CHAPTER 3

PRESENT CONDITION OF THE ELECTRIC POWER SECTOR

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3.1 Present Conditions of Transmission Line and Substation

The present conditions of the generation facilities are described in detail in Chapter 4 "Electric Power Supply and Demand." In this chapter, we shall describe the present conditions of the power transmission and substation facilities.

3.1.1 National Grid

Tanzania's national grid as of 2000 is diagrammatically shown in Fig. 3.1. With Kiadatu, Mtera, and Kihansi as the main power stations, the national grid consists of 220 kV extrahigh-voltage transmission lines. Extending south to Mbeya and north to Arusha and Mwanza from Dar es Salaam, the national grid supplies electric power to many of the major cities of the country.

The cities in northern Tanzania receive electric power from the 132 kV transmission system with three power stations on the Panagni River. This system is linked to the 220 kV systems in Arusha and Morogoro to form the national grid. The national grid also supplies electric power to Zanzibar Island over a 41 km submarine cable.

Since the 220 kV transmission line between the Kidatu Power Station and the Ubungo Substation was put into operation in 1975, several 220 kV transmission lines have been constructed. These transmission lines, which were newly designed to serve as trunk transmission lines in Tanzania, employ a thick, large-capacity conductor (382 to 565 mm^2) to allow for expansion of the national grid in the future. On the other hand, the 132 kV transmission lines that transmit power to Hale, Tanga, and Moshi in northern Tanzania use a comparatively thin conductor (150 mm^2). Therefore, in the case of long-distance transmission lines, like the one between Hale and Kiyungi, the transmission capacity is about 60 MW. Since it is expected that electric power demand in 2010 will be about 120 MVA in Arusha and about 75 MVA in Moshi, it is to be desired that the transmission capacity should be increased as soon as possible.

In the past, the 66 kV system was applied only to the transmission line from the Nyumba ya Mungu P/S - the Kiyungi S/S – to the Unga LTD S/S constructed in the 1960s. Recently, however, this voltage class has been adopted for a medium-distance transmission line in the neighborhood of Babati.

THE NATIONAL GRID SYSTEM

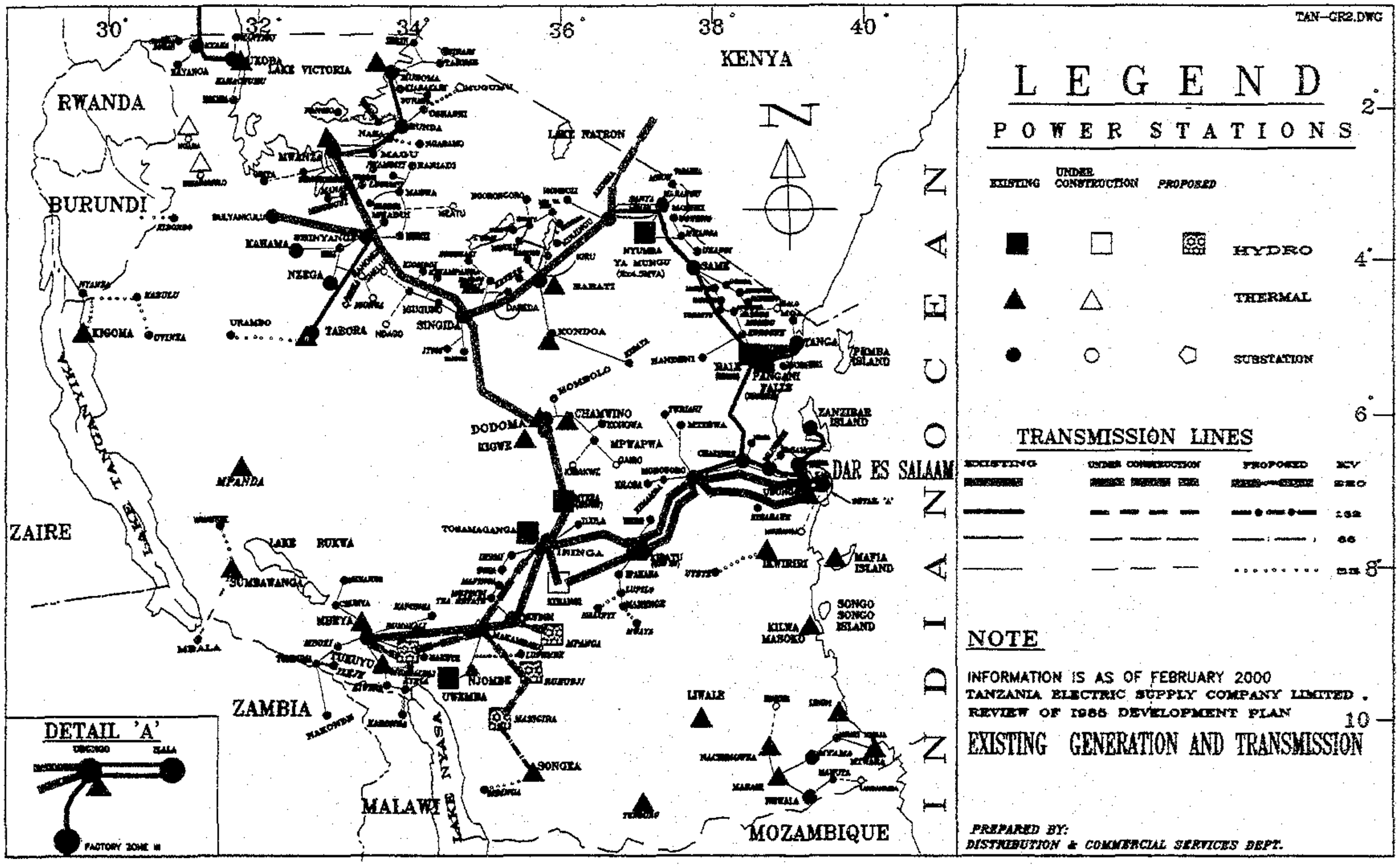

Fig 3.1 Power System in Tanzania (as of 2000)

3.1.2 Power Distribution Network

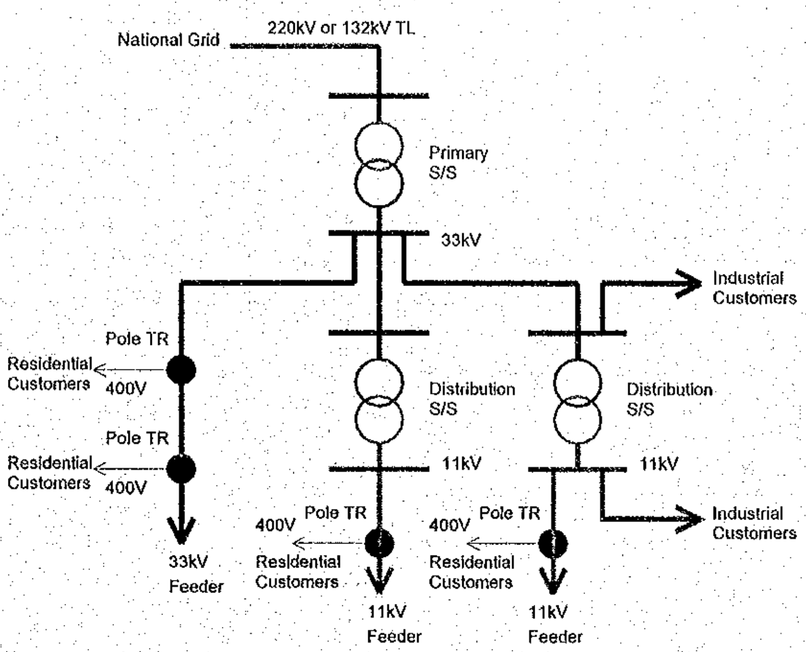

Fig. 3.2 Distribution System of TANESCO

The power distribution network of TANESCO is shown in Fig. 3.2.

Electric power generated at the power station is transmitted from the National Grid to the primary substation, where the electric power is stepped down to 33 kV or 66 kV before it is transmitted to the nearby distribution substation. There are several large users to which 33 kV is supplied.

In urban areas, the electric power is stepped down from 33 kV to 11 kV before it is supplied to factories, etc. over a 11 kV feeder. It is also distributed to residential customers after it is further stepped down to 400 V via a pole transformer. In rural areas, etc. where customers are sparse, electric power is distributed over a 33 kV feeder so as to reduce the transmission loss.

In Japan, the distribution system employs 6.6 kV/100・200 V. At present, boosting it to 22 kV/400 V is under discussion. Under the influence of the United Kingdom that was its suzerain state, Tanzania, like European countries, employs a 33 kV, 11 kV/230 V, 400 V system. Tanzania aims to establish an open-loop distribution network in the future. Due in part to budgetary limitations, however, the present distribution network is mostly of tree structure.

3.1.3 Problems with Distribution Network

In terms of fund, technology, and supply capacity, TANESCO's distribution network has a number of serious problems as shown below.

- Because of the drastic personnel reduction at TANESCO, the manpower required for equipment maintenance has become insufficient.
- With the electrification and urbanization of more and more rural areas, the demand for electric power has been ever increasing. Nevertheless, there are insufficient tools and materials for expansion and maintenance of the electrical facilities.

- The DAMP that was installed to enhance the maintenance function for TANESCO's distribution facilities has been functioning poorly since the period of cooperation of JICA ended.
- Devices required to protect the facilities, such as the CTs and the circuit breakers for transformer/line, have not been installed.
- Although defective facilities are rehabilitated with the aid of Japan and other donor nations, the rehabilitation is far from sufficient.
- The problem of voltage drop common with the 33 kV, 11 kV, and low-voltage distribution networks. This is due to the use of excessively low voltages and excessively thin conductors relative to the scale of users.
- Voltage problems arising from insufficient number of pole transformers relative to the number of users.
- Problems ascribable to the moral of people, such as the stealage of pole transformer insulating oil, the destruction of devices, and the stealing of electricity.

Many of the facilities installed in the 1960s have become superannuated. As a matter of fact, serious troubles which were apparently due to superannuation, such as transformer failures and fallen distribution lines, occurred with several obsolescent facilities during the period of the present study. It may be said that those obsolescent facilities are in a critical condition.

3.1.4 Status of Cooperation of Other Donors

The status of cooperation of other donor nations that we confirmed during the present study is as follows.

