystem are thus known.

The Pangani Redevelopment Project represented the first real attempt in the series of Sida-supported projects, to carry out an EIA during the planning process. This process has not always been a smooth one, but there was a genuine ambition to collect comprehensive baseline data and mitigating measures were proposed, implemented and followed up during both the construction and operations phases.

The most recent project, the Lower Kihansi, which is still under construction, has had a very high ambition level in terms of carrying out a comprehensive EIA already in the planning phase. It is also the first project where environmental studies preceded the site choice.

6 Other Studies and Programmes Financed by Sida

In addition to the support to different generation projects, Sida has also financed other studies and programmes within the energy sector. These studies and programmes are listed in the Desk Study and we refer to the Desk Study for a more detailed description of the programmes.

The Evaluation Team has not carried out a detailed evaluation of these studies and programmes, however, we have some observations and comments. It should first of all be stressed that some of the studies have a general energy approach and it is therefore difficult to evaluate the value of these studies.

Great Ruaha Power Project. Ecological Studies (1970-95)

These reports include extensive and detailed studies of mainly environmental impacts of the hydro power projects in the Great Ruaha River basin, in particular of the environment at the Mtera basin, from 1970 up to 1995. According to observations made by the team, these studies are unique and have been a significant contribution to increase the knowledge about impacts of hydro power projects with man made dams. The team has however also noticed that the co-operation between the consultant - SWEEP - and TANESCO has not functioned smoothly during recent years.

This might have had a negative effect on the value of the reports as a basis for decision-making about new hydro power projects.

Studies, Seminars and Workshops by the Stockholm Environment Institute (SEI)

Many of the studies of SEI have had a focus on rural electrification. The Team wants to underline that the studies and the results from the assessments made of rural electrification projects implemented by TANESCO are, in this context, internationally unique. They also give very valuable, and also to some extent surprising information about the effects of rural electrification.

It should also be noted that there is an on-going pilot project of rural electrification of Urambo village (Tabora Region), jointly carried out by TANESCO and SEI with support from Sida. The important issue of rural electrification and the importance of Swedish support in that context is highlighted in section 10 below.

In addition to the work on rural electrification, SEI has also - with Sida assistance - taken part in and supported the work with the national energy plan of Tanzania in the beginning of the 90's.

Studies by ESMAP

ESMAP's work is focused on increasing the efficiency of power subsector operations, increasing the use of indigenous energy and enhancing the efficiency of both commercial and traditional energy end-use. Sida has during several years provided financial support to ESMAP for studies and projects in Tanzania. Under this heading, the studies and activities concerning loss reduction in supply together with DSM and energy efficiency should be noted particularly.

During 1989-1992, TANESCO with technical assistance from ESMAP and financing from Sida undertook a loss reduction program with the following objectives:

i) Determine how much the various loss sources contribute to overall losses.
ii) Assist in development of a program to reduce losses to an economic optimum.
iii) General improvement of the quality of supply to the consumers

Evaluation of the implementation of the program has shown that transmission and distribution losses have been reduced from about 25% to about 17% of net generation at the end of year 1995.

TANESCO has also with technical assistance from ESMAP and with financial support from the World Bank and Sida carried out detailed energy audits of 25 selected big consumers. The study was conducted during March 1994 to March 1995. The study findings indicated significant energy conservation opportunities, approximately 12 MW of capacity and 37 Gwh/annum from the 25 audited premises. The investment pay back period is estimated to 4-5 months. In addition to that, implementation of load management (agreement to clip the load during peak hours) in some of the big consumers can give additional capacity of the order of 10-12 MVA in the grid.

To implement the study findings, ESMAP with financing from Sida has facilitated Tanzania's joining of IEA's DSM Program and has established an energy conservation fund in Tanzania.

The team has arrived to the conclusion that the Swedish support to these studies and, in applicable cases, the implementation of the findings from the studies, has been successful and in full accordance with Sida's guidelines for the Swedish energy assistance.

7. The Power system in Tanzania

7.1 Power Balancing in a Hydro-thermal Power System.

All hydro power generation is, to some degree, dependent on an inflow which can vary between the years. If generation from hydro power plants is the major source of generation, then some provision must be made to handle generation during years with very low precipitation and low inflow to the reservoirs. There are a number of options available.

One can build very big reservoirs which provide the possibility of storing water during years with good inflow and release it during dry years. The reservoir can thus reduce generation during wet years and increase generation during dry years to reduce the variations.

The system can be designed so that during a year with normal inflow there will be more generation capacity than necessary. In that way there will be sufficient during dry years. Some generation can be added which is independent of the water situation. This can, for instance, be thermal power generation or it can be a transmission line for interconnection with a neighbouring system which gives a possibility to buy additional energy during dry years and sell surplus energy during wet years.

It can also be possible to vary the consumption by signing special delivery contracts with some customers with a clause that the deliveries can be reduced during dry years. Examples are hot water boilers which can be either supplied from electric system or oil-fired. Often some kind of combination is chosen depending on the conditions for each power company.

It is necessary to make a special study to find the most economical way of guarantying the supply during dry years. This study must also reflect the actual situations for the company in terms of hydrological variations. If, as in Africa, it is common that a number of dry years will follow each other in sequence, this must also be considered in the study.

The evaluation team has not seen any study of this kind during our review of documents. The exception is the oldest study for Kidatu which recommended an installation of an additional 30 MW diesel generation at Ubungo to have a possibility to compensate for a low inflow. This recommendation was also implemented.

Another aspect of this is the financial implications for the power company. During a year with good inflows the expenses for oil will be very low and during the dry year very high. Especially when a number of dry years follow sequence the financial stress for the company will be very high. The tariffs for the customers are set based on some average production situation. But then it is necessary that the company has the possibility and right to build up funds to smooth out the differences between years.

7.2 An Attempt to Understand the History of the Load Shedding

The load shedding period which occurred 1992-95 created much attention for the electricity sector and it is natural to ask why it happened in spite of the heavy investments which had been made in generation. An analysis could perhaps also reveal some shortcomings in the executed programs why it here is included an attempt to describe the situation leading up to the shortage situation.

TANESCO had a surplus of generation capacity from mainly Kidatu during years with normal inflow until the annual load reached a level of about 1300 GWh. Dry years could easily be compensated with savings from the long term reservoir at Mtera and the reservoir could be filled again during next normal or wet year. That this was done can be seen in figure H 1. The reservoir at Mtera has a volume of 3200 Mm3 which is 1.3 times the annual flow of water at Mtera during the average year. This means that it is a very large reservoir which can be used for regulation of water between dry and wet years.

The planned utilisation of the production from Kidatu is shown in the appraisal by the World Bank for Kidatu phase II. The table is based on simulations of the power system made by SWECO. The table shows that the production from Kidatu will be fully utilised 1989 which means that the surplus production capacity has disappeared this year. Some other source for balancing the system must be made available. The extra generation coming in is the Mtera power plant. However, this contribution is not sufficient to balance the load increase and the low values for the inflow. The level of the Mtera reservoir is starting to go down and has not recovered at this time (Fig H2).

From 1990 the load was more than 1 400 Gwh per year. Mtera power plant had been added with about 320 GWh. But this was not enough to compensate for the load which now was growing quite fast as a result of the economic reform program and other factors.

For the first years of the 1990s the deficit in the reservoir should have been compensated for by thermal power generation. The existing diesels had not been needed previously nor used for a long time and could not be used efficiently. Fuel supply was not working. However, some diesel generations were rehabilitated in the beginning of the 90's with support from KfW.

One generator at Kidatu was faulty and reduced the possible generation from that plant. Probably TANESCO decided to compensate for the lost generation at Kidatu by increasing the production at Mtera. This water was spilt at Kidatu in the spillway without giving any generation. This can be seen in the relation between annual generation at Kidatu and Mtera which for 1991 and 1992 has a lower value. That meant that more water was released from the long term reservoir at Mtera. This reduced the level in the reservoir a great deal, especially as the inflows were lower than normal.

It can also be assumed that the operational department at TANESCO became aware of the situation too late. If the capacity for thermal generation is low, then thermal generation must be started very early in the season to produce the necessary quantity of energy. In a Swedish power utility with hydro power generation the power balance is normally updated once a month to reflect load growth and actual reservoir position. The operational department in Tanzania did not have any computer models for these calculations and were not aware of the need for thermal generation due to the new situation.

(Values for the rainfall has not yet been received so this assumption remains to be proven. So far it is based on calculated local inflows only)

The values for the inflow have been compared with the observed rainfall at some locations in the catchment area. The values for the

rainfall indicates that the years 1990-1995 have been dry but not extreme enough to be the only explanation for the reduced generation at Kidatu and Mtera. We do not have enough information to come up with a definite conclusion about the observed deviations. However, the deviation is of such significant financial importance that it will justify close follow up in the future. And if inspections in the catchment area should prove that there is a wasteful use of water, improvements should be made.

A natural instance to handle the release of water for Great Ruaha should be a water office, similar to the one established for Pangani. This office should then have the duty to supervise the use of water for irrigation purposes as well as for power generation. Possibly this could be a way of dealing with the alleged unauthorised abstraction of water. A disadvantage for TANESCO is that their possibility of using the Great Ruaha river for balancing their generation balance will be reduced. They will most likely be restricted to follow more closely a discharge value set by the Water Office and as a consequence they must find another way for balancing their generation, such as the gas turbine generation.

7.3 How to Fill Mtera Reservoir Again

The present situation for the Mtera reservoir with operation at the minimum level is not advisable. It means that TANESCO has no reserves in the reservoir to compensate for a year with low inflow or lower than expected availability from the gas turbines. However, it should also be understood that the value of the energy which can be stored in the Mtera reservoir, if it is given the production cost of gas turbine generation, is about 300 MUSD or fully 2,000 MSEK. It is therefore unrealistic for TANESCO to try to fill the reservoir in a short time by using the gas turbines as base load and reducing the discharge of water to a minimum.

The statements which we met that some water in excess of approved water rights was used for irrigation purposes in the catchment area should be investigated very urgently as they could be the most economical way of improving the situation.

The low level of the reservoir also has the effect that the head at Mtera is reduced by about 5 meters. This gives a lower output which, during a normal year, can be calculated to 45 GWh, which in turn, if evaluated in line with the cost for gas turbine generation, has a value of 5.4 MUSD or 36 MSEK.

7.4 Operational Planning

The operation of a mixed hydro thermal system is complex, especially given the existence of a reservoir big enough for regulation

over several years. The methods for simulation of the operation used for system expansion have not been used during operation. Instructions as to operational methods were handed over by SWECO after the completion of Kidatu I. However, as there was no need for these during the first years of operation, they seem to have been forgotten. Using this type of calculation could possibly have reduced or eliminated the load shedding by encouraging the commencement of the available thermal power generation at a much earlier time. There is reason to be pessimistic in this respect also for the future if the relation between the costs for gas turbine generation is compared with the average cost for sold energy.

At present a simple manual calculation of the energy balance is made. However, this covers only a short period of time and does not include stochastic inflows.

A contract has been signed with Power & Water System Consultants Ltd from Great Britain (with ESMAP funding) for a reservoir management study, including delivery of hardware and software systems. The contract includes both a short term and a long term planning.

Generators are operated at maximum capacity which, in principle, is not a good idea. For a Francis turbine, the most economical point is normally around 80 %. Maximum capacity is then only used during periods of peak demand.