(1) Kfw (Germany)

In Dar es Salaam and Mwanza, respectively, an energy situation improvement project, financed by a loan (No. 98 65 254) from Kfw, is under way. The purpose of each project is to improve the efficiency of power distribution through rehabilitation of the existing distribution facilities and construction of a new distribution network (11 kV/33 kV transmission and distribution lines and substations). The contents of the project in Dar es Salaam are as follows:

(a) Temeke Region

- Construction of a new Tandika S/S (33/11 kV, 15 MVA)
- Rehabilitation of the Kurasini S/S (renewal of the obsolescent 33 kV oil circuit breaker)
- Rehabilitation of the FZ I S/S
- Renewal of the 33 kV distribution line (7 km) between the Ilala S/S and the Kurasini S/S
- Construction of a new 33 kV overhead transmission line (between the FZ III S/S and the Chang'ombe S/S)
- Installation of load-break switches to the 11 kV distribution lines

(b) Kinondoni South Region

- Construction of a new Magomeni S/S (33/11 kV, 15 MVA)
- Renewal of the 33 kV Nordic feeder (between the Ubungo S/S and Kibaha)
- Renewal of the 11 kV feeders (U1, U2, U8) from the Ubungo S/S and the 11 kV

feeder (D7) from the Ilala S/S, and installation of load-break switches to them
- Renewal of the low-voltage distribution networks in the Magomeni, Tandale, and Manzese areas

(2) NORAD (Norway)

NORAD has been extending generous cooperation to the electric power sector. For example, it constructed the Chang'ombe S/S and the Tandale S/S in Dar es Salaam. The latest substation built by NORAD is Bahari Beach S/S which has comparable scale (33/11 kV, 15 MVA) and was commissioned in July 2002. In the Kilimanjaro Region too, we noticed that construction of the YMCA S/S financed by NORAD was under way.

(3) SIDA (Sweden)

With the aid of SIDA, the Ubungo S/S is undergoing an extensive rehabilitation project aimed to improve the reliability of power supply in the Dar es Salaam and Zanzibar Regions. The contents of the project are as follows:

- Renewal of some of the 220 kV switches
- Renewal of most of the 132 kV switches and their accessories, and renewal of the control and protective devices
- Installation of a new 33/11 kV, 15 MVA transformer and rehabilitation of the existing two 132/33/11 kV, 50 MVA transformers
- Renewal of all the 33 kV switches installed outdoors
- Construction of a new building for 11 kV switches and auxiliary equipment
- Training of TANESCO's personnel and supply of working vehicles, spare parts, and radio communication equipment

3.2 Plans to Expand Power Transmission and Transformation Facilities

Concerning the development of power generation and transmission facilities, TANESCO has a long-range master plan (up to the year 2025) which it formulated with the cooperation of Acres International of Canada. In line with this master plan, the company has prepared plans for development of power sources. According to the master plan (Tanzania Power System Master Plan 2000 Update Report), there are two plans for expansion of the National Grid—Plan A and Plan B—for different times at which to start operation of the 330 kV transmission line between Pensulo in Zambia and Mbeya in Tanzania. With respect to the expansion plans up to the year 2005, Plan A and Plan B are the same, except that Plan A includes two 220 kV transmission lines of the Kinyerezi. Looking at the 2006-2010 period, when Tanzania will be able to receive electric power from Zambia, Plan B includes neither the plan to develop a hydropower source in southern Tanzania nor the plan to construct 220 kV transmission lines, both of which are included in Plan A. (Generation expansion plan was revised by TANESCO in 2002 and given in section 4.2(5) in detail)

Plan A (base case)

Schedule for development of large-scale power sources

2009 Ruhudji Hydropower Station (358 MW)
2015 Zambia grid connection line (200 MW)
2020 Rumakali Hydropower Station (222 MW)

Transmission line expansion plans

2004 Construction of new 132 kV transmission line (15 km) between Kinyerezi Power Station and Ilala S/S
Construction of new 132 kV transmission line (13 km) between Kinyerezi Power Station and Ubungo S/S

2005 Construction of two 220 kV transmission lines (2 km) to Kinyerezi Power Station
Construction of second 220 kV transmission line (669 km), Iringa – Mtera – Dodoma – Singida – Shinyaga

2010 Construction of second 220 kV transmission line (139 km), Shinyaga – Mwanza
Construction of second 220 kV transmission line (316 km), Singida – Babati – Arusha
Construction of third 220 kV transmission line (359 km), Mtera – Dodoma – Singida
Construction of third 220 kV transmission line (130 km), Kidatu – Morogoro
Construction of third 220 kV transmission line (180 km), Morogoro – Ubungo
Construction of new 220 kV transmission line (100 km), Ruhudji – Mufindi
Construction of new 220 kV transmission line (100 km), Mufindi – Kihansi
Construction of new 220 kV transmission line (150 km), Ruhudji – Kihansi

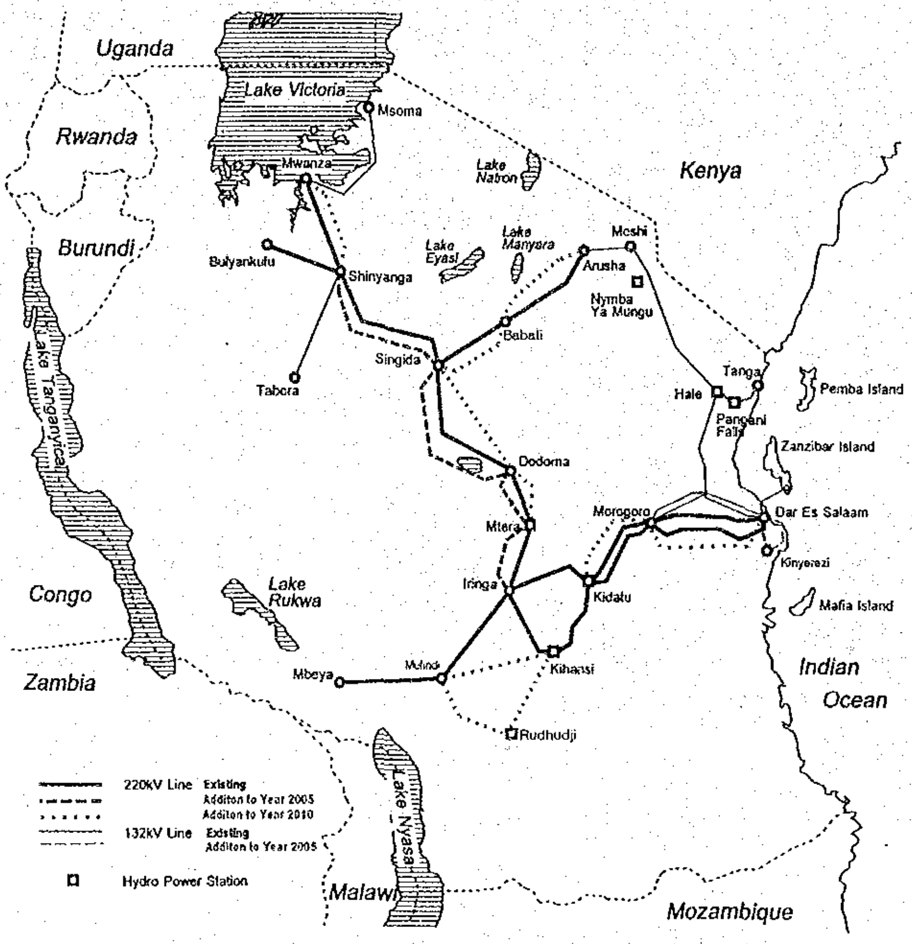

Fig. 3.3 National Grid Expansion Plan to 2010 (Plan A)

Plan B (Zambia grid connection is completed early)
Schedule for development of large-scale power sources

- 2005 Zambia grid connection (200 MW)
- 2012 Ruhudji Hydropower Station (358 MW)
- 2018 Rumakali Hydropower Station (222 MW)

Transmission line expansion plans

- 2004 Construction of new 132 kV transmission line (15 km), Kinyerezi P/S – Ilala S/S
  Construction of new 132 kV transmission line (13 km), Kinyerezi P/S – Ubungo S/S
- 2005 Construction of second 220 kV transmission line (669 km), Iringa – Mtera – Dodoma – Singida – Shinyaga
- 2010 Construction of second 220 kV transmission line (139 km), Shinyaga – Mwanza
  Construction of second 220 kV transmission line (316 km), Singida – Babati – Arusha
  Construction of third 220 kV transmission line (359 km), Mtera – Dodoma – Singida

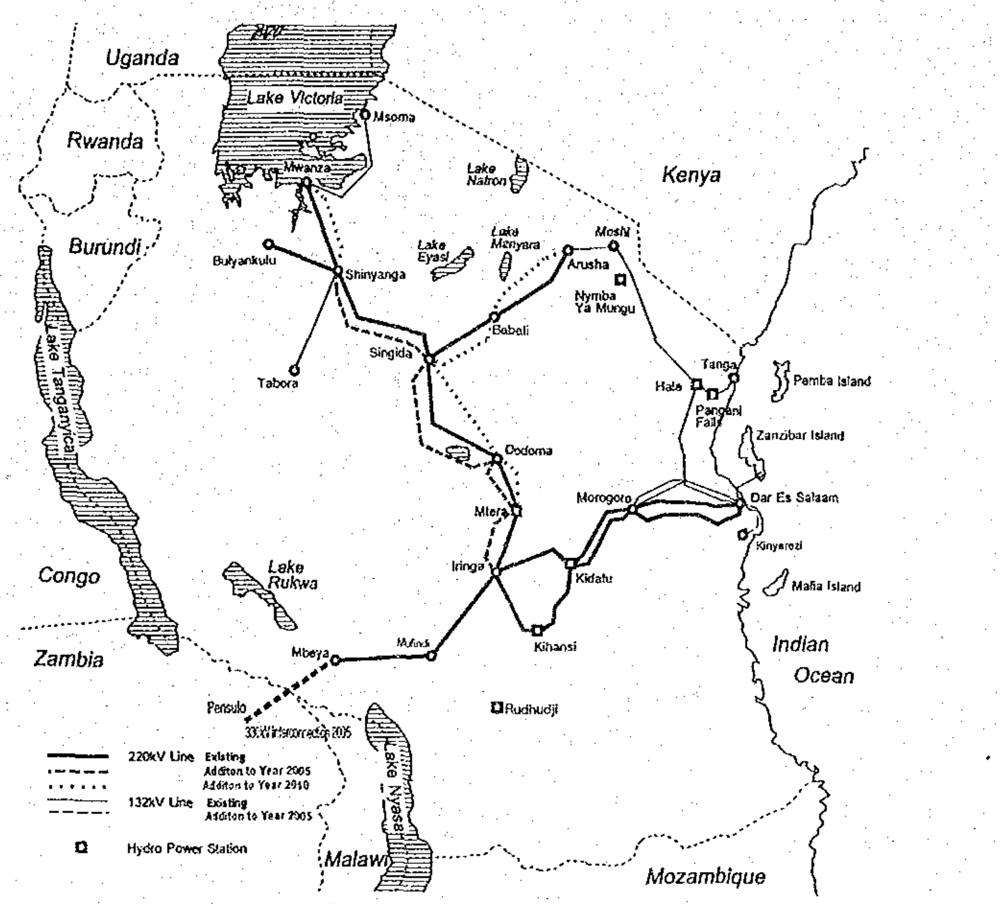

Fig. 3.4 National Grid Expansion Plan to 2010 (Plan B)

3.3 Organization and Management of Electricity Sector

The first public electricity industry in Tanzania was established by Germany in 1908. When the territory was mandated to the United Kingdom in 1920, a Government Electricity Department was formed to take over and operate the public supplies left by the Germans. In 1931, the Government handed over to two private companies. They were The Tanganyika Electric Supply Company Ltd. (TANESCO) and The Dar es Salaam and District Electric Supply Company Ltd. (DARESCO). After the independence from the United Kingdom, the government aimed to nationalize the electric power industry. Between 1964 and 1975, the government purchased all the shares of the two companies. TANESCO and DARESCO decided to merge into single organization and the name Tanzania Electric Supply Limited (TANESCO) was adopted in 1968.

Until 1992, TANESCO had monopolized the generation, transmission, distribution, and sale of electricity. Since then, with the change of the government's energy policy, participation of private companies in the electricity sector has been gradually permitted. At present, two independent power producers (IPPs) have a business license. They are Independent Power Tanzania Ltd. (IPL) of Malaysia and Songas Ltd.

TANESCO is under the control of the Ministry of Energy and Mining. Its top management organ is the Board that consists of Chairman appointed by the President and nine Board Directors appointed by the Minister of Energy and Mining. Practical affairs are handled by the Senior Management Team that consists of 16 members. As a rule, Managing Director; head of the Senior Management Team; is appointed by the President and the other members of the Team are appointed by the Board. TANESCO's organization is shown in Fig. 3.5.

TANESCO operates 22 regions mostly according to political administrative boundaries with the exception of Dar es Salaam, which is divided into Temeke, Ilala, Kinondoni North, and Kinondoni South.

3.4 Structural Reform and Legislation in the Electricity Sector

3.4.1 Structural Reform in Tanzania

In 1993, the Government of Tanzania initiated a public sector reform program with emphasis on introducing greater competition, liquidating uneconomic units and divesting others. Prior to 1992, corporate activities in Tanzania were governed by Companies Ordinance of 1932 and the Public Corporation of 1969. In April 1992, the Public Corporation Act of 1969 was repealed and replaced by the new Public Corporation Act 1992 to legalize private participation in public enterprises, or provide for the Government to divest the ownership of business enterprises.

In November 1993, the new Public Corporation Act was amended extensively to define the institutional framework and procedures for divestiture. The act created the Parastatal Sector Reform Commission (PSRC) as the organization responsible for the public sector reform including privatization.

The primary objectives of public sector reform program are as follows.

- Improve the operational efficiency of public enterprises, and their contribution to the national economy;
- Reduce the burden of public enterprises on the Government budget;
- Expand the roles of the private sector in economy, permitting the Government to concentrate public resources on its role as provider of basic public services, including

health, education, and social infrastructure; and

- Encourage wider participation by the people in the ownership and management of business.

In pursuing these primary objectives, the PSRC aims to:

- Transform the performance of most significant enterprises in the public sector within five years, through commercialization, restructuring and divestiture;
- Ensure liquidation of all non-viable Parastatal enterprises as soon as possible.

3.4.2 Structural Reform of Public Enterprises

Based on the above structural reform program, many public enterprises were privatized. As of September 2001, a total number of privatized enterprises was 124. Many of those privatized corporations have improved in earning power and are contributing much to the country as they pay more taxes (corporation tax and VAT), create more job opportunities, and so on. Most of the privatized public corporations are those of commercial nature such as hotels (New Africa Hotel, Bahari Beach Hotel, etc.) and manufacturing companies. Recently, however, public enterprises with highly public nature are also being privatized. Concerning the telecommunication sector (Tanzania Telecommunication Company Limited: TTCL), 35% of its stock was sold to Detecom of Germany and MSI of the Netherlands. In the financial sector, the ABSA Bank Group of South Africa purchased 70% of the stock of The National Bank of Commerce in 1997. Privatization of utility and infrastructure sectors shown below is planed or underway.

- Dar es Salaam Water and Sewage Authority (DAWASA)
- Tanzania Harbor Authority (THA; excluding container terminals which was already leased.)
- Tanzania Telecommunication Company Limited (TTCL; disposal of the remaining portion of the stock owned by the government)
- Tanzania Railway Corporation (TRC)
- Air Tanzania Corporation (ATC)
- Tanzania Electric Supply Company Limited(TANESCO)

3.4.3 Restructuring of TANESCO

It has been decided that TANESCO shall be restructured to increase the efficiency. Various investigations and discussions on the restructuring have been made, and study trips in Argentina, Jamaica, Bolivia, etc. in which the electricity sector has been privatized were also conducted. The plan for the restructuring of TANESCO basically consists of "Vertical Separation," whereby the functions of TANESCO which virtually monopolizes power generation, transmission, and distribution shall be served by different companies, and "Horizontal Unbundling," whereby the power generation and distribution departments shall be divided into two or more companies. To formulate an actual structural reform plan, foreign consultants are employed under the financial aid of the World Bank. The tasks of the consultants are "studying unbundling method of TANESCO (Restructuring)" and "studying the sale and purchase of electricity among the companies after unbundling (Trading Arrangement)." For each task, a different consultant is employed.

The consulting work for Trading Arrangement was entrusted to a consortium of Mercados Energiticos S.A. of Argentina, econ ONE of the United States, SYNTAX Ingenieros Consultores of Chile, and Economic Consultants Associations of the United Kingdom, and the consortium submitted the a report to the Tanzanian government in

January 2002. As the consultant for Restructuring, the government selected in November 2001 a consortium of Stone & Webster Consultant Inc. of the United States (affiliated company of Stone & Webster Inc., a major engineering firm) and Coro Securities, a local establishment. According to TANESCO, Stone & Webster Consultant Inc. was selected because the government highly rated its achievements in the United States (i.e., the company's experience in assessment of existing power stations, transmission lines, and other assets in the division and privatization of public electric power companies). The consultant is supposed to come up with a report on Restructuring in 18 months, after which the report is to be reviewed and approved first by the World Bank and then by the Tanzanian government.

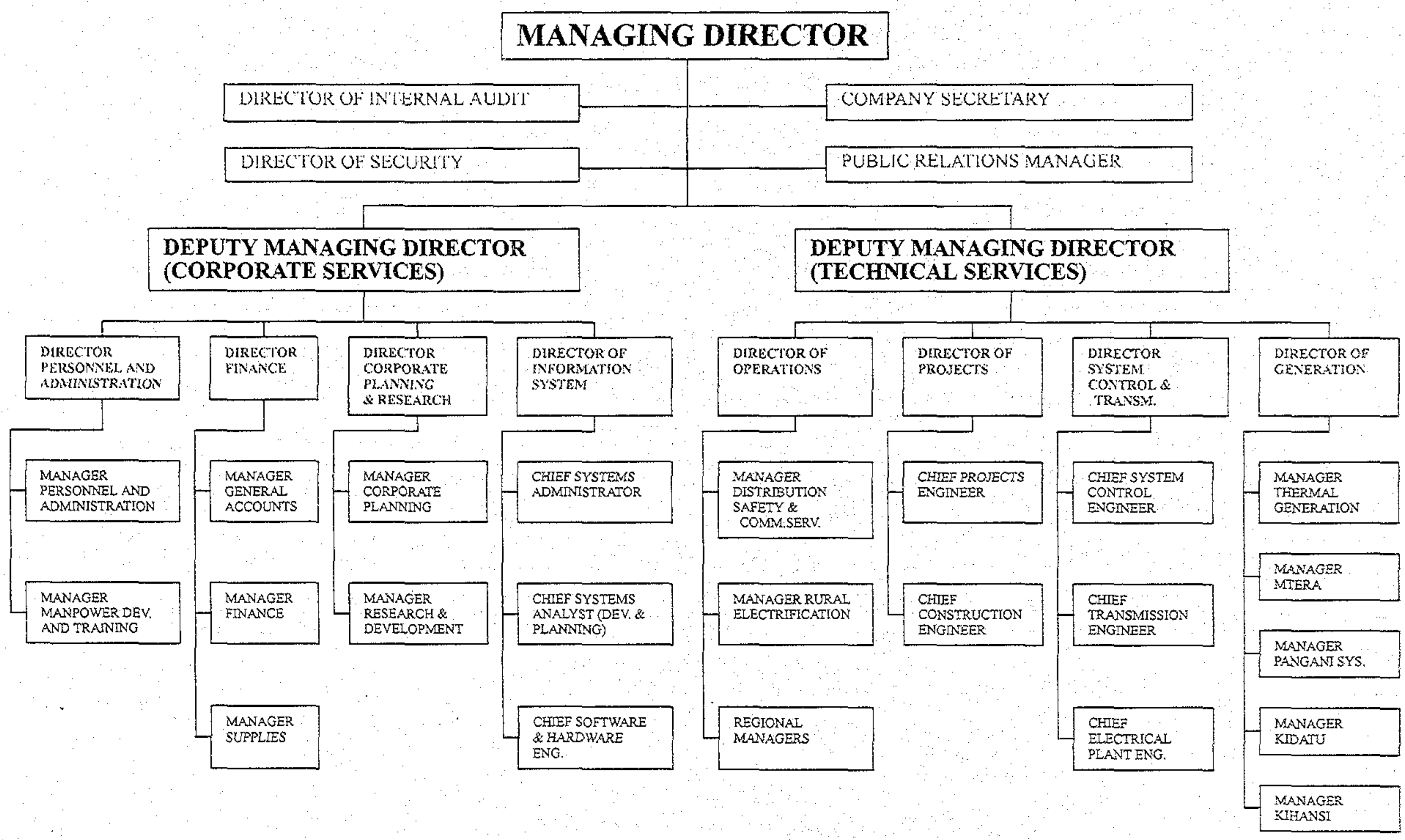

Fig. 3.5 Organization of TANESCO (in 2001 Source:TANESCO)

The government of Tanzania has reviewed recommendations by consultants, and made partial modifications on the recommendations. As of the end of July 2002, basic recognition of the government on restructuring of TANESCO is as follows:

- The function of TANESCO shall be divided into power generation, transmission and distribution sectors.
- Power generation sector shall be divided into 3 companies with following power stations.
  - Kidatu + Mtera (Both hydro power stations are located on same stream)
  - Kihansi + Pangani Fall + Nymba Ya Mung + Hale (Hydro power stations other than Kihansi are located on same stream)
  - Ubungo Gas Turbine and other thermal power stations
- Transmission sector shall be operated by a semi-governmental organization.
- Distribution sector shall be operated by 2 companies (one covers northern area and the other covers southern area). The idea of TANESCO in which distribution sector shall be operated by 3 companies was not approved by PSRC.