Assessment and conclusions

The knowledge about operational planning for the hydro-thermal system has not been sufficient fresh at the time when it was needed. Measures have now been taken in the program financed by the World Bank to upgrade the capabilities for handling the generation system both with computer facilities and training. It does not seem advisable that Sida should involve themselves in additional training programmes in this field, but the result of the program should be followed closely.

8. Restructuring of the Power Sector in Tanzania

Mainly because of the poor performance of the electricity sector in most of the Sub-Saharan African countries, the existing model for designing the national utilities began to be strongly challenged in the beginning of the 90's. This has also been the case in Tanzania.

The international donors, led by the World Bank, have thus put pressure on the Tanzanian Government to impose structural changes in the electricity sector in Tanzania as a condition for future energy assistance. These matters are extensively dealt with in The Word Bank: "STAFF APPRAISAL REPORT, TANZANIA, POWER VI PROJECT", April 1993.

To get support to the projects within the frame of Power VI the Government of Tanzania (GoT) then agreed, among others, to:

- Separate TANESCO´s in-house business of construction of transmission and distribution lines from the rest of the company and offer this business for sale to private investors by December 31, 1993

- Engage consultants, by January 1, 1994, to study privatisation options

The team can observe quite slow progress in these matters and it was not until April 1996 a final report with some suggestions was submitted. The TOR for the study indicated a number of key objectives for the study:

- The introduction of competition where feasible.
- The attraction of private finance into the sector.
- The introduction of incentive mechanisms in order to improve performance.
- The distancing of Government from day to day operations.

The study, which focused extensively on generation included the following recommendations:

- A "single buyer" (=TANESCO) model should be introduced to encourage competition and investment in generation,

- A bidding process should be introduced in order to facilitate the introduction of Independent Power Producer

- As an interim measure, a performance agreement should be established between TANESCO and the Government in order to focus attention on performance improvement in the short to medium term.

These recommendations have been rejected by the World Bank which has instead recommended the Government to start with privatisation of the distribution system. According to the World Bank, any further efforts by the consultants should be devoted to working out details and providing the necessary technical and legal support for a privatisation of the distribution system.

According to information given to the evaluation team from Ministry and Energy and Minerals the situation concerning the restructuring of the power sector is as follows.

- A revised study by ESBI will be presented in January 1997,

- The Government of Tanzania has decided to sell out 49% of TANESCO to private investors,

- Private investors will be invited to take over the distribution; to attract private investors to do this in areas outside the big cities, it will be permitted to have different tariffs for different parts of the country.

Assessment

The Evaluation Team makes the assessment that there is an urgent need for a radical and far-reaching restructuring of the whole power sector in Tanzania. This restructuring should on the first hand focus on how to establish TANESCO (or/and other private or public agents within the power sector) as a fully independent and effective company. This company should have the full opportunities to generate enough resources to ensure proper running and maintenance standards of its power stations and transmissions lines and also for investments in new generation capacity.

This restructuring must, obviously, include the policy for tariff setting, regulations preventing the Government from interfering in the company's day to day business, the right for the distribution company to disconnect all consumers (including governmental subscribers) not paying their bills and also radical measures to improve the performance of TANESCO.

The team can, however, notice that progress in restructuring the power sector has been very slow, in practice nothing positive has happened since the agreements between the World Bank and Government in 1993. What has happened is that TANESCO´s performance has declined, the need for rehabilitation of Kidatu has accelerated, etc.

The team can observe that decisions has been taken by the GoT to go forward in the restructuring of the power sector. However, the team recommends that Sida, together with other concerned donors, execute a close follow-up of the implementation of these decisions.

9. TANESCO

It has not been possible within the scope of this mission to make a complete survey and analysis of TANESCO. The team's observations and assessments are based on studies of relevant documents, site visits, including interviews with the personnel at the stations, and also discussions at TANESCO head office in Dar es Salaam.

In line with the priorities expressed in the TOR, the team has focused primarily on analysing the capability of TANESCO to run and maintain their hydro power stations, and indeed the transmission and distribution systems, in a satisfactory way. In addition to this, the team has also studied TANESCO's institutional and organisational capacity in general, which has a bearing on the operation of the power system.

The institutional strengthening of TANESCO is a part of the Power VI Project, financed by the World Bank. The outline of this programme is presented in World Bank: STAFF APPRAISAL REPORT, TANZANIA, POWER VI PROJECT, April 1993. The intention is that TANESCO will focus its institutional development efforts in four key areas:

- corporate planning,
- management,
- manpower development and
- Productivity Improvement Program (PIP)

The international consulting services for this work are executed by ESB International, Ireland. So far ESBI has presented two reports: Draft Diagnostic Report, May 1996 and a Draft Report, September 1996, concerning human resources and the personnel function.

Corporate Planning

The corporate and business planning process in TANESCO is underdeveloped and there is a significant lack of medium and long-term plans, programmes and strategies. Together with inadequate delegation of authority this means i. a. that the guiding principle for daily work is to react to the situation at hand. This results in slow or occasionally no performance at all at lower levels due to lack of directions and delegations.

There is no observable strategy for running the power system, (see the discussion above in chapter 7). This is very serious, especially bearing in mind how highly technically sophisticated the hydro power system is and how important it is for TANESCO and Tanzania as a whole.

Despite some attempts made to clarify the position, the objectives of TANESCO are unclear. Statements made by the government and TANESCO concerning objectives are inconsistent.

In 1993, the World Bank made an agreement with TANESCO to prepare an Annual Corporate Plan for each year, starting 1 January 1995. TANESCO prepared a provisional Corporate plan in August 1995, the more comprehensive corporate plan will obviously be prepared in connection with the consulting services from ESBI.

The Corporate Structure

There are three Deputy Managing Directors, covering Corporate Services, Technical Services and Operation. A detailed organisational chart is given in Appendix IX. Technical Services covers the operation and maintenance of hydro and diesel plants and transmission. The seven zones within Operation have geographic responsibility for distribution of electricity including billing and collection and other customers services.

TANESCO has, during its fully 30 years as the national power utility, has expanded very significantly and has gone through a number of profound organisational changes. Thus, the number of employees has increased significantly to about 7 500 at present. The decisive cause underlying both the expansion and the changes at TANESCO is the introduction and building up of the hydro based power system with power stations, substations, transmission lines etc.

Of the total 7 500 employees, about 6 000 work in Zones or power plants and 1 500 in the head office.

Human Resources and Staffing

TANESCO has many experienced and dedicated managers who have in depth knowledge of the electricity sector and appear to be committed to making the necessary structural changes. The team has observed how the competence and capacity of the company to manage and implement big hydro power projects has developed to a high level. In addition to that, the team has noticed during the site visits the high professional standards of operation and maintenance managers at the power stations.

This being said, there are still some notable weaknesses in this area, such as skill deficiencies among both professional, technical and administrative staff. It should also be noted that although the structure of the company is formally decentralised, there is very little delegations of responsibility in carrying out the day to day business. One example of this is the fact that it took about two years to get approval from the head office to buy some needed spare parts to the Kidatu Station. This is not an acceptable way of working for a power company.

Another weakness is the lack of modern computerised systems which support the personnel in their work. The existing manual systems are old, slow and labour-intensive. However, it should also be pointed out that a new accounting system is under implementation and also that a new system for billing and collection is in progress.

Concerning recruitment of skilled electrical engineers and technicians the team could observe that TANESCO has difficulties to recruit and keep this type of personnel. This is the case, for example, at Mtera where there is a shortage of 10 engineers and technicians within the maintenance department of the station.

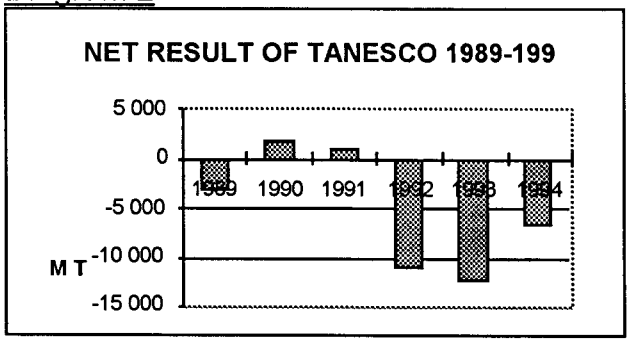
In terms of the sheer number of staff, however, TANESCO is undoubtedly over staffed. One standard for measuring this is the amount of customers per employee, which at TANESCO currently stands at 40. Compared to most other utilities in Sub-Saharan Africa this is quite low. Due to a hiring freeze (in terms of number of employees) and many new customers connected during the last years this figure, however, has changed to the better.

The Financial Situation of TANESCO

The financial situation of TANESCO is poor.

TANESCO's net result (after taxes) for the years 1988-1994 has been as follows:

Diagram 2



Total losses for the years 1989-1994 amount to 33 977 MTSH. which can be compared to a Share Capital of 31 033 MTSH and an Advance towards Share Capital of 12 255 MTSH. TANESCO is by all standard measurements financially a weak company.

The main causes for this situation are:

- Delays in obtaining permission to implement tariff increases,
- Consistent non payments, mainly by Governments agencies, parastatals and the Zanzibar Sate Fuel and Power Corporation. Electricity debts have increased from 25 689 MTSH in July/Sept 1995 to 34 061 MTSH in

April/June 1996. The number of days outstanding currently is around 185 days against the desired 60 days,

- Sharply increasing debt service burden, caused by the devaluation of the Tshilling. The total debt June 30 1996 was 329 billions TSH and the debt service due but not paid 150 billions TSH,

- Erratic and faulty billing of customers. The actual collection the last 12 months has steadily decreased. The actual collection for April/June 1996 was almost 15 billions compared to target collection of 21 billions,

- Inadequate management information from the accounting system,

This poor financial situation has, of course, a number of serious consequences. One is that there is not enough money allocated for maintenance and spare parts to the power stations. The state of Kidatu is a very clear example of this.

TANESCO is today a rich company in the eyes of the government of Tanzania. It is natural, then, that they give conditions for the development of the company which are harder than for utilities in other parts of the world. The financing conditions are much harder for TANESCO than for the development of Swedish power companies, for example.

In on-going extension TANESCO is financing the local costs directly from the operational budget. No loans or bonds are issued by TANESCO.

Assessment

The Sida financed projects have, to a great extent, included activities focused on institutional and competence development. The team has also observed that these activities have increased in quantity and quality from Kidatu to Pangani and Lower Kihansi. The team makes the assessment that institutional and competence development activities have been successful and that, technically speaking, the planned objectives have been met to a very great extent

However, and this is very important, these activities have been confined to developing the technical competence and capacity of TANESCO´s concerned staff to construct, operate and maintain the stations. Sida has not financed any activities in Tanzania focused on the general strengthening of TANESCO in areas such as corporate culture and structure, management, financial performance, human resources, etc. Neither has Sida financed any activi-

ties directed towards the level above TANESCO, that is the government level and the policy world which sets the framework within which TANESCO operates.

The World Bank has been very active in these areas although progress has been insignificant. The team can thus observe that one part of TANESCO - the construction and operation of the power system - has developed with high technical skill and competence, while other parts of TANESCO, and also the policy framework within which the company operates, have not developed at all. The team's observation and assessment is that this uneven development has very much hampered TANESCO's ability to run the power system in a proper way.

The conclusion is that the Swedish support to institutional and competence development has been too limited to the hydro power projects and the technical parts of TANESCO to be a substantial contribution to TANESCO´s total capacity to develop its power sector in a sustainable way.

The further activities concerning institutional and competence development should thus be focused on three levels:

1. A continuation of the transfer of technical and management skill and competence to build and run the power system in connection with hydro power projects.

2. Reinforced activities directed to strengthen TANESCO in areas such as corporate culture and planning, management, financial performance, human resources, etc. The team makes the assessment that Swedish competence and profile in these areas could be a substantial contribution to TANESCO.

3. Very strong support to the restructuring of the power sector and to create a legal and regulatory framework which enables TANESCO to, inter alia, generate and keep the needed resources to operate the power system.

Future Swedish energy assistance should, then, address all these levels. It is otherwise a great risk that the money directed to level 1 above will, to a certain extent, be wasted.

The team has also observed that Sweden during the 90's has increased its activities in this direction and together with other donors now puts pressure on the government and the management of TANESCO to implement structural reforms. This is a promising trend which should be reinforced.

10 Supply/Demand and Use of Electricity in Tanzania

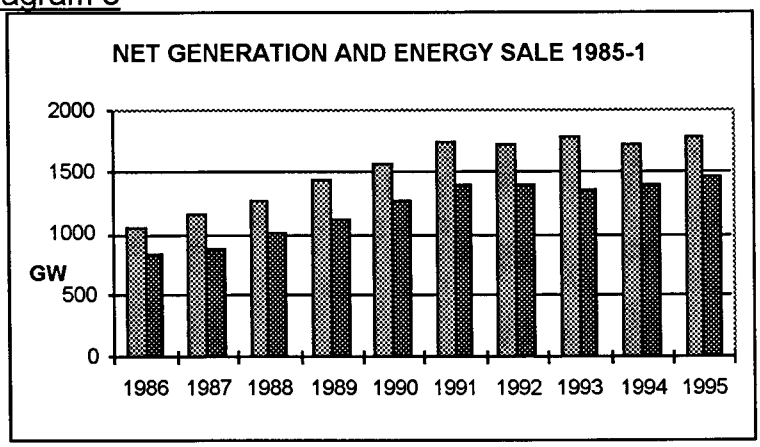
10.1 Supply and Use of Electricity

The electricity system consists of power plants and transmission lines within the interconnected system, see Appendix V, and small isolated systems. The interconnected system generates about 96% and the isolated systems meet the rest of the total electricity supply. (We deal in the rest of this section only with the interconnected system)

The total installed capacity within the interconnected system is 522 MW with fully 300 MW from hydroelectric power plants and about 218 MW from thermal power plants, see Appendix VI. Available capacity/output is estimated at 295 MW/1476 GWh from hydro power and 137 MW/761 Gwh from thermal power.

Load statistics for the interconnected system show the following figures for generation and sale during the years 1985-1995.

Diagram 3



The difference between generated and sold energy is the total loss in the system. The low figures for sale of energy during the years 1992-94 reflects the load shedding these years.

10.2 The Electricity Customers

The degree of electrification in Tanzania is still very low; it is estimated that only about 7-8% of the population have access to electricity.

TANESCO has currently about 302 000 connected customers. They can roughly be divided into following categories:

Table 4

Category	Number	Energy Sales per category GWh	%
- Residential	240 000	541	37
- Light Commercial	54 000	186	13
- Light Industrial	7 000	70	5
- Other Industrial and commercial	1 000	446	30
- Agriculture	255	68	5
- Public Lighting	2010	10	0,5
- NUWA Water Auth.	56	85	5
- Zanzibar	1	57	4
	304 322	1463	100

The statistics concerning the energy sales from 1985 until 1995 show that :

- energy sales to residential consumers has increased both in terms of GWh (174 to 541) and relative share of sales (25 to 37%) during the entire period

- energy sales to commercial users have increased during the entire period

- energy sales to large industry and commercial users increased between the years 1988 and 1991 but was then reduced 1992-94. It is obvious that the load shedding period these years effected these customers very severely.

In addition to these facts there are some features about the currently connected customers that should be noted in this context. One is that a great majority of the customers are located in Dar es Salaam and in coastal areas north of DSM. Another is that about 90% of the customers are located in urban areas.

A third feature is that, in the electrified areas, there is a high correlation between household income and the use of electricity.

Around 90% of new customer applications for connection are from residential consumers and the rest is from small industries and commercial users. It is thus the small/residential customers who are pushing for load development.

Another aspect to consider is the efficiency of energy use. All statistics show that the low per capita use of energy in the developing countries is highly correlated with inefficient use. There is, thus, a great need for energy effective measures in Tanzania. Experi-

ences from such activities show that quite moderate achievements can make free 5-10% of the existing capacity and 10-15% of the energy use for connecting new customers, without building new power stations. One basic condition for results like that is that the tariffs reflect the Long Run Marginal Cost (LMRC) and are not biased by any subsidies.

10.3 Load Forecasts and Determination Factors for the Demand for Electricity

During the 1970's there was a quite strong relationship between GDP growth and electricity consumption. As has been shown in chapter 5, all the hydro power projects were justified solely with the latest load forecast. All these load forecasts, in turn, demonstrated that in some years time demand would exceed supply and that fact, then, justified the concerned project.

In the Feasibility Studies by SwedPower a comparison is made between five of the latest load forecasts prepared for Tanzania by various consultants and the actual sale of energy 1985-1995. This comparison shows that the margins of error in forecasting error are rather large. All the load forecasts are based on econometric models which assume a given relationship between electricity demand and other factors, primarily the GDP.

These relationships are most likely not as strong as they used to be. One important factor is that after 1979 the industrial sector, which by that time accounted for about 65-70% of the electricity consumption, has declined, whereas consumption from the residential and commercial sectors has continued to increase.

The serious errors in load forecasting can thus be explained by the great fluctuations in the Tanzanian economy and, of course, also by load shedding during the period 1992-1995.

Significant future demand for electricity can come from the industrial sector, which will increase its present low rate of utilisation if growth speeds up. If it does not, the conclusion from this could be that in a country like Tanzania the measured load for the coming 10-15 years will increase in the same rate as new customers (mostly residentials) will be connected in accordance with the increase in the supply.

10.4 The Tariff Policy and System

In The Energy Policy of Tanzania some statements are made concerning the electricity tariffs:

- Stability of energy prices is an important policy consideration,
- The electricity tariffs should be same all over the country,
- Electricity pricing will be based on long-run marginal cost pricing modified by such consideration as equity and social and development considerations,
- Pricing will be used to stimulate or moderate energy use in a particular consumer category.

Together with the great delays in receiving government approval to adjust tariffs in relation to cost increases, the tariff policy outlined above has, in reality, led to the following consequences:

- A steady deterioration of TANESCO´s financial situation,
- Electricity consumption in the diesel-supplied areas is heavily subsidised, primarily by large industrial consumers supplied by the national grid
- The consumption of the most affluent customers is heavily subsidised compared to that of poor households.

However, the team has established that there during the 90's have been taken measures to introduce a tariff system and specific tariffs which are based on long run marginal cost and also a abolishing of subsidises of different groups of consumers. This has been done in combination with the introduction of a "life-line tariff" which will enable the poorest parts of the consumer to use electricity mostly for lightning to reasonable costs.

This new way of looking on the electricity tariffs also means that there in the future will not be a uniform tariff over the whole country. Private investors in distribution in the countryside will have the permission to introduce tariffs to meet their costs.

10.5 Rural Electrification

Since all regional towns have been electrified, it is stated in The Energy Policy of Tanzania that efforts will be focused on the electrification of all district towns by the year 2005. First priority will be given to districts and areas with agro-based industries and other community productive power needs which are within an economic break-even distance from the interconnected grid in order to use relatively cheaper hydropower.

The rural electrification programme has resulted in the electrification of 37 rural towns and 14 villages so far. The major portion of the investment has been covered by international donors. It is es-

timated that less than 1% of the rural households in Tanzania have access to electricity.

The rural electrification program has stagnated and about 30 rural townships and a very large number of villages remain to be electrified. TANESCO can implement rural electrification provided only that the financing is secured from the Government.

Two of the main objectives with the rural electrification program are conservation of natural resources through fuelwood substitution with electricity and promotion of small industries. To evaluate how these and other objectives had been achieved an extensive evaluation of the experiences from rural electrification program in Tanzania was carried out in 1989-1991 by SEI with financial support from Sida.

The four main conclusions from this evaluation were:

- Electrification is appreciated by the rural people.
- Rural electrification is a large financial burden on TANESCO.
- The quality of the service, in particular reliability of supply, is low in rural areas.
- The two objectives above have only been achieved to a marginal extent. It is also clear that a significant impact of electrification on fuelwood use should not be expected in the next decade.

Nevertheless, it is necessary to speed up the rural electrification and to try different concepts in this effort. The team wishes to point out the promising results and experiences from electrification in Urambo and Urambo Electric Consumers Co-operative Society (UECCO). This society has the support from SEI (Sida) and TANESCO.

The basis for this concept is

- The villagers form a electric society
- External support for initial investment
- Electric supply from small diesel generators
- Technical support from TANESCO
- Some initial external support to management and accounting

The evaluation team makes the assessment that this concept for rural electrification is in line with the Sida's guidelines for energy assistance and thus is worth Swedish support. But it is true, which is pointed out in the guidelines, that it is difficult to improve the situation of the poor households through specific energy support.

Energy aspects should be included into integrated development programmes.

A programme for rural electrification must probably to a large extent be based on electricity from diesel generators, but it should also be possible with electricity from renewable sources as small hydro power stations and solar energy.

Experiences from rural electrification in other developing countries show that no dramatic effects will be achieved in short run but also that many of the positive impacts are in benefit of the rural women.

11. The Relevance of the Swedish Energy Assistance

11.1 Relevance in Relation to the Needs of Tanzania

It was not until April 1992 that Tanzania's first specific National Energy Policy was adopted. However, the energy issue has played an important role in national development plans before that. A secure supply of energy has been viewed as an essential contribution to national development. Another more operative objective has also been to substitute expensive oil imports with indigenous energy resources. Electricity from hydro power stations is then a natural and significant substitute.

From the National Energy Policy some of the overall goals which are applicable here include:

- To exploit the abundant hydro-electric sources,
- to minimise energy fluctuations in order to contribute to general price stability through strengthening and rationalisation of energy supply sources and infrastructure and a rationale energy pricing structure,
- To develop human resources for development of energy technologies development;
- To ensure the continuity and security of energy supplies.

Immediate, short term strategies of the National Energy Policy include:

- Rehabilitation of the electric power generation, transmission and distribution infrastructure;
- Generation and distribution of electricity at affordable prices and commensurate with demand;
- Supply of electricity to small townships and industries lying adjacent to and far off the grid system, starting with agro-based industries and using alternative sources;

- Development and dissemination of simple and affordable electric stoves and appliances for rural and urban households.

It is difficult to measure, with any degree of accuracy, the extent to which the build-up of Tanzania's power sector has contributed decisively to achieve national development goals. This question is further elaborated below.

Concerning the overall goals, it appears that they have been achieved to a great extent by the construction of hydro power plants and that this also is in line with the short term strategies in the Energy Policy.