It is scheduled that Mercados and Stone & Webster have a series of meetings on September 2002, and the government of Tanzania makes further investigation based on the result of discussions by the above 2 consultants. As for a scheme of private participation into TANESCO, a concession (lease) system shall be applied to each unbundled companies, because TANESCO has huge amount of assets and it is difficult to obtain consent of the nation for a disposal of TANESCO to private companies. A regulatory agency, EWURA (Energy and Water Utility Regulatory Authority) will be established under the assistance of World Bank, and it will independently monitor the operation by concessionaire.

It has been decided to entrust the management of TANESCO to Netgroup Solutions (Pty) Ltd. of South Africa until completion of the restructuring that is being implemented under the leadership of the World Bank. All expenses for the management support consultant are to be borne equally by SIDA of Sweden and the Tanzanian government. According to PSRC, the circumstances that led to the choice of Netgroup Solutions as the management consultant were as follows.

(i) The board members of TANESCO entrusted management analysis of TANESCO to local accounting firm "Deloitte & Touche" at the beginning in 2000.

(ii) Deloitte & Touche pointed out the weakness on management of TANESCO in the report submitted in June 2000. Following this, MEM decided to hire the consultant who supported TANESCO's management until the completion of restructuring of TANESCO.

(iii) Selection of Consultant was entrusted to PSRC. Although 11 firms are said to show the interest to the business, however, 10 firms mentioned below are identified. (Name of 1 firm remains unclear)

1.Arnett Consulting, USA
2.Birka energy, Sweden
3.ESB International, Ireland
4.Eskom Enterprises (Pty) Ltd., South Africa
5.IberAfrica, Spain
6.Eltel Networks International, Finland

7.Netgroup Solutions (Pty) Ltd., South Africa
8.NRECA International, USA
9.Revenue Loss Management, South Africa
10.Vattenfall, Sweden

(vi) PSRC formed the evaluation team consist of personnel from President's office, MEM, FOR and selected 6 candidate firms.
1.ESB International, Ireland
2.Eskom Enterprises (Pty) Ltd., South Africa
3.IberAfrica, Spain
4.Netgroup Solutions (Pty) Ltd., South Africa
5.NRECA International, USA
6.Vattenfall, Sweden

(v) PSRC invited 6 firms above to bidder's meeting. Pre-bid conference was held November 2001 and 4 firms below attended it in consequence.
1.ESB International, Ireland
2.Eskom Enterprises (Pty) Ltd., South Africa
3.Netgroup Solutions (Pty) Ltd., South Africa
4.Vattenfall, Sweden

(vi) Representative of MEM, MOF, President's office, TANESCO, WB, SIDA (Sponsor of management consultant) attended pre-bid conference held in PSRC office. It was confirmed that the due date of proposal submission was Nov. 30 in 2001 and proposal is based on two-envelope proposal.

(vii) 3 firms below submitted proposals before due date. Iber Africa, Vattenfall and NRECA expressed the declination by letter.
1.ESB International, Ireland
2.Eskom Enterprises (Pty) Ltd., South Africa
3.Netgroup Solutions (Pty) Ltd., South Africa

(viii) Technical evaluation team evaluated 3 technical proposals from Nov.30 to Dec.3 in 2001. Finally the evaluation team suggested to disqualify the proposals of ESB and ESCOM.

(ix) Joint team consists of MEM, board members of TANESCO and PSCR decided to disqualify the proposals from ESCOM and ESB and open the commercial proposal of Netgroup Solutions on Dec. 7 in 2001.

(x) The joint team opened the commercial proposal of Netgroup Solutions on Dec. 11 in 2001 and determined to contract with Netgroup Solutions under and subject to governmental agreement. The Negotiating Team consists of top ranking executives of MEM, PSRC and TANESCO was formed at the conference.

(xi) The negotiation was held from Dec. 18 to 20 in 2001 between the Negotiating Team and Netgroup Solutions. After that, PSRC requested MEM the governmental agreement on Dec. 21

Since May 2002, four persons from Netgroup Solutions are residing and managing TANESCO, and other specialists will be dispatched in case of need. Titles and roles of four persons from Netgroup Solutions are as follows:

- Managing Detector
- Deputy Managing Director (Distribution and Customer Services)
- Deputy Managing Director (Generation, Transmission and Engineering)
- Deputy Managing Director (Finance)

The status of Netgroup Solutions in Tanzania is a Contractor hired to increase the value of TANESCO, and the responsible organization for management and operation of TANESCO is the Ministry of Energy and Mines. The major works of Netgroup Solutions are shown below. As a part of major works, Netgroup Solutions are conducting works such as an improvement of computer systems (both hardware and software), development of customer database and reinvestigation of tariff system.

- Collection of account receivables
- Improvement of energy losses
- Quick start of power supply to customers who are waiting of connection

The most important work of Netgroup Solutions is the collection of account receivables. Under new management, TANESCO is taking strong measures including disconnection to individuals and private customers, if necessary. The government of Tanzania gave TANESCO permission to disconnect electricity supply to governmental institutions including army camps and police stations, if necessary, because many private customers have opinion that unpaid bill of the governmental institutions should be settled first. The ministry of Finance is making effort to allocate budgets required for settle unpaid bill of governmental institutions. The government of Zanzibar has agreed to pay full amount of electricity charge from October 2002. However, problems of unpaid electricity charges for past years leave unsettled.

In Tanzania, the restructuring of public corporations was started in the sector that allowed the planned restructuring to be carried out most easily. In the future, the government plans to restructure the infrastructure sector that has much to do with the country's economy and national life. Apparently the electric power sector is the one that will be restructured last. This is positive proof that the Tanzanian government is fully aware of the difficulty involved in restructuring TANESCO. The major difficulties are described below.

(1) Revision of electricity tariff

In recent years, many countries have managed to reduce their power tariff through restructuring of the electric power industry, improvement of the efficiency of management, introduction of the principle of competition, etc. On the other hand, there are not a few countries in which the power tariff has gone up as a result of abolition of the subsidies to the electric power industry, entry of profit-seeking private companies into the industry, etc. In Tanzania, since the power tariff had been set at levels lower than the cost levels, there was the need to review the power tariff even if the improvement in management efficiency by the restructuring was taken into account.

In April 2002, the government announced a revision of power tariff, including a sharp increase in tariff for household use. In the face of a strong objection of the nation, the government withdrew the revision. Then, in May, it announced another revision of power tariff. As far as we know, the latest revision has not caused much trouble to date. However, in view of the sharp increases in power tariff for household use and Zanzibar, there is the fear that the revision should meet with a strong objection, as did the previous revision. If it becomes necessary to further raise in the future, the government might find it hard to obtain approval of the people. In addition, it will become necessary for the government to thoroughly review the current power tariff set by category—for household use, for industrial use, for Zanzibar, etc.

(2) Re-investigation by Consultant

Although the restructuring of TANESCO can be made in various ways, it is not easy to arrive at a consensus among the persons concerned while giving the utmost consideration to the welfare of the nation. Besides, there is a problem unique to Tanzania, that is, the great difficulty involved in adjusting opinions of the Zanzibar government and the Federal Government. Therefore, it is unlikely that both the World Bank and the Tanzanian government will unconditionally agree to any of the consultant's recommendations.

(3) Huge amount of account receivable

As of the end of 2000, the total amount of account receivable of TANESCO was 204 billion Tsh (about $230 million), far greater than the 2000 sales of 130.8 billion Tsh (about $150 million). The government and public corporations account for about 35% of that amount and private companies account for the remaining 65%. In restructuring and unbundling TANESCO, handling the huge amount of account receivable (bad debts) properly, as well as evaluating the assets accurately, is an extremely important, and difficult, task. It should be noted that even after restructuring, it is not always easy to collect electricity charges from users (private companies and individuals) and illegal acts, such as stealing electricity and tampering with the meter, will not end.

(4) Hydropower main, thermal power subordinate

In Tanzania, electricity is generated mainly by hydropower, with thermal power used to make up for shortage of hydropower. Therefore, in a dry year, the cost of electricity generation rises markedly, causing the profitability to decline sharply. Comparing with thermal power based business, unbundling of the electricity business highly depending on hydropower is difficult.

(5) Huge amounts of debts

In Tanzania, electricity tariff is not properly linked to the costs. Therefore, TANESCO cannot secure sufficient revenue to cover the investment cost required to meet the ever-growing demand of electricity. Nor can it repay loans introduced for investment in plant and equipment. Besides, the exchange risk involved in repaying long-term loans from foreign countries has become a major problem. As of the end of 2000, the total amount of TANESCO's deferred long-term loans was 68 billion Tsh (about $76 million). In addition, TANESCO has long-term loans amounting to 320 billion Tsh (about 360 million). In restructuring and unbundling TANESCO, it is necessary to settle all those loans by some method or other. Reportedly, the Tanzanian government has no intention of putting in a large sum of money to TANESCO.

(6) Delay in electrification of rural areas

After restructuring (unbundling) of TANESCO, the Government must secure the fund required for rural electrification. However, for the Tanzanian government that has the problem of insufficient revenue, it must be difficult to allocate enough amount of budget for this purpose. An establishment of a system, which unbundled companies contribute rural electrification, is also difficult.

(7) IPTL

TANESCO has concluded the Power Purchase Agreement (PPA) with IPTL of Malaysia, and purchasing electricity for peak shaving at the price of US ¢ 13/kWh. Since the purchase price is very high, it is very difficult to find a company that takes over PPA on same terms.

(8) Others

Incidentally, in the wake of the recent blackout in California, the United States and many other countries are becoming more cautious about the restructuring of electric power business. In Tanzania too, there are people who are against the restructuring of TANESCO.

3.5 Tariff System

3.5.1 Overview

The current tariff system of Tanzania was determined following the 1993 tariff study by London Economics Ltd. of the U.K. (updated in 1996). The tariff system introduced in 1993 differs from the former one that had been applied since 1986 in the following points:

- The tariff category is simplified as shown in Table 3.1.
- The average tariff rate has been based on the Long Run Marginal Cost (LRMC).
- The tariff rate for low-income users (small users) has been set low.
- The tariff rate for large users has been set high.
- The tariff rate for Zanzibar bulk supply has been set low.

Table 3.1 Classification of the Electricity Charges

1986 Study	1993 Study
Tariff-1: Residential	Tariff-1: Residential, Light Commercial
Tariff-2: Light Commercial	Tariff-2: Low Voltage Supply
Tariff-3: Light Industry	Tariff-3: High Voltage
Tariff-4: Low Voltage Supply	Tariff-4: Public Lighting
Tariff-4A: Agricultural Consumers	Tariff-5: Zanzibar Supply
Tariff-5: High Voltage Supply	
Tariff-5A: High Voltage Supply –	
Tariff-6: Public Lighting	
Tariff-7: Water Supply Accounts	
Tariff-8: Zanzibar Supply	

Source: Deloitte and Touche

The current tariff system is shown in Table 3.2.

Table 3.2 Current Electricity Tariff System (VAT excluded)

Class	Demand/Month(kWh) From	To	Tariff (/kWh) Tshs	US ¢	Plus Service Charge (/mth) Tshs	US ¢
Tariff-1 Residential/ Light Comm./ Light Industrial	0	100	24.00	2.7	200	22.5
	101	500	38.75	4.3	750	84.5
	501	2,500	88.50	9.9	2,000	224.5
	> 2,500		165.50	18.6	2,000	224.5
Tariff-2 Low Voltage (400 V)			70.35 plus 7,660	7.9 plus 860.7	4,000 per kVA Billing Demand	449.4
Tariff-3 High Voltage (11 kV or more)			67.50 plus 5,950	7.6 plus 668.5	4,000 per kVA Billing Demand	449.4
Tariff-4 Public Lighting			27.80	3.1		
Tariff-5 Zanzibar Bulk Supply			21.5 plus 3,350	2.4 plus 376.4	4,000 per kVA Billing Demand	449.4

Source:TANESCO

The new tariff system introduced in May 2002 is as shown in Table 3.3.

Table 3.3 Current electricity tariff system (VAT excluded)

Class	Demand/Month (kWh) From	To	Tariff (/kWh) Tshs	Plus Service Charge (/mth) Tshs
Tariff-1 Residential/Small Commercial and Industrial/ Public Lighting/Billboard (230V - Single Phase 400V – Three Phase)	0	100	25.90	200.00
	100	Over 100	90.00	1,500.00
Tariff-2 Low Voltage (400 V)			58.50 plus 6,220.00	6,000 per kVA Billing Demand
Tariff-3 High Voltage (11 kV or more)			55.50 plus 6,050	6,000 per kVA Billing Demand
Tariff-4 Zanzibar Bulk Supply			54.15 plus 10,507.00	10,507.00 per kVA Billing Demand

Source: TANESCO

3.5.2 Tariff Increase

TANESCO has been increased the tariff rate to accommodate the increase in cost. The increase in average tariff is shown in Table 3.4 and Fig. 3.6. The revision to make the average tariff 9 ¢/kWh was made several times. The reason for this is that the study conducted by London Economics Ltd. estimated the LRMC at 9 ¢/kWh.

Table 3.4 Change of Electricity Tariff System (VAT excluded)

Date of Increase	Average Tariff (TSch./kWh)	Increase		Reasons for Increase
		TSch.	%	
April 1998	67.73	3.23	5	Increase total revenue to 9 US cents/kWh
Nov 1997	64.50	2.15	3	To accommodate increase in cost
May 1997	62.35	3.81	7	Increase total revenue to 9 US cents/kWh
Nov 1995	58.54	11.07	23	Increase total revenue to 9 US cents/kWh
June 1995	47.47	2.32	5	Increase total revenue to 9 US cents/kWh
July 1993	45.15	20.23	81	Cater for increase in generation and investment cost
Mar 1993	24.92	5.67	29	Reasons not available
Jan 1993	19.25	1.14	6	Reasons not available

Source:Deloitte and Touche

The main points of the May 2002 revision are as follows. (The average unit prices and the rates of increase are unknown.)

- Formerly, Tariff-1 consisted of four steps - 0 to 100, 101 to 500, 501 to 2,500, and over 2,500 (kWh/month). Now, it consists of two steps - 0 to 100 and over 101 (kWh/month). In addition, as a result of a review of the gap between small users and large users, the tariff for 101 ~ 500 kWh/month that is applied to the majority of general homes has been raised to more than twofold, whereas the tariff for 2,500 kWh/month or more has been lowered.
- Tariff-2 and Tariff-3 have been slightly lowered.
- "Public lighting" which was formerly an independent class has been included in Tariff-1 (for general use).
- The tariff for Zanzibar has been raised to more than twofold.

3.5.3 Weakness in the Tariff

It has been pointed out that there are numbers of weakness in the current tariff. They include:

(1) The current average tariff rate is too low to cover input costs

TANESCO adopted the policy to set average tariff based on the LRMC, and TANESCO can increase tariffs by 5% twice a year. With the agreement Ministry of Energy and Mining and the Ministry of Finance, these increases can be by 10% twice in a year. Practically, however, despite the marked increase in costs, including the fuel cost, the tariff has not been revised at all since April 1998. In terms of the U.S. dollar, the average tariff rate declined to about 8.4 ¢/kWh in 2000 and about 7.6 ¢/kWh in 2001. The implication is that the tariff rates have really been lowered. The comparison between cost and average tariff rate is shown in Fig. 3.7. Apparently the May 2002 revision of power tariff has eliminated or narrowed down the differences between cost and selling price.

(2) Uniform national tariff

TANESCO applies the uniform tariff throughout the country, in spite of the fact that cost of power supply in rural areas where users are sparse and areas isolated from the national grid is higher than elsewhere. Although we cannot make a sweeping statement as to whether TANESCO's practice is right or wrong because the question of policy may be involved, it is an undeniable fact that the uniform tariff system affects adversely the financial situation of TANESCO.

(3) Problem related to VAT

The value added tax (VAT) that was introduced in June 1997 requires each user to pay the bill plus 20% VAT. Although TANESCO is simply entrusted with collecting VATs, it is obligated to pay to the Tanzania Revenue Authority (TRA) the VAT on all the bills at the point of raising invoice even though it remains unpaid for long, since the amount of VAT payable to TRA is calculated based on the bills.

(4) Cross subsidy

The Tanzanian government does not grant any subsidies to TANESCO. On the other hand, based on the recognition that electricity is one of the basic infrastructure, the tariff rates for small users, who are apparently not so well-off as large users, have been set low, whereas they have been set high for large users. In other words, the burden of small users is partly shifted to large users. This concept (cross subsidy) is adopted in many countries and justifiable as a basic policy. Since the question of policy is involved, we cannot say whether it is right or wrong. In this connection, the following problems have been pointed out. However, the problem of cross subsidy is being solved by the latest revision of power tariff.

- To Tariff-1 users (residential, light commercial, light industrial), the lowest rate of Tsh 24.00/kWh (US¢ 2.7/kWh) is applied for the first 100 kWh/month of consumption charge. There are very few developing countries in which the high limit of power consumption to which the lowest rate is applied is as high as 100 kWh/month. In many countries, the high limit is 30 to 50 kWh/month.
- There are no welfare arguments for applying the lowest tariff rate to light commercial and light industrial users (Tariff-1), even though they are supposed to be small users.
- The tariff rates for Zanzibar (Tsh 21.50/kWh, or US ¢ 2.4/kWh) and public lighting (Tsh 27.8/kWh, or US ¢ 3.1/kWh) are low relative to the cost. The differences between tariff rate and cost are transferred to the tariff rate of residential, light commercial, and light industrial users consuming 2,500 kWh/month or more (Tsh. 165.50/kWh, or US ¢ 18.6/kWh) and other large scale users. Users who pay high tariff rates feel great dissatisfaction.
- Some large users say that self-generation is less expensive.