It is probably not reasonable to assume that the same amount of electricity as today comes from hydro power could have been generated by diesel generators. It is obvious that the build-up of the supply of electricity from hydro power stations has lessened Tanzania's costs for imports of expensive fuel. The Swedish support has obviously been instrumental in building a Tanzanian power system based on renewable domestic energy from hydro power.

There is, however, the issue of import of spare parts to the power stations, substations and transmissions lines which remains, and which seems to have been neglected by the Tanzanian side. This need is much smaller in relation to the costs of imported fuels, so it must be concluded that the objective to reduce the import burden has been fulfilled.

One potential gain from investments in energy, the spin off effect resulting from construction projects, seems not to have been realised in the case of Tanzania. In many countries local contractors participate in the construction work either directly or as subcontractors. In Tanzania the involvement of local contractors seems to have been rather low. The local contribution, though not small in terms of money, has consisted mainly of transport of material. No local civil contractors were established through the project and also the number of local staff working with building of substations seems to have been low. If promoting of spin off effects from the construction of power plants has been an objective from Sida or any other donors, this objective has not been fulfilled.

Supply of electricity to small townships and rural electrification in general has also been one objective/strategy in Tanzania. As has been shown in chapter 10 above this objective has been met to a very limited extent.

11.2 Relevance In Relation to Swedish Development Goals and Sida's Guidelines for Energy Assistance

Swedish goals for developing assistance

It is not possible within the scope of this mission to make an in depth analysis to in what extent the Swedish goals for developing assistance have been achieved by the Swedish energy assistance to Tanzania. The evaluation team therefore confines itself to, to evaluate two of the development goals with the help of a LFA-matrix. However, It should be emphasised that this is not at all a complete analysis, but more a way to indicate how a further analysis could be carried out.

The two development goals which are used here are
- The growth of resources
- Economic and social equality

The team makes the assumption that the goals above can be applicable during the whole period for the Swedish energy assistance.

Table 5

Goals for the Swedish dev. ass.	Indicators of achieving the goal	Means of verification	Timedimension	Measured outputs up to now
GROWTH OF RESOURCES	The raise in GDP, percent, per capita	Offical statistics	Long run	See statistics in the report
	Percentage of sales to industries out of the total load	Load statistics and field observations	Medium run	See statistics in the report
ECONOMIC AND SOCIAL EQUALITY	The rate of rural electrification Percentage poor among new customers	Statistics and field observations "-	Short to medium	See report

To complete this LFA-matrix the team has tried to make a comparison between the load forecasts used to justify the hydro power projects and the actual measured load. The result of this comparison is given in the table below.

Table 6

Project	The time for justification of the project	Load forecast used	Estimated demand/Year	Actual measured load/Year (energy sold)
Kidatu St.. I	1969		580 GWH/1975	579 GWh 80 MW/1975
Extension Kidatu St.. II Mtera Dam	1974		1000 GWh/1980	n a 115 MW/1980
Mtera Power Plant	1981		(2 080 GWh)	1 259 GWh 220 MW/1988 (peak demand)
Pangani	1991	Acres Power Sector Dev. Plan 1989	1811 GWh 378 MW/1995 (peak demand)	1460 GWh 333 MW/1995 (peak demand)
Lower Kihansi	1995	Updated power Sector Master Plan. Year ?	2750 GWh 1999	

It has not been possible to get accurate and reliable data and it is not possible to draw any firm conclusions from Table 6. However, Table 6 shows that the load forecasts used to justify the projects have more or less overestimated the future demand/need of electricity in Tanzania.

To be able to draw any reliable conclusions of the importance of access of electricity for the development in Tanzania, the LFA-matrix and the table above should be analysed and evaluated together with an analysis of the economic development in Tanzania, see macroeconomics indicators, page 5.

From this (incomplete) analysis above the team draws the (unreliable) conclusion that there is no indication that the supply of electricity from hydro power has so far had any decisive effect

- on the growth of resources in Tanzania.
- on reducing the poverty and promoting social equality

This conclusion is confirmed by other analyses which indicate that energy becomes an instrument for the eradication of poverty only when it is directed deliberately and specially towards the needs of the poor. (For a further discussion of these issues see "Energy as an Instrument for Socio-Economic Development" UNDP 1995, and "Human Development Report 1996" UNDP 1996)

There are, of course, many other strong external factors which have had impacts on development in Tanzania. And it is also true that supply of energy/electricity is only one of many macro economic factors which all together constitute a positive economic de-

velopment in a country. And it is further possible that the situation would have been worse without the Swedish energy assistance.

Nevertheless, the teams opinion is that the relative lack of results in relation to the Swedish goals is also a consequence of the fact that Sida has "jumped" from project to project without having comprehensive objectives or strategies for the energy sector or who will benefit from the electricity generated with Swedish support. One explanation to this could be that the energy assistance to Tanzania has never had the status of a "Sector Programme" but sometimes has been used to fill up to the every year decided total Swedish assistance to Tanzania.

Referring to the teams analysis on three levels, the team concludes that Sida has not made the necessary connection between the different levels in order to get out most of the support and achieve the Swedish goals.

As has been shown above, all the projects have been justified by more or less exaggerated load forecasts, without any analysis of how the electricity will be used. It should however be mentioned that in the "Insats-promemoria 195-05-03, STÖD TILL ENERGIPROGRAMMET POWER 6 I TANZANIA" it is stated that the prime target group for the electricity from Lower Kihansi is the industrial sector. No analysis is presented in the promemoria which supports that statement. Now Lower Kihansi will not be commissioned until 1999 and perhaps some radical changes in the demand for electricity may take place by then, but for the time being, 90% of new applications are from residential consumers.

With the ambition on the part of the Swedish (and Tanzanian) governments to achieve the goals above, more capacity for generation of electricity should thus not be installed without comprehensive plans and strategies for the distribution of the new electricity.

Sida's Guidelines for Energy Assistance

The evaluation of the actual Swedish energy assistance in relation to Sida´s guidelines for energy assistance during the period from 1967 onwards is presented below.

Sida has issued guidelines for energy assistance in 1980, 1990, 1995 and 1996 and summaries of these guidelines are given here together with decisions from Sida to support the power sector in Tanzania.

1967-1980

During this period decisions were taken to support the building of Kidatu stage I and II and also to support the construction of the Mtera Dam. As Sida at this time did not have any guidelines, it should be reasonable to view this decision in relation to the gen-

eral goals for Swedish aid, and the team refers to that analysis above.

The guidelines from **1980** emphasised:

- Planning assistance
- Further development of the hydroelectric sector

During the period 1980-1990 decisions were taken to support the construction of Mtera Power Plant and also to support rehabilitation of Kidatu, Phase I. The teams assessment is that these decisions are in accordance with the guidelines from 1980.

The new guidelines from **1990** stated that Sida will give support to:

- Energy efficiency
- Energy planning and policy development through ESMAP and SEI
- Hydro power plants but with a gradual shift from hardware to more software, also upgrading existing capacities in management, planning and operation and maintenance skills
- Measures to improve the energy situation for the poor people
- Competence improvement and institution building.

During the period 1990-1995 decisions were taken to support improvements in the Grid System Voltage, Pangani Falls Redevelopment Project and Dar es Salaam Gas Turbine Project. In addition to that support has also been given among others to ESMAP concerning DSM activities and to SEI concerning rural electrification.

As is presented in section 5.5, the Pangani project included an extensive transfer of technical training in maintenance and operation of the station, as well as environmental considerations and an ambitious Community Development Program. All this is an improvement compared to earlier support to power projects.

The evaluation team, however, makes the summarised assessment that there was still an overwhelming focus on generation during this period. A 'shift' in energy assistance in line with the guidelines was not accomplished during this period. It should be stressed that to be able to make a fair assessment, there should also be an evaluation of to what extent it was possible to make a shift in the energy assistance in line with the guidelines. That evaluation is not however within the scope of this mission.

As the new guidelines from 1995 and 1996 are identical to a great extent, they are dealt with together here.

1995:
- Development of institutions and of the legal and regulatory framework
- Support to power projects combined with support to institutional and manpower development
- Support to energy efficiency and environment
- Include energy aspects into integrated development programmes to improve the energy situation for the poor people

1996:
Prioritised areas are
- Development of institutions and of the legal and regulatory framework
- Support to institutional reinforcement of organisations/institutions within the field of energy and environment
- Energy efficiency
- Introduction of renewable energy resources
- Sida will support feasibility studies and power projects provided that the recipient country carries out a sound energy policy in favour of environment and sustainable development

During the period 1995-1996 decision has been taken to support the Power VI projects. This includes support to Lower Kihansi and the team can on the whole make the same positive assessment of that project as of Pangani. This is also in line with the environmental parts in the guidelines as hydro power is a renewable energy source and the generation (hydro power) and use of electricity has few negative environmental impact compared with many other energy sources.

However, any notable shifts in energy assistance in line with other parts of the guidelines have not been taken. And what is more, according to information given to the team, the energy assistance during the next 2-3 years will (to almost 100%?) consist of support only to generation (=Rehabilitation of Kidatu+Lower Kihansi+Feasibility Studies).

To sum up the evaluation in this section; the team makes the assessment that the energy assistance during the 70's and 80's was, on the whole, in line with the guidelines of that time, but concurrently with the new guidelines during the 90's the actual energy assistance has to a very great extent come out of line with the new guidelines. That because the actual energy assistance has during the whole time had the focus on generation and in the new guidelines other prioritised areas than generation have been included.

12. Conclusions

The Swedish assistance to Tanzania's power sector with the construction of hydro power plants, has to a great extent been relevant to meet many of the stated goals in Tanzania's National Energy Policy. The Swedish assistance has thus been instrumental in building a Tanzanian power system based on renewable domestic energy from hydro power and significantly lessened Tanzania's costs for imports of expensive fuel.

There are no reliable indications that the access to electricity from hydro power has so far had any decisive effect

- on the growth of resources in Tanzania.
- on reducing the poverty and promoting social equality
- on promoting equality between women and men

This is confirmed by conclusions from other energy studies that energy becomes an instrument for the eradication of poverty only when it is directed deliberately and specially towards the needs of the poor.

Sida has "jumped" from project to project without having comprehensive objectives or strategies for the energy or who will benefit from the electricity to be generated. The energy assistance to Tanzania has never had the status of a "Sector Programme" but sometimes has been used to fill up the every year decided total Swedish assistance to Tanzania.

Sida has not made or seen the necessary connection between the different levels of the Tanzanian energy sector/system in order to get out most of the support and achieve the Swedish goals.

All the projects have been justified by more or less exaggerated load forecasts, without any analyses of how the electricity will be used.

The conclusion of this could be that access to electricity is not enough in the short run for a successful and sound development of a country but it is the team's firm opinion that a reliable supply of electricity is a basic condition for economic growth and development in the long run in Tanzania.

The Swedish energy assistance during the 70's and 80's was, on the whole, in line with the guidelines of that time, but concurrently with the new guidelines during the 90's, the actual energy assistance has to a very great extent come out of line with the new guidelines. That because the actual energy assistance has during the whole time had the focus on generation and in the new guidelines other prioritised areas than generation have been included.

The selection of sites for new hydro power plants has to a great extent been prepared by pre-investment studies and various appraisals which together with thoroughly project planning have contributed to a efficient project implementation.