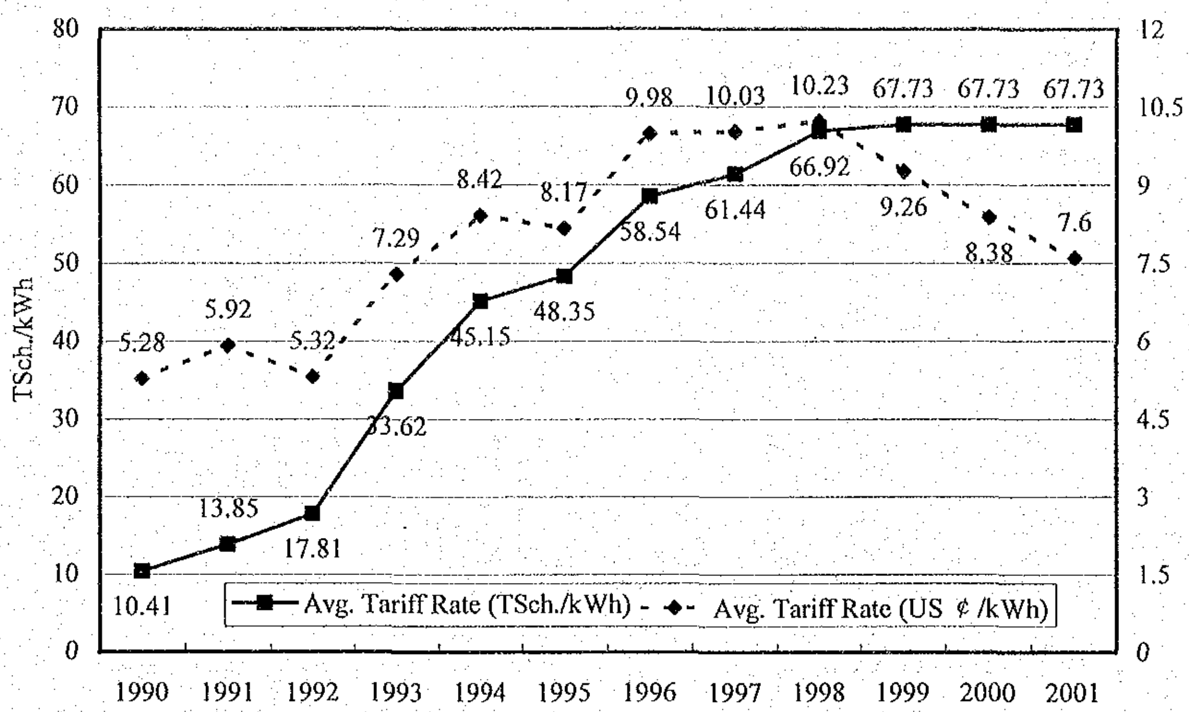

Fig. 3.6 Change of Average Unit Price of Electricity (VAT excluded)
Source:Deloitte & Touche

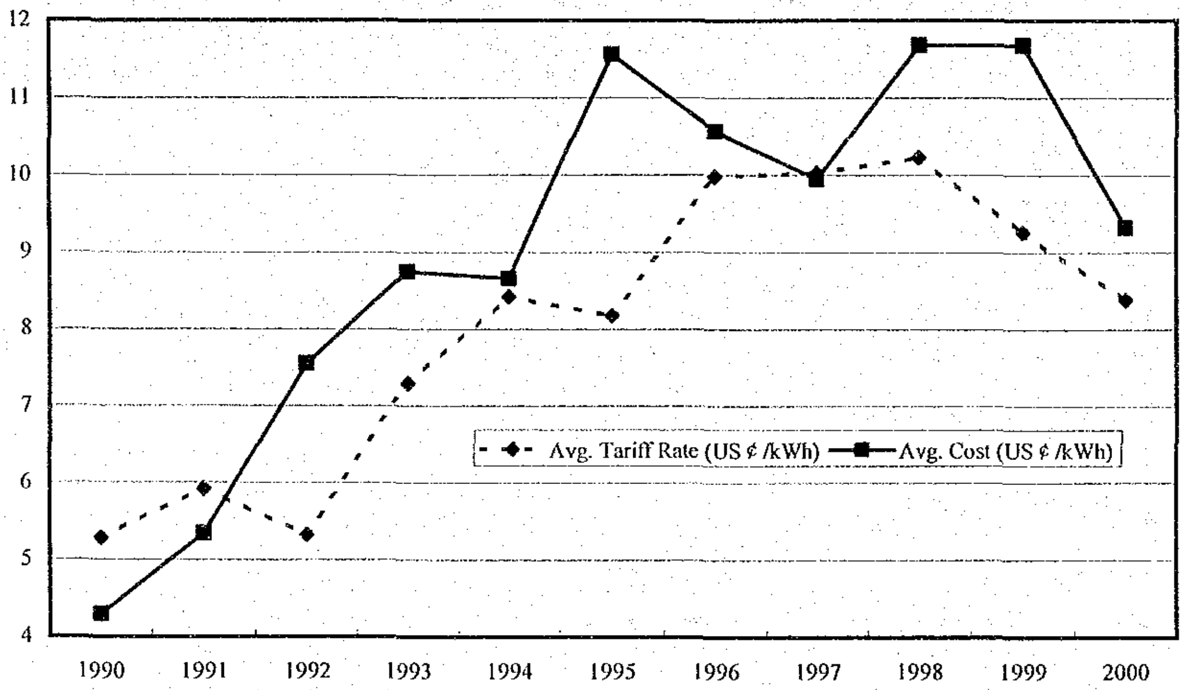

Fig. 3.7 Comparison between Average Price of Cost and Tariff
Source:Deloitte & Touche

3.5.4 Comparison with Other Countries in Africa

The tariff rates applied in the countries in Southeast Africa are compared in Fig. 3.8. From the table, the characteristics of Tanzanian power tariff before the May 2002 revision can be summarized as follows. From the facts given below, it may be said that the latest revision of power tariff (increased for household use and decreased for commercial and industrial uses) is reasonable in a certain measure.

- The rates for industrial users are the highest in the region.
- The rates for commercial users are the fourth highest, next to Zimbabwe, Zambia, and Kenya.
- The rates for domestic users are comparatively low.
- In view of the average of the above three items, it can be said that the tariff rates of Tanzania are high.

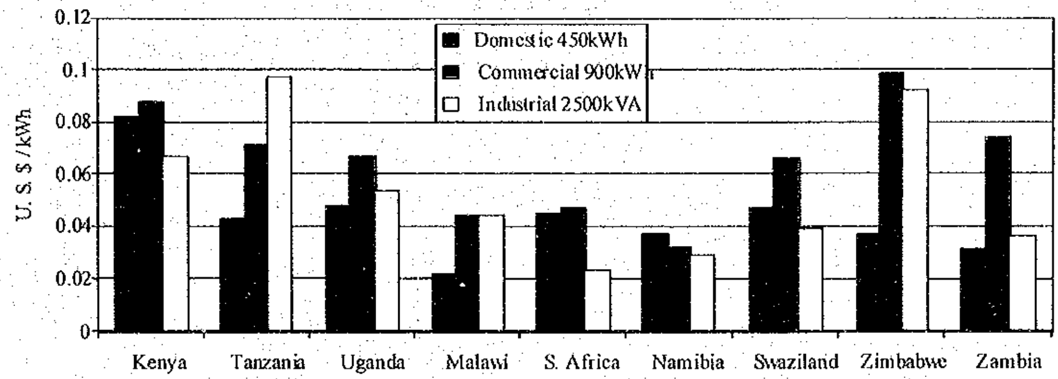

Fig. 3.8 Electricity Charge in Southeast Africa

3.5.5 Opinions of Users

By using a local consulting firm, Deloitte & Touche, a questionnaire survey on opinions of users in Dar es Salaam was conducted. Questionnaires were delivered to the following users selected at random from the telephone directory.

- Commercial/industrial Users: 150 (50 each in Temeke, Ilala, and Kinondoni regions)
- Domestic Users: 150 (same as shown above)

The number of replies from commercial/industrial users was 13 (26%) for Temeke, 30 (60%) for Ilala, and 46 (92%) for Kinondoni. The number of replies from domestic users was 20 (40%) for Temeke, 25 (50%) for Ilala, and 29 (58%) for Kinondoni. The survey results are summarized below.

- Users are dissatisfied with the quality of electricity and the service of TANESCO, rather than the tariff rates. Nevertheless, many of the respondents said that they would not accept any increase in tariff rates even if the quality of electricity and the service of TANESCO are improved.
- Those who answered that they would accept tariff rates higher than the current ones account for only 25% of all the respondents, and 82% of them were not willing to pay more than a 5 percent increase of the current rates.
- Only 17 percent of the Industrial users were willing to pay more compared to the 30 percent of the Domestic users were willing to pay higher electricity tariffs.
- To the question, "Should the current power rates be lowered?", 89% of the

respondents answered, "Yes," as expected.

- Concerning the rate of reduction, 53% of the respondent domestic users and 68% of the respondent commercial/industrial users said that it should be 10% or more.
- Concerning the comparison between the prepaid card-type meter (LUKU) and the conventional meter, majority of respondent prefers LUKU meter. The preference of LUKU meter among domestic users was 80%, compared to industrial/commercial users where 70% preferred the LUKU meter.

Although the number of respondents was not very large, it was confirmed that the commercial/industrial users (large users) are more dissatisfied with the current tariff system than are the domestic users (small users). The above results agree well with the results of comparison between the Tanzanian tariff and those of other countries.

CHAPTER 4

POWER SUPPLY
AND
DEMAND

CHAPTER 4 POWER SUPPLY AND DEMAND

4.1 Current Power Supply and Demand Situation

In 1998, TANESCO's Grid System registered a maximum power demand of 367.5 MW, power sales of 1,822 GWh, and total losses of 12.9%. In the past 11 years, annual power sales grew at a respectable 7.6% on average. Hydropower is the main source of electricity generation, with thermal power being a supplementary one. In 2000, 89% of the electricity was generated by hydropower plants. There are two main water systems for hydropower generation. One is the Rufiji river system in the southwestern part of Tanzania. A total capacity of 464 MW has already been developed there. The Lower Kihansi hydropower plant (180 MW) that was put into operation in 2000 has significantly reduced the need for load shedding during the dry season. This river system has a huge amount of potential hydropower and will become a large source of electric power in the future. The other is the Pangani river system in the northeastern part of the country. It includes hydropower plant, the total capacity of which is 97 MW. Since TANESCO depends much on hydropower for electricity generation, its supply capability has been directly influenced by the volume of river water in the past.

The thermal power mainly comes from the Ubungo thermal power plant in a suburb of Dar es Salaam. Equipped with gas turbines and diesel-engine generators, this thermal power plant has an installed capacity of about 120 MW. Since it uses imported jet fuel which is expensive, it spends valuable foreign currency during a drought. Two years ago, the country's first IPP 100 MW diesel power plant (owned by Independent Power Tanzania Limited) was completed at Tegeta. But the commissioning was delayed up to January 2002 due to arbitration regarding Power Purchase Agreement. According to a Canadian consultant, Songo Songo Island in the Indian Ocean where a natural gas development project is being planned has a total reserve of 1 trillion cubic feet of natural gas. If a low-cost domestic fuel like natural gas becomes available, TANESCO's financial condition will improve appreciably.

Table 4.1 Existing Power Source in Grid System in Feb.2001

		Name	Installed Capacity (MW)	Effective Capacity (MW)
Hydro	Rufiji River Basin	Kidatu	204	204
		Lower Kihansi	180	180
		Mtera	80	80
	Pangani River Basin	Pangani Falls	68	66
		Hale	21	17
		Nyumba ya Mungu	8	8
	Hydro Total		561	555
Thermal	Gas Turbines	Ubungo	120	112.5
	Diesel	Ubungo	26.5	10
	Other Remote Diesels		55.5	25.3
	Thermal Total		202	147.8
Total Grid System			763	702.8

Source ; TANESCO

The existing power plant of TANESCO are shown in Table 4.1. It should be noted that the electric power consumption by people scattered in remote areas and not covered by TANESCO's Grid System accounts for only 3.1% of the country's total electric power consumption (in 1998). Dar es Salaam, Arusha, and Moshi that are included in the scope of the present study belong to the Grid System, and the data and electric power facilities shown in this report concern the Grid System unless otherwise noted.

4.2 Macroscopic Demand Forecast

The Team made a macroscopic forecast of power demand up until the year 2010 for: (1) Grid System, (2) Dar es Salaam, (3) Arusha, and (4) Moshi.

4.2.1 Grid System Power Supply and Demand

First, the Team made a long-range forecast of electric power demand for the Grid System. Then, the Team studied whether or not TANESCO's Grid System supply plan was in balance with the forecast demand. Since the three cities of Dar es Salaam, Arusha, and Moshi are included in the Grid System and connected with large-capacity trunk lines (220 kV and 132 kV), the Team does not consider it necessary to study them separately.

(1) Correlation with GDP

Generally speaking, there is a strong correlation between GDP (gross domestic product) and power demand. Table 4.2 and Fig. 4.1 show changes in GDP and power sales in Tanzania for the 18-year period from 1980 to 1998. It can be seen that there is a marked correlation between them.

Table 4.2 GDP in Tanzania and Energy Sales in TANESCO

Year	GDP (Billion TSh)	Energy Sales (GWh)
1980	856.7	579.1
1981	844.8	600.4
1982	848.4	604.8
1983	824.9	587.9
1984	852.4	603.4
1985	936.1	700.6
1986	1,001.3	822.3
1987	1,072.5	868.6
1988	1,119.0	1,005.8
1989	1,147.7	1,109.6
1990	1,219.2	1,254.4
1991	1,253.1	1,375.8
1992	1,275.9	1,373.9
1993	1,281.0	1,371.3
1994	1,298.9	1,397.8
1995	1,345.2	1,539.4
1996	1,401.7	1,717.6
1997	1,448.2	1,735.8
1998	1,505.8	1,822.4

Source : GDP : Bureau of Statistic, Energy Sales : TANESCO

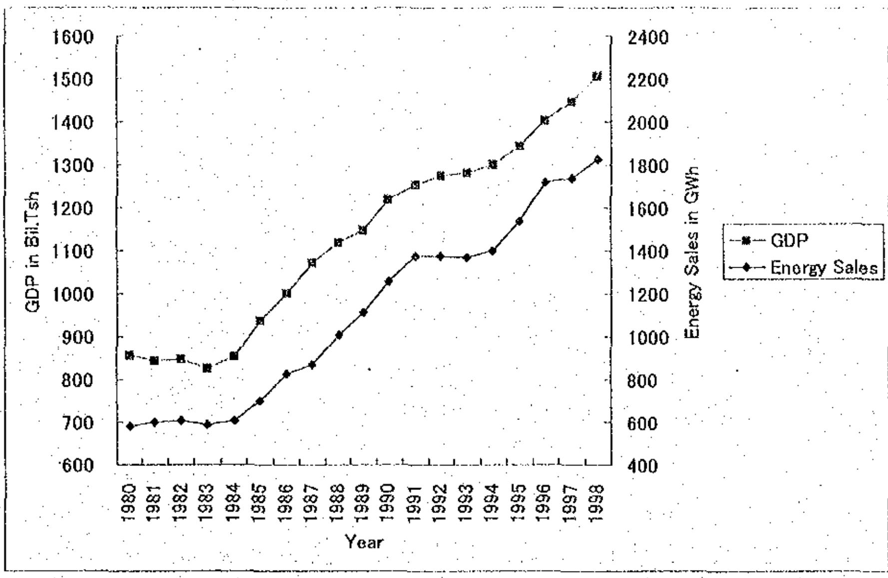

Fig.4.1 Relation between GDP and Energy Sales

With an eye on the correlation between GDP and power demand, the Team verified similarities between them using a linear regression equation. The relationship between GDP of Tanzania and power demand for TANESCO's Grid System in the seven-year period from 1992 to 1998 becomes as follows.

$$Y = 1.98x - 1{,}158$$

where, Y denotes power demand (GWh) and x denotes GDP (billions of TSh).

In the early 1980s, Tanzania's GDP showed a negative growth rate twice. Since 1983, however, GDP has continued to grow, with the average annual growth rate for the 18 years being 3.2%. It was in 1985 that GDP showed the highest growth rate—9.8%. In the recent four years, from 1995 to 1998, the GDP growth has been very stable, with the growth rate ranging from 3.3% to 4.2%. In the near future, the only definite factor that should increase GDP significantly is industrialization of Tanzania, especially the development of mines around Lake Victoria that is considered promising.

Looking at the breakdown of GDP by sector (agriculture, industry, service), the proportions remained almost the same for the 1980-1998 period as shown in Table 4.3. Generally speaking, the service sector tends to increase in proportion with the lapse of time. In this context, it may be said that the Tanzanian economy has continued to grow with the same industrial structure. Therefore, it is safe to say that in Tanzania the growth rate of electric power demand is proportional to the total growth rate of GDP

Table 4.3 Ratio of the Sectors in GDP (%)

Year	Agriculture	Service	Industry	Total
1980	45	18	37	100
1990	48	17	35	100
1998	49	17	34	100

Source : Bureau of Statistic

(2) Current power demand

The actual power sales of TANESCO's Grid System from 1980 to 1998 were as shown in Table 4.2 and Fig. 4.1. In 1992 to 1997, the levels of water in the main dams dropped due to droughts and the hydropower plant decreased in output, calling for an unprecedented, nationwide load shedding to tide over the difficulty. Nevertheless, the power sales in 1996 were large. The reason was that gas turbines which require costly fuel were operated to make up for the shortage of power supply. As a result, the 10-year period from 1988 to 1998 showed an average annual growth rate of 6.1%. Considering that the three years from 1992 to 1994 showed minimal growth, it may be said that the average annual growth rate of 6.1% was appreciably high. In 1997, El Nino brought large amounts of rain, filling the Rufiji and Pangani river systems with water. However, the fluctuations of electricity generation caused chiefly by weather are not so marked, though a certain trend can be seen from Fig. 4.2. The demand forecast was made by correcting the decreases in power sales and maximum demand due to abnormally dry weather in the past.

As the latest demand forecasts made by TANESCO, there are "Tanzanian Power System Master Plan, May 2000" and "Power System Master Plan, 2000 Update, Nov. 2000" by Acres International, a Canadian consultant firm. The former, based on the actual power supply and demand for the 18-year period (1980-1998), forecasts electric power demand up until the year 2030 using various parameters. It is dependable since it is reviewed and corrected every year. The latter studies mainly the types, capacities, and times of power supply up until the year 2025.

In this report, the Team studied the former demand forecast—the only demand forecast that the Corporate Planning and Research Department of TANESCO authorizes and uses in formulating its power development plans. The Team slightly modified the forecast and prepared JICA's own plan. As the premises for demand forecast, the following combinations of parameters were used.

(3) Premises used for demand forecast

When it comes to forecasting future demand, actual results in the past are the most important. In addition to the actual results, the following four parameters were used.

- Annual GDP growth rate	A: Medium (5.0%) B: Low (3.4%) C: High (5.8%)
- Annual increase rate in number of customers	A: Medium (5%) B: Small (4.5%) C: Many (6%)
- Annual power consumption growth late per customer	A: Increase (4%) B: No change (0%) C: Decrease (-4%)
- Time in which demand from new, large industries starts up	Short (3 years) Long (5 years)

As described in 4.2.1, GDP has been growing stably, at 3.3% to 4.2%, in recent years. The Team assumed that GDP would grow at 5% annually in the years ahead. The reason for this that the mining sector will be sure to grow in the near future. Estimating the contribution of the mining sector to the GDP growth to be 1%, the Team assumed the future GDP growth rate to be 5% (4.2% plus 1%). The Rolling Plan and Forward Budget (1996/97 ~ 1998/99) of the Tanzanian government also assumes the future GDP growth to be 5%.

Concerning the increase in number of customers of the Grid System, it is assumed to be 21,600, in addition to waiting 5,000 households in the first year of forecast (1999). With 21,600 households as the base, an annual growth rate of 5% was assumed to be an average one, with 4.5% being low and 6% being high (see Annex 4.1: Energy Sales and Number of Customers). The growth rate of new customers varies from region to region.

With respect to the demand for the Grid System from new, large industries, it is expected that the increase in demand due to the development of mines will call for substantial expansion of the two substations, Mwanza S/S and Shinyanga S/S, on the south side of Lake Victoria (see Annexes 4.2.1-4.2.3: List of New Industries). Normally, as long as business is good, a new industrial plant can be put into full operation to capacity in three years or so after the application for electricity supply is submitted to TANESCO. But if business is slow, it is expected that about five years will be required. Since the development of mines is extensive and the mines are scattered over a wide area, there is tendency that the project will be delayed. Therefore, the time in which the demand starts up is assumed to be five years.

The combinations of parameters used to forecast demand for the Grid System are as shown below. The Base Case is the most realistic, the High Case optimistic, and the Low Case pessimistic.

Cases of Load Forecast

Case	GDP Growth			Growth in Number of Customer			Growth in kWh per Customer			Industry's Year to Full	
	Low 3.4%	Mod. 5.0%	High 5.8%	Slow 4.5%	Mod. 5%	Fast 6%	Low -4.0%	Mod. 0%	High 4%	Short 3 ys	Long 5 ys
High			x			x	x			x	
Base		x			x				x		x
Low	x			x				x			x

Note : Mod.:Moderate, ys:years

It should be noted that those premises were applied to Dar es Salaam, Arusha, and Moshi, as well as to the Grid System.