So far actual production values for Kidatu and Mtera have not reached the projected targets for the two power stations. There is also reason to believe that the future actual production values will not reach the projected values. The calculations of the inflow to the Mtera reservoir seems to indicate that the major reason to the deficit is from the abnormally low values for the inflow during the period. Combined with the information given to the evaluation team about additional use of water for irrigation purposes in the catchment area there are strong reasons for an objective and independent assessment of the situation immediately. Correct hydrological data are necessary both for the annual operational planning and the system expansion planning.

The maintenance situation at Kidatu is very bad. The cause for the situation is to be found both in technical area and in the financial/ administrative procedures for purchase of spare parts and consumable.

TANESCO has benefited very well from the training given as part of the construction projects and the staff has achieved a good technical knowledge for the operation and maintenance of the plants. TANESCO has also transferred the experience from older plants to new ones by transfer of some experienced staff to the new installations.

Too little attention has been given to the area of planning of production for the interconnected system. The load dispatch centre has been used mainly for the transmission system operation while the work of long term generation scheduling has been given less attention.

Most of the projects are hydro power plants which in comparison with thermal generation will require very little future support from abroad. For the control and protection equipment there has been a development towards including much more electronic devices in the later installations. This has a potential to improve the reliability for the installations. But this will only be achieved if proper resources and methods are applied for the maintenance. For the moment this prerequisite is not fulfilled at TANESCO and there is every reason to closely follow the development.

The modern technology used for gas turbines is in principle new for TANESCO. As this type of installations are more sensitive for correct handling than hydro power it is well justified to arrange a

management support . The long periods when the turbines not have been used makes it however doubtful if the extent of the support with eight persons is the correct choice. Also for the future TANESCO can not afford to use the units for base load generation why they will be used only during day time or at times when there is an obvious risk for load shedding.

The construction projects in Tanzania have included a local contribution which financially has been of normal size. The content of the contribution has been mainly transportation of the goods from harbour up to the site. Because of that the projects have given very small spin off effects in the form of creating or reinforcing local companies for civil engineering etc.

In the Sida-supported projects during the 90's in the Tanzanian energy sector, the goal of ensuring the timely inclusion of EIA results into the project cycle has not to a full extent been achieved. On the other hand, the quality and comprehensiveness of the environmental studies in connection with hydroelectric power development has been steadily improving since the first projects began in 1974 when, it must be remembered, the concept of the EIA did not exist. Environmental assessments of thermal power development have been hastily implemented and are superficial in nature.

Site selection for hydroelectric power plants has been carried out without much regard to the potential environmental impact, but rather based on technical and economic considerations. On the other hand, the overall environmental impact of these installations and their concomitant reservoirs and desiccated river beds has been relatively benign.

The Pangani Redevelopment Project represented the first real attempt in the series of Sida-supported projects, to carry out an EIA during the planning process. This process has not always been a smooth one, but there was a genuine ambition to collect comprehensive baseline data and mitigating measures were proposed, implemented and followed up during both the construction and operations phases.

The most recent project, the Lower Kihansi, which is still under construction, has had a very high ambition level in terms of carrying out a comprehensive EIA already in the planning phase. It is also the first project where environmental studies preceded the site choice.

The socio-economic impacts on the surrounding area from construction and running of hydro power stations has been paid much attention to in the projects - Pangani and Kihansi - during the 90's. Ambitious Community Development Programmes have been plan-

ned, and in the case of Pangani, been implemented. The implementation has to a certain extent been successful but many of the planned activities started, however, too late.

The Sida financed projects have, to a great extent, included activities focused on institutional and competence development and these activities have been successful and the planned objectives have been met to a very great extent

Sida has not financed any activities in Tanzania focused on the general strengthening of TANESCO in areas such as corporate culture and structure, management, financial performance, human resources, etc.

One part of TANESCO - the construction and operation of the power system - has developed with high technical skill and competence, while other parts of TANESCO, and also the policy framework within which the company operates, have not developed at all. The Swedish support to institutional and competence development has been too limited to the hydro power projects and the technical parts of TANESCO to be a substantial contribution to TANESCO´s total capacity to develop its power sector in a sustainable way.

There is a great need of restructuring of the power sector in Tanzania and in combination with that an institutional and competence strengthening of TANESCO which will enable TANESCO to develop as an independent company and also generate enough funds for operating the power system in a proper way.

13. Recommendations for the Future Swedish Energy Assistance to Tanzania

13.1. Overall Policy Issues

1. With the goals for Swedish international co-operation and Sida's guidelines for energy assistance as starting points, Sida should undertake a study how to form the future energy assistance in line with these goals and guidelines with focus on alleviating poverty and improvements of the women's position.

2. If the future Swedish energy assistance shall be in line with the guidelines from 1996, there should be a reduction in supporting generation and an increase in support to, among others, institutions (including TANESCO) and NGOs within the energy sector, rural electrification, DSM and other energy efficiency activities

and on the whole, to activities directed to poor people and women.

3. Sida should give strong support to Tanzania to work out a comprehensive energy policy comprising all the dimensions and levels of the energy sector, from generation to end use. This policy should be completed with operative objectives and strategies for measures to be taken in short, medium and long run.

4. The Team calls for urgent measures concerning the restructuring of the energy sector to be taken within short time. The team gives the recommendation that Sida together with the other donors put most possible pressure on the Government of Tanzania to come to appropriate measures.

13.2. Operation and Maintenance of the Power System

1. The team stresses the importance of the extension of capacity of the thermal power production during the next years in accordance with plans of TANESCO. This reinforcement of 100 MW private diesel power plants are necessary to get a proper balance in the whole power system.

2. It is a matter of urgency that a neutral (i.e. independent from both TANESCO and the Ministry of Agriculture) investigation of inflow and abstractions in Mtera dam be carried out to avoid further water use conflicts.

3. The Swedish support should also be directed to measures to improve the standard, quality and operation of the power system and also to improve energy efficiency use by the customers (DSM/ energy efficient activities).

4. The extension of the operation management contract of the Gas Turbines should be based on firmer commitments about the availability of funds for fuel and spare parts for the plant.

13.3. Support to Generation Projects

1. Swedish support to Kidatu rehabilitation should be given provided that there be a plan from TANESCO encompassing a management, training, maintenance programme for the Kidatu station and also close follow-ups of implementation.

2. The proposed funds for rehabilitation of Kidatu are 50+24 MSEK. This will be sufficient only for items with priority 1 and 2 which are the most urgent needs. It is doubtful if the proposed rehabilitation is sufficient. The reasons for the deterioration must

be better explained in order to guaranty a sustain ability of the effects of the rehabilitation.

3. For financing of the hydro power projects so far the local financed part has been very low, with one exception: Lower Kihansi. In this project the local part is stated to 33 MUSD or almost 13% of the total costs. It could be considered to be a Swedish requirement that the self financing in future projects shall continually increase.

4. If Sida in the future shall give support to another hydro power station after Lower Kihansi, it should be given provided only that the following basic conditions are fulfilled:

   That TANESCO will have the full opportunity to (within overall policies set by the owner) develop as an independent company which can use funds generated from own sources for an proper operation and maintenance standard of its power stations and for investments in new generation capacity,

   That TANESCO will during the rest of the 90's show the capacity for an independent organisational and institutional strengthening in line with the demands from the World Bank,

   TANESCO should draw up and apply a economic model showing the financial situation for the company with different assumptions about the water levels in the dams, components (hydro, thermal, gas turbines) in the power system, tariffs, demand for energy etc. From this a strategy for operation of the power system should be formulated and applied.

13.4. Transfer of Technology and Training

1. The part of transferring of technology and training for operation and maintenance in the future projects should include, among other, a follow up (brush up) about two years after completion.

13.5. Environmental Aspects and Considerations

1. Water quality measurements, including sedimentation rates and measurement of heavy metals, should be carried out both upstream and downstream of the reservoir at Kidatu.

2. A more systematic inventory of wildlife resources in the catchment area of the Mtera dam should be carried out.

3. Ensure that EIAs are carried out simultaneously with technical and economic feasibility studies of power plants and that they form an input into pre-project decision-making.

4. Ensure that EIAs are carried out by a consultant/institution independent of the construction/engineering implementation consultants.

5. Specify follow-up measures for EIA and socio-economic baseline studies, including an institutional responsibility for co-ordinating the follow-up. This should be a national or local (as opposed to foreign) institution.

6. There should be regular measurements of the air quality at Ubungo, although it is far more likely that vehicle emissions (and the old diesel generators in operation there) are a more serious source of pollutants. This is not necessarily the responsibility of TANESCO, but should be carried out in a wider study of air quality in Dar es Salaam.

13.6 Socio-Economic Aspects and Considerations

1. Malaria is a serious health problem in the area. Co-operation between TANESCO and the local authorities to promote prophylaxis and eradication measures should be encouraged.

2. In the Kihansi project, take care of lessons learned from Pangani, mainly the need of close follow ups of mitigative measures concerning socio-economics impacts and also ensure that other conditions laid down by Sida are fulfilled.

3. Community Development Programmes in surrounding villages in connection with the construction of new hydro power stations should be agreed on with the local and central government and to that level of activities that it will be possible to run the programmes also after the completion of the station. It is also important that there will be a mobilisation among the villagers for local works as a part of the programme.

13.7 Institutional and Competence Development

1. The further activities concerning institutional and competence development should be focused on three levels:

   (i) A continuation of the transferring of technical and management skill and competence to build and run the power system in connection with hydro power projects.

   (ii) Reinforced activities directed to strengthen TANESCO in areas as corporate culture and planning, management, financial performance, human resources etc. The team makes the assessment that Swedish competence and profile in these areas could be a substantial contribution to TANESCO.

(iii) Very strong activities to the restructuring of the power sector and create a legal and regulatory framework which enables TANESCO to, inter alia, generate and keep the needed resources to operate the power system.

The further Swedish energy assistance must then address all these levels. It is otherwise a great risk that the money directed to level (i) above will to a certain extent be wasted money.

13.8. Others

1. Sida should work out (or apply already existing) system/routines to ensure that experiences/lessons learned in one project are transferred and implemented in other projects.

2. Swedish support to local Tanzanian institutions/organisations, mainly within the field on environment to carry out independent EIAs.

3. Sida should give strong support to rural electrification and together with TANESCO develop different concepts. One concept which seems to be promising is a consumers co-operative society, as in Urambo. This electrification in Urambo is built on power from diesel and that is perhaps the most realistic in short run. For the long run rural electrification should however be connected with the exploitation of local renewable energy sources.

4. When the size of the system is growing the annual amount of investment is increasing so that other sources for financing must be sought. It is natural that Sida's role is reduced.

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DRAFT

A Preparatory Desk-Study for the Evaluation of the Swedish Support to Tanzania's Power Sector

By

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June 24, 1996

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Preparatory Desk-study for the Evaluation of the Swedish Support to Tanzania's Power Sector

Table of Contents **Page**

APPENDICES

Appendix 1

TERMS OF REFERENCE

EVALUATION OF THE SWEDISH SUPPORT TO TANZANIA'S POWER SECTOR

1. BACKGROUND

Sweden has contributed to the development of Tanzania's power sector since 1967. Apart from a brief review and assessment carried out in 1981, the Swedish assistance to the sector has never in any acceptable sense been evaluated. Considering Sweden's continued assistance since the late sixties as a major donor within the power sector and the current growing need of heavy investments in the country, an evaluation is now of importance. Sida has therefore decided to undertake an evaluation of the Swedish support over the years to Tanzania's power sector.

To contribute to the effectiveness of the work of the evaluation team, a preparatory desk study has been carried out in advance of the assignment of the evaluation team, encl. 3. The desk study also gives a detailed background to the evaluation. The objective of the desk study has been to identify all key elements of the power sector and the Swedish support. Analysing the data, formulating observations, establishing findings and recommendations for the future will be tasks for the evaluation team.

2. OBJECTIVES

The objectives of the evaluation are:

i) To facilitate updated and improved informed decisions regarding strategies and investments on the parts of concerned bodies, actors and decision makers in Tanzania and in Sweden, through increased knowledge of the power sector and its needs, and any "lessons learned" that may be identified from projects assisted by Sweden

ii) To account for the results and the effects of the Swedish assistance to the sector

3. SCOPE OF WORK

The projects to be evaluated are identified in the desk study, encl. 3.

The evaluation shall provide answers to the questions listed below.

3.1 General aspects

Has the Swedish support been relevant over the years in relation to the changing needs and problems as identified and experienced by the recipient? In relation to the Swedish development goals?

Which have been the objectives, targets and rationale set out by Sida for Sweden's support to the sector?

To what degree have the stated objectives at different levels (outputs and project, sectoral and development objectives) been achieved? What were the causes of high or low achievements?

What have been the main problems and constraints during implementation? What constraints and what opportunities exist in the project environments?

What results and what impact on the development of the sector has the Swedish support had, positive as well as negative ? What role and significance has the Swedish support played?

Have any unforseen effects from support occurred, positive or negative?

3.2 Economical aspects

What are the total contributions through Sida to the sector, economically and in terms of power supply?

Have the investments been financially sound? To what extent have calculated economic rates of return been achieved?

Has the Tanzanian power system been economically operated?

Were the objectives achieved within the specified time and budget?

Have resources been utilized efficiently? Could the same or better results have been achieved with less resources? Could the allocated resources have been utilized more efficiently?

3.3 Technical aspects

Has the choice of technology been appropriate for the Tanzanian conditions?

Have appropriate operational and maintenance routines been established at the power stations? Have investments been sufficiently maintained over the years? Has the need for spare parts been satisfactorily met?

To what extent has the technical capacity of the power plants been utilized (in terms of efficiency, availability etc)?

To what extent has transfer of technology, skills and responsabilities been a feature of the Swedish contribution? Were the counterparts adequately prepared for the handing over of the projects? Has sufficient "ownership" been developed and sustained?

3.4 Institutional and competence development

To what extent have the Sida financed projects included activities focused on institutional and competence development?

How has TANESCO's organisation developed over the years? To which extent does the organisation today have objectives for the institution buildning process which are both clear and and agreed with other parties? Are these objectives being achieved? What impact has Sida's support to the energy sector had on the organisational development?

How have the human resources within TANESCO been developed and utilized? Is the competence profile in line with existing needs of the company? To which extent have Sida financed projects involved training and capacity building? Has this support been relevant and what impacts can be noticed?

To what extent has the support contributed to permanent and sustainable changes or improvements in Tanzania's capacity to develop its power sector?

3.5 Environmental aspects

What environmental considerations have been taken in the development of the Tanzanian power sector? What environmental consequences, positive or negative, have been noted? Have measures been taken to decrease possible negative impact? The handling of each project started since 1991 should be checked against the checklist for energy projects in Sida's "Riktlinjer för miljökonsekvensbedömningar i biståndet" (Guidelines for EIA), annex 1, to determine to what degree various environmental aspects have been taken into account.

To what extent is there a mechanism for checking the environmental impact? Is it adequate, and how has it been used?

3.6 Gender/poverty aspects

In what way has the Swedish contributions to the sector affected the status, influence and economic opportunities of women? How were the interests and roles of women (in comparison to those of men) examined and considered during the implementation of the projects?

To what extent has the development of the sector affected or impacted on poverty? Could Swedish assistance have been more focused on poverty alleviation?

3.7 Conclusions

The conclusions should cover all aspects specified above. Particular emphasis should be put on the following:

Has the Swedish support been relevant over the years in relation to the changing needs and problems as identified and experienced by the recipient? In relation to the Swedish development goals?

What were the main sucesses/failures of the projects to-date. What were the causes underlying the outcome?

Do the effects/impacts justify the costs involved?

Is post-project maintenance of investments and and support of institutional structures likely to be adequately funded and executed?

Is the policy environment likely to ensure sustainability of the project's benefits?

3.8 "Lessons learned" and recommendations for future cooperation

What are the important lessons to be learned from the Swedish involvement (i) experiences and lessons of more general nature, and (ii) lessons of interest to those who are not directly involved in the development of the sector (consumer categories etc)?

To what degree do ongoing projects comply with Sida's new energy policy (annex 2)? Which aspects could possibly be further incorporated in ongoing projects?

In the light of the outcome of the evaluation, what recommendations would the evaluation team make to Sida concerning strategies, future fields of cooperation, methodology etc. within the energy sector?

4. METHODOLOGY, EVALUATION TEAM AND TIME SCHEDULE

The evaluation shall include the following steps:

1) Preparation
2) Field work in Tanzania, interviews, visits to projects, preliminary formulation of conclusions, approximately 2 weeks
3) Draft final report
4) Presentation of the work at a seminar arranged by Sida.
5) Final report

The evaluation shall be performed in close cooperation with a senior officer at TANESCO who will assist the evaluation team in finding relevant information and organizing a visiting programme. Relevant publications and reports will be made available from the Swedish Embassy in Dar es Salaam and Sida/INEC, Stockholm.

LFA analyses shall be used whenever applicable (see LFA-guide, annex 3).

The intended evaluation approach and methodology shall be specified in the tender.

The evaluation team shall be composed of 2-4 persons possessing competence in the fields of economics, power systems and environment and sufficient knowledge of gender and poverty aspects. The team members should neither have been assigned by a company or as an individual within the energy sector in Tanzania in the past, nor at present being assigned by a

company with Sida financed contract in the energy sector. However, experience from Africa or other developing countries would be an asset.

The visit of the evaluation team to Tanzania should preferably take place during September-October 1996. Before leaving Tanzania, a summary covering the preliminary findings and conclusions, shall be presented, preferably in writing, to relevant authorities and to Sida's representation in Dar es Salaam. A draft final report shall be presented to Sida within three weeks after the completion of the visit to Tanzania followed by a seminar at Sida in Sweden. The final report shall be submitted to Sida within one week after the completion of the seminar.

5. REPORTING

The report shall be written in English and in accordance with the Standardized Format as described in the Sida Evaluation Manual 1994, annex 4. Word Perfect 6.1 for MS-DOS or a compatible program shall be used and the report should be presented in a way that enables publication without further editing. Sida shall be provided with 10 copies and on diskette. Subject to decision by Sida, the report will be published within the Sida Evaluation Series.

The evaluation assignment includes production of a summary in English according to the guidelines for Sida Evaluations Newsletter, annex 5, and the completion of a Data Work Sheet, annex 6.

PEOPLE MET AND INTERVIEWED DURING THE VISIT TO TANZANIA.

Ministry of Energy and Minerals (MEM)

Ms E. M. Mazunzu	Commissioner of Department of Energy
Mr T. Bwakea	Electrical Engineer

TANESCO, Head Office

Mr B. E. A. T. Luhanga	Managing Director
Mr K. R. Abdulla	Director Corporate Planning and Research
Mr S. P. Mabada	Director Diesel Plants

KIDATU Hydro Power Station

Mr. Lyamue	Manager Maintenance
Mr. Munno	Manager Operations

MTERA Hydro Power station

Mr. N. Kachwamba	Manager Maintenance

PANGANI Hydro Power Station

D. Mhaiki	Manager Operations
J. Mtolera	Manager Maintenance
Mrs. S.P. Mwaiko	Senior Environmentalist (PBWO)

UBUNGO Grid Control Centre

Mr M. F. Mallale	Manager System Control

UBUNGO, Dar es Salaam Gas Turbines

Mr C Elvin	Operation Manager

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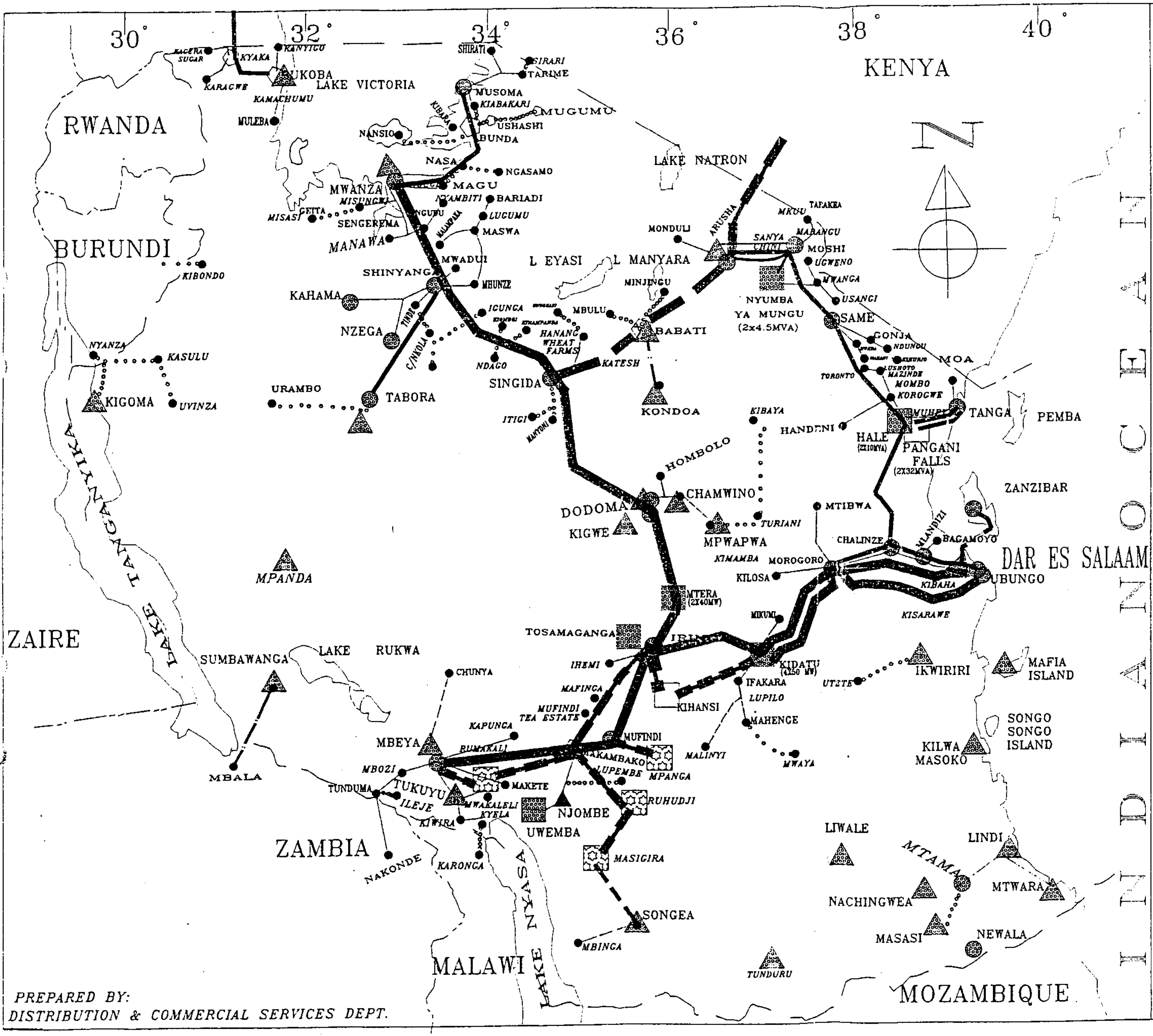
APPENDIX V

THE NATIONAL GRID SYSTEM



LEGEND

POWER STATIONS

EXISTING	UNDER CONSTRUCTION	*PROPOSED*	
■	□	⬡	HYDRO
▲	△		THERMAL
●	○	⬠	SUBSTATION

TRANSMISSION LINES

EXISTING	UNDER CONSTRUCTION	PROPOSED	KV
			220
			132
			66
			33

NOTE

INFORMATION IS AS OF JANUARY, 19[illegible]
TANZANIA ELECTRIC SUPPLY COMPANY LIMIT[illegible]
REVIEW OF 1985 DEVELOPMENT PLA[illegible]

EXISTING GENERATION AND TRANSMISS[illegible]

Hydropower Plants	Installed Capacity (MW)	Available Capacity (MW)	Total Available Capacity (MW)	Available Firm Gen. Capacity (GWh/year)	Available Average Gen. Capacity (GWh/year)	Total Available Capacity (GWh/year)
Kidatu	200.0	200.0	200.0	1160	1160	1160
Mtera	80.0	80.0	280.0	464	464	1624
New Pangani Falls	66.0	66.0	346.0	383	383	2007
Hale	21.0	21.0	367.0	122	122	2129
Nyumba Ya Mungu	8.0	8.0	375.0	46	46	2175
Tosamaganga	1.2	0.0	375.0	0	0	2175
Kikuletwa	1.2	0.0	375.0	0	0	2175
TOTAL	377.4	375.0	375.0	2175	2175	2175

Thermal Power Plants	Installed Capacity (MW)	Available Capacity (MW)	Total Available Capacity (MW)	Available Firm Gen. Capacity (GWh/year)	Available Average Gen. Capacity (GWh/year)	Total Available Capacity (GWh/year)
Ubungo ABB, GT (GT10)	37.0	32.0	32.0	160	160	160
Ubungo EPP, GT (LM6000)	75.0	75.0	107.0	375	375	535
Ubungo diesels	32.0	10.0	117.0	70	70	605
Arusha	3.7	0.0	117.0	0	0	605
Dodoma	7.4	7.0	124.0	49	49	654
Mbyea	13.9	6.6	130.6	46	46	700
Mwanza	12.0	6.0	136.6	42	42	742
Tabora	10.3	6.6	143.2	46	46	788
Mpwapwa	1.0	0.9	144.0	6	6	794
Musoma	6.7	2.2	146.2	16	16	810
Tukuyu (1.7 MW)	0.70	0.25	146.5	2	2	811
TOTAL	199.7	146.5	146.5	811	811	811

Hydropower and Thermal Power Plants	Installed Capacity (MW)	Available Capacity (MW)	Total Available Capacity (MW)	Available Firm Gen. Capacity (GWh/year)	Available Average Gen. Capacity (GWh/year)	Total Available Capacity (GWh/year)
TOTAL	577.1	521.5	521.5	2986	2986	2986

4.3.2 Expansion Plans

The planned new generation capacity and planned new international interconnection lines are shown in the table below.

Comments to the table below:

- Generation additions assumed to be in service at the beginning of each year indicated.
- The table shows the available firm capacity in the plants.

Elon Dahlström
Verksamhetsutveckling AB

20/10 96

EVALUATION OF THE SWEDISH SUPPORT TO TANZANIA´S POWER SECT

Survey of the projects with Swedish support MSEK (If not other stated)

PROJECTS	TOTAL PROJECT COSTS,	ACTUAL	SWEDISH CONTRIB	OTHER DONORS	PROJECT PERIOD	INSTALLED CAPACITY	PROJECT COMPONENTS
5.1 KIDATU STAGE I		214,4	80,75	WB, CIDA	1967-1971-1975	Diesel 15 MW	Studies 3,7
						Hydro 100 MW	Diesel
							Hydro 75
							Training Inst. 2,0
5.2 EXTENSION		351,4	89,6	WB, KfW	1974-1977-1980/81	Hydro 100 MW	Studies 3,6
KIDATU, MTERA DAM				EU			Op. Staff 4,7
							Booms etc.1,25
							Hydro
							Dam 80
5.3 MTERA POWER		245 USD	135,3	IDA,KFAED	1980-1983/84-1988	Hydro 84 MW	Studies 3.3
PLANT				MCC,KfW			Plant 132,0
				NORAD			
4 REHABILITATION							
KIDATU PHASE I		23,5	23,5	None	1990-1991-1993/94		Rehabilitation of performance
							Improving TANESCO´S finan.
							situation
5.5 IPROVEMENT							
GRID		10	10	None	1990-1992/93-93/94		Improv. Operat. Perf. TANESCO´S
							Power System
							Dito Financial Performance
							Reduction cost unused energy
							Eff. utilisation of energy
5.6 PANGANI FALLS				FINNIDA	1989-1991-1995	Hydro 66 MW	(See Desk Study page 31)
REDEVELOPMENT	820 NOK	< 820 NO	208	NORAD		313 GWh	
5.7 DeS GAS	206+20 NOK						
TURBINES	PLUS WB		206	NORAD	1992-1994	37+70 MW	
				WB			
5.8 POWER VI PROJECT			300				
5.8.1 LOWER KIHANSI	257 MUSD		-200	IDA and o.	1995-1999	180 MW	I.A. Water Management Plan
						plus 180 MW	
5.8.2 REHABILITATION			-50		1995-?		
KIDATU, Phase II							
8.3 FEASIBILITY STUDIES	30		-15		1995-?		

Appendix 8

Calculation of inflows to the Mtera reservoir.

The calculated inflows at Kidatu for the period 1990-96 are shown in enclosed Table 1. The inflows are based on the measured power generation at Kidatu. The production values for 1996 are based on actual values for ten months which have been extrapolated to the full year. The values will be updated in the final report when actual values are available. No correction has been made for spill of water even if it is known that some amounts have passed outside the turbines due to the non-availability of one unit at Kidatu during 1990 and 1991. The inflows can be compared with the statistical distribution curve used by Sweco in the pre-investment study for the plant. None of the observed values are coming up to average value. And none of them are outside the range of values used for the simulation of the power plant operation for the pre investment studies.

The average annual production for the period 1990-95 at Kidatu is 964 GWh/year to be compared with the calculated average of 1,300 GWh/year in the pre-investment study. This means that the average for the period is only 74 % of the expected. This deviation is surprisingly big. The explanation can be either that Sweco used values for the inflow which were too high or that the inflows have diminished e. g. by increased use of water for irrigation in the catchment area as stated by TANESCO. A reduction of the inflow to Mtera with 1 m3/s as an annual average means a reduction of 25 GWh/year in the production at Mtera and Kidatu.

The inflow to Mtera dam has also been calculated in the same manner in enclosed Table 2. The calculated inflows are compared with the statistical distribution for the inflow used by Sweco in the pre investment study. This shows that the inflows 1990-95 has been extremely low for all years. For the year 1992 the inflow has only been 29% 0f the average estimated by SWECO.

Knowing the release of water from Mtera and Kidatu the local inflow between the power plants can be calculated. The values for 1990 and 1991 are extremely low possibly because of spill of water at Kidatu which will underestimate the local inflow. For the period as a whole the inflows are only coming up to 47% of the average value assumed by Sweco. This would support a statement that the period has been exceptionally dry.

In Table 1 is also shown the relation between production at Kidatu and Mtera. This value is clearly lower for 1990 and 1991 compared with the later years. An explanation for this could be the fault on one generator at Kidatu and that water has been spilled at Kidatu. This amount could have corresponded to about 200-250 GWh per year.

The information about volume of spilled water has not been clear in terms of quantities. If it is so that a considerable amount of water has been spilled at Kidatu the effect would be that the later load shedding was less caused by low inflows and more by the type of operation caused by the generator fault at Kidatu.

In the pre-investment study is mention about big difficulties to obtain reliable statistical data for the inflows to the reservoir. There is a description of attempts to make an calculated series for the inflows to extend the observed values for fourteen years. The calculated values came out as considerably lower than the observed series so they were not used for the dimensioning of the plant. There is also descriptions of gauges being washed away by severe floods. There is thus reason to closely follow up future values in order to create a reliable basis for operational planning. Possibly the values prepared for the pre-investment study have been on the high side or there is an abstraction of water for irrigation reducing the inflows to the reservoir today.

Conclusions of the calculations

1. The inflows to the Mtera reservoir are extremely low and clearly outside the data range used for the design for Kidatu and Mtera power plants.

2. The annual production at Kidatu has never reached the average annual production value of 1300 GWh per year for which it was designed. The hydrological statistic used for future planning should be revised.

Inflow Kidatu Reservoir 1990-96

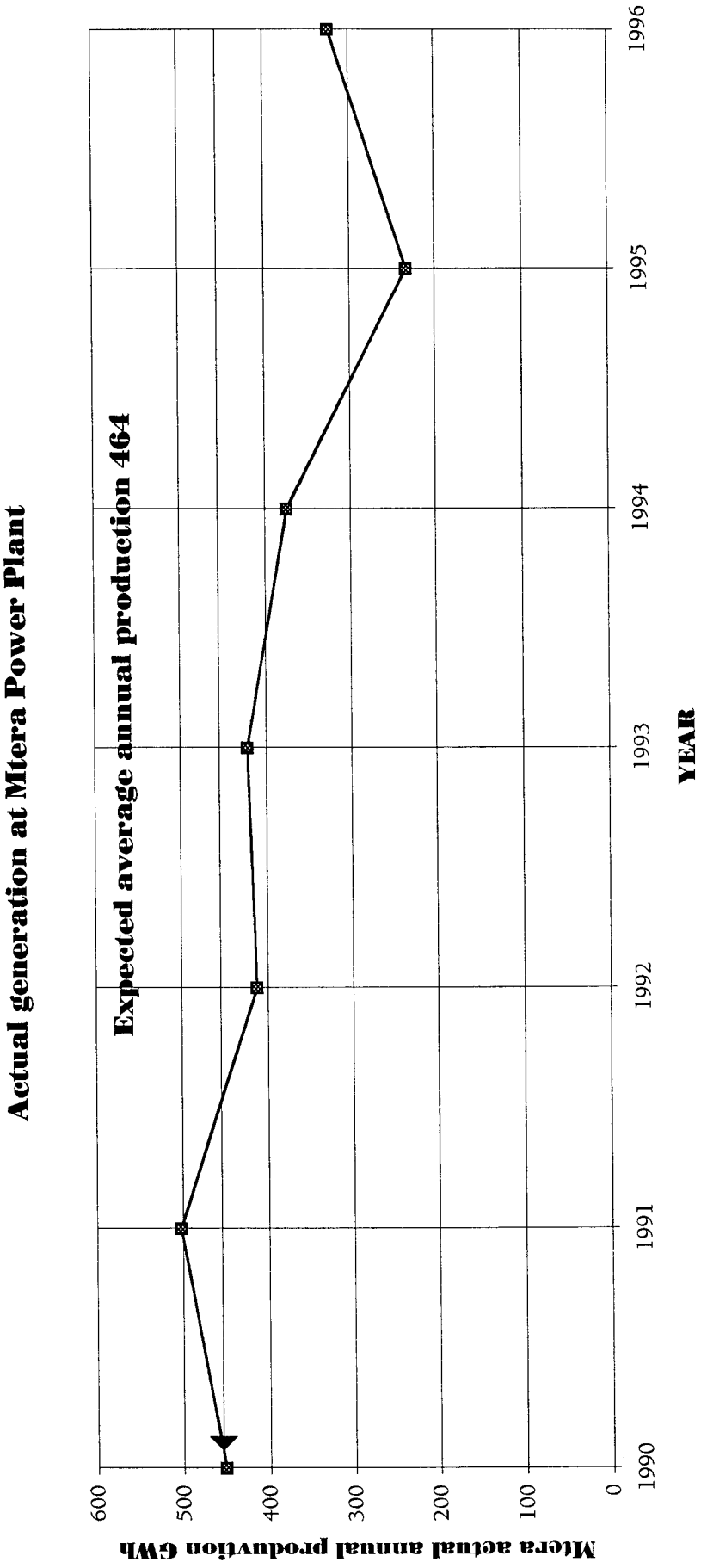
	A	B	C	D	E	F	G	H
1		1990	1991	1992	1993	1994	1995	1996
2	Kidatu prod MWh	891 246	978 605	989 800	1 107 115	963 478	855 726	964 328
3	Normal year MWh	1 300 000	1 300 000	1 300 000	1 300 000	1 300 000	1 300 000	1 300 000
4	Percent of Normal year	69%	75%	76%	85%	74%	66%	74%
5	Water volume Mm3	2 315	2 542	2 571	2 876	2 503	2 223	2 505
6	Annual average MW	102	112	113	126	110	98	110
7	Annual average m3/s	73	81	82	91	79	70	79
8	Mtera start Mm3	2 800	2 360	1 520	520	800	100	400
9	Mtera end Mm3	2 360	1 520	520	800	100	400	100
10	Total inflow Kidatu Mm3	1 875	1 702	1 571	3 156	1 803	2 523	2 205
11	Probability of better inflo	90%	93%	97%	58%	92%	75%	
12	Percent of average in Swec	54%	49%	45%	90%	52%	72%	63%
13								
14	Load shedding acc SwedPower in MWh		0	91 000	98 800	207 700	152 400	
15								
16	Mtera prod MWh	450 834	501 591	411 819	421 490	374 070	233 002	323 000
17								
18	Relation Kidatu/Mtera	1,98	1,95	2,40	2,63	2,58	3,67	2,99

Appendix VIII, Table 1

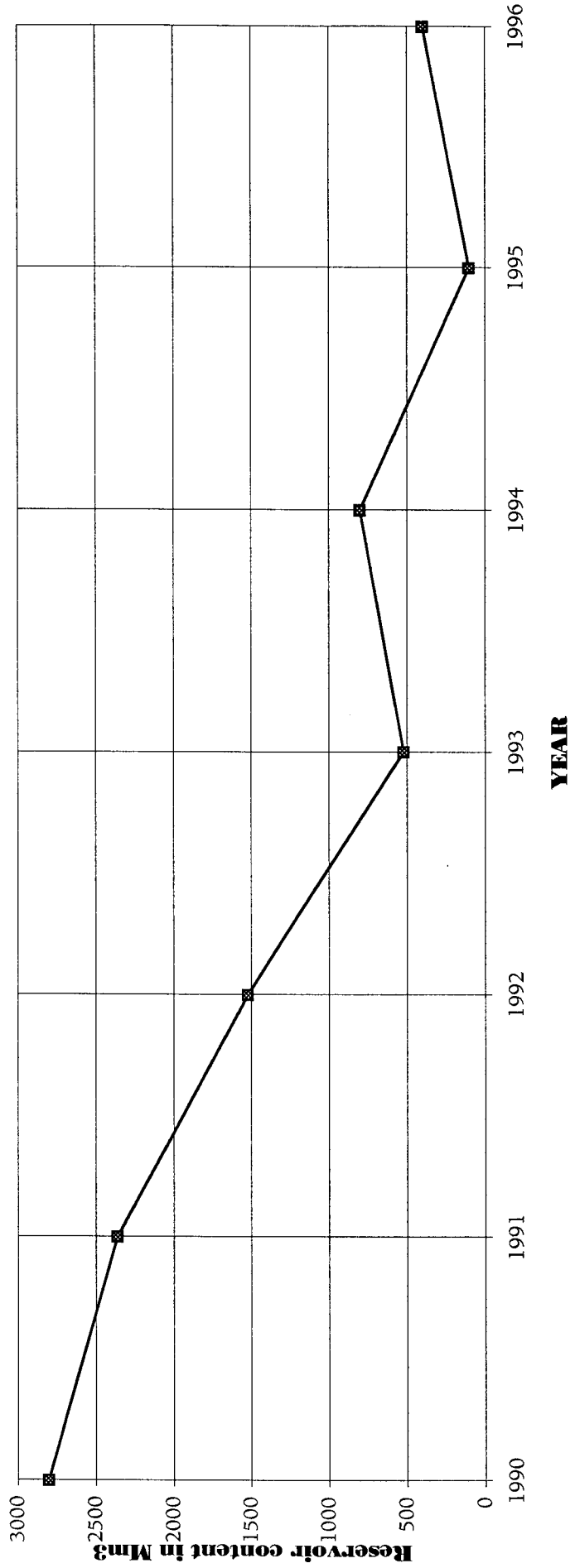
Inflow Mtera reservoir 1990-96

	A	B	C	D	E	F	G	H
1		***1990***	***1991***	***1992***	***1993***	***1994***	***1995***	***1996***
2	Mtera prod MWh	450 834	501 591	411 819	421 490	374 070	233 002	323 000
3	Normal year MWh	464 000	464 000	464 000	464 000	464 000	464 000	464 000
4	**Percent of normal year**	97%	108%	89%	91%	81%	50%	70%
5	**Water volume Mm3**	1 932	2 150	1 765	1 806	1 603	999	1 384
6	**Annual Aver MW**	51	57	47	48	43	27	37
7	**Aver m3/s**	61	68	56	57	51	32	44
8	**Mtera start Mm3**	2800	2360	1520	520	800	100	400
9	**Mtera end Mm3**	2360	1520	520	800	100	400	100
10	**Total inflow Mtera**	1 492	1 310	765	2 086	903	1 299	1 084
11	**Probability of better inflow**	84	89	96	65	94	85	90
12	**Percent of average in Sweco**	57%	50%	29%	80%	35%	50%	42%
13								
14	**Load shedding acc SwedPower in M**		0	91 000	98 800	207 700	152 400	
15								
16								
17								
18	**Local inflow Mtera-Kidatu**							
19	**Discharge from Kidatu Mm3**	2 315	2 542	2 571	2 876	2 503	2 223	2 505
20	Local inflow Mtera-Kidatu	383	392	806	1 069	899	1 224	1 120
21	Average 30 years in preinvestment	1 800	1 800	1 800	1 800	1 800	1 800	1 800
22	**Percent of average**	21%	22%	45%	59%	50%	68%	62%

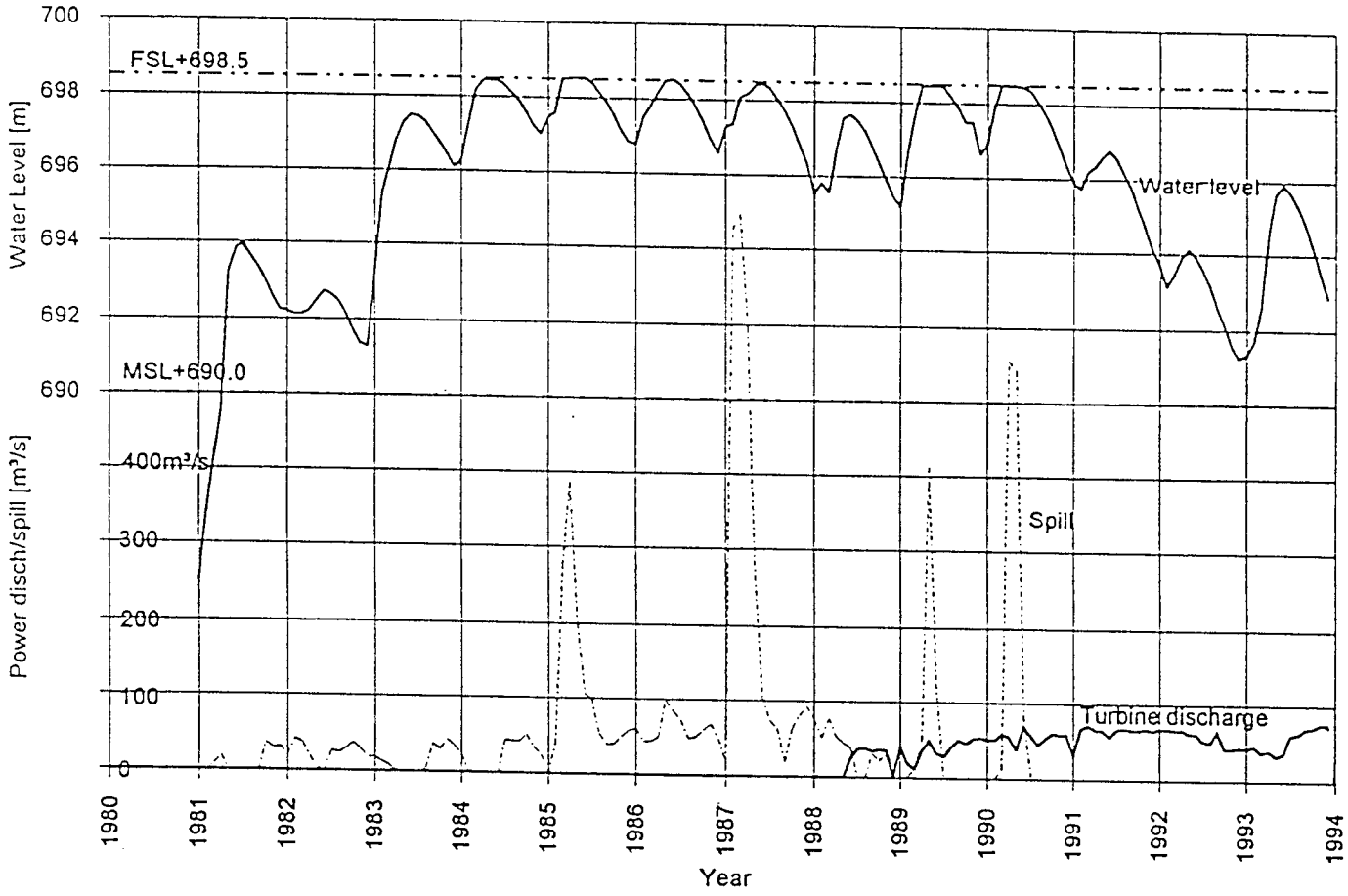
Appendix VIII, Table 2


Actual generation at Mtera Power Plant
Expected average annual production 464
Mtera actual annual production GWh
600
500
400
300
200
100
0
1990
1991
1992
1993
1994
1995
1996
YEAR

Reservoir content at Mtera



MTERA RESERVOIR
Water Levels, Turbine Discharge and Spill 1980-1993



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