(4) Demand forecast

The Base Case that is considered the most realistic assumes: (1) medium growth rate of GDP (average growth rate of 4.2% in the past plus 1%, that is, 5%), (2) medium increase in number of new customers (5.0% a year), (3) high rate of increase in power consumption per customer (4.0% a year), and (4) long time for new industries to start up (5 years). Demand forecast in the Base Case was made by regression analysis. The future demand and actual demand in the past are shown in the form of a graph in Fig. 4.2. According to the graph, the actual demand for the past decade up to 1998 was 6.1% on average and the demand for 1999 to 2010 is estimated to grow at 7.7% annually.

In the High Case of high rate of GDP growth, the annual growth rate of demand for 1999-2010 is 9.2%, whereas in the Low Case of low rate of GDP growth, the annual growth rate of demand becomes 5.4%.

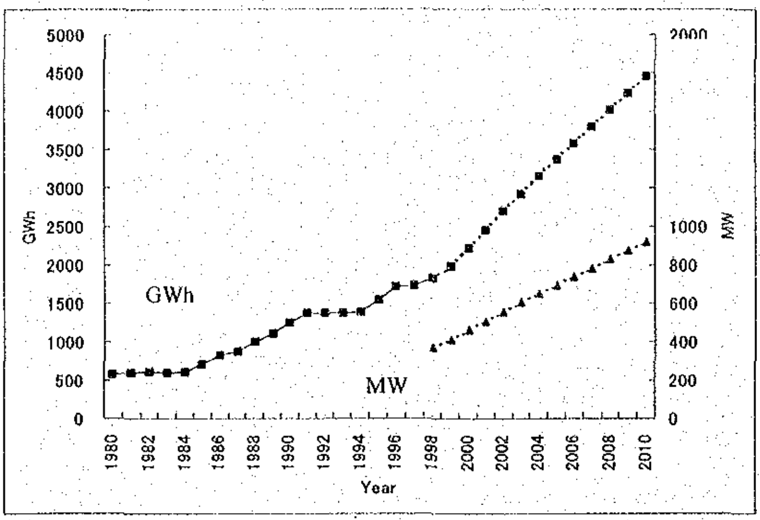

Fig.4.2 ast and Future Energy Sales and Maximum Demand in Grid System
Source: TANESCO

Maximum electric power demand which is required for equipment planning can be obtained from electric energy and load factor. The actual and forecast values are shown in Annexes 4.1 and 4.3, and the graph is shown in Fig. 4.2. Generally speaking, when the difference between peak and off-peak demands is wide, the load factor becomes poor and the rate of growth of maximum electric power becomes higher than that of electric energy. In the case of TANESCO, the Grid System and the three cities show little difference in growth rate between electric energy and maximum electric power. In the Base Case, the annual growth rate for the 12 years from 1999 to 2010 is assumed to be 7.9%. By the way, the annual growth rate is 9.6% in the High Case and 5.7% in the Low Case. In Tanzania, the peak demand occurs in the evenings, apparently due to the use of much electric power for cooking. Yet, a peak demand has not occurred with cooling equipment in the hottest hours of the day. Though air conditioners have not become widespread among average-income households, you can see new air conditioners in newly opened supermarkets and restaurants in Dar es Salaam. Marked peak demands for cooling in summer and for heating in winter which occur in Japan are not observed in Tanzania. The annual load factor in Tanzania is higher than in Japan.

(5) Supply Capability

Supply capability must have a certain allowance for maximum demand. The types, capacities, and times of operation of new power sources planned by TANESCO's update 2001 plans are as shown below. Transmission lines and substations associated with those new power sources are also planned, but these facilities shall not be discussed in the chapter.

1 Tegeta IPP diesel 100MW 2002

Although the installation of power plant was completed two years ago, commissioning was delayed up to Jan. 2002 due to arbitration regarding Power Purchase Agreement. Because the charge of power is still set at high rate, operating factor in future is uncertain.

The fuel for the diesel power plant is planned to be switched from heavy oil to natural gas when SONGAS is introduced.

2 Ubungo Gas Turbine #5 40MW 2004

3 Oil Combustion Gas Turbine (60MW) 2004

Since the gas turbine output was not shown in the data supplied by TANESCO, it is assumed to be 60 MW, which is the standard output of the gas turbine under consideration.

4 Kinyerezi Gas Turbine with SONGAS 60MW 2005

5 Ruhudji Hydro(89.5MW×4) 358MW 2012

With the exception of Ruhudji hydropower plants, all the new power sources that are planned to be installed by 2012 depend on SONGAS. Thus, it is not too much to say that the success of failure of the SONGAS project determines the supply-demand balance at TANESCO. *It will carry natural gas by a 230 km pipeline to Dar es Salaam* and construct or expand gas turbine and combined cycle power plants in the existing Ubungo power plant and Kinyerezi power plant southwest of Dar es Salaam Airport in the future. Natural gas is strongly needed not only by the electric power sector but also by the chemical and fuel industries. It is said that the cost of pipeline construction, which is estimated to be $200 million, will be financed by the International Development Association.

In addition to the above plans, TANESCO has the following plans to be carried out in and after 2012, though they have still low priority and involve many uncertain factors.

Plans to develop new power sources in and after 2012 (by TANESCO)

1 No. 4 and 5 units at Lower Kihansi hydropower plant

The No. 1, 2, and 3 units (60 MW each) were put into operation in 2000. They now have an environmental problem of the Kihansi Spray Toad (small rare species of toad) inhabiting downstream the dam. Biologists and environmentalists maintain that the rare animal requires a certain flow rate of river water and hence water must be constantly discharged from the dam. The water thus discharged does not contribute to power generation at all. Depending on the volume of water to be discharged constantly, it can pose a serious decrease of power generation not only for the existing three units but also for the planned two units.

2 International interconnection with Zambia

Since *1995*, TANESCO and ZESCO (Zambia Electricity Supply Corporation) have been making a joint study about international interconnection. In the study, they plan to connect Pensulo S/S in the northern part of Zambia and Mbeya S/S (220 kV) in the southwestern part of Tanzania with a 330 kV AC single circuit transmission line over a distance of approximately 700 km so that TANESCO receives 200 MW. It is said that input tariff is proposed to be less or equal to US 4.5 cent/kWh as per PSMP (Power System Master Plan) 2000 and not US 6 cent/kWh. The international interconnection, led by ESKOM (in South Africa), is a grand plan aimed to form part of wide area operation by AC transmission line in the major countries in South Africa beyond national borders by SAPP (South Africa Power Pool) for use of power interchange over a wide area and to connect the entire power grids in Africa in the future.

Therefore, in a sense, this interconnection might not only serve the economy of TANESCO but also decide international interconnection with Zambia if the power pool by multiple electric utility companies will prove advantageous.

3 Rumakali hydropower plants 222 MW (74 MW x 3)

This plan aims to construct a dam on Rumakali river that flows into Lake Nyasa situated on the national border with Malawi. Like the projects planned at the Ruhudji point (Ruhudji river) and Mandera point (Pangani river), this plan is at the stage of feasibility study, and it is considered that it will take many years before the construction work is started.

4 International interconnection with Kenya

Kenya that often suffers electricity shortage in the dry season is especially eager to carry out this plan. The governments of Kenya and Tanzania are going to make a joint feasibility study on interconnection between Arusha and Nairobi by a 220 kV single circuit transmission line over a distance of about 250 km. It is considered that the plan expects the generation of surplus electricity by SONGAS in the near future. In any case, installation of a new interconnection line between Arusha and Nairobi is insufficient even for power transmission of several hundreds of megawatts. It will require reinforcing TANESCO's existing transmission lines from the SONGAS power plants or hydropower source in the southwestern part to Arusha. This will involve substantial cost of construction. Because of many uncertain factors, the plan will not be carried out in the near future.

(6) Marginal supply capability

Fig. 4.3 shows maximum power demand for the Grid System and supply capacity of the Grid System in the form of a graph. In order for the Grid System to ensure stable supply of electricity, it must have a certain margin, or extra supply capacity.

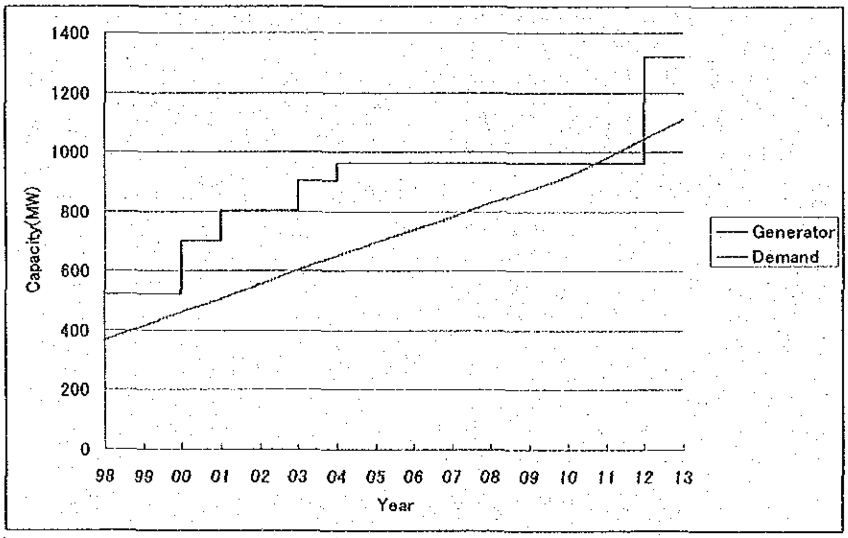

Fig.4.3 Demand and Effective Generation
Source TANESCO

According to TANESCO, the marginal supply capacity shall be 20% of maximum demand.

Unlike the case in Japan, the marginal supply capability factor defined by TANESCO is one including generators which are out of operation for inspection.

Assuming the maximum demand during the severest time of the year, 20% of maximum demand becomes as shown below.

Table 4.4 Supplying Margin

	2001	2002	2003	2004	2005	2007	2009	2010
Max. Demand (MW)	506	555	605	652	698	782	872	918
20% of above (MW)	101	111	121	130	139	156	174	184
Effective Supply (MW)	802	802	802	902	962	962	962	962
Supplying Margin(MW)	297	248	197	250	264	180	90	44
Supplying Margin (%)	59	45	33	38	38	23	10	5

Source : Fig. 4.3 *Supplying Margin (MW) = Total Effective Supply-Maximum Demand

Fig. 4.3 and Table 4.4 show rough figures which do not reflect the system loss. However, the difference between maximum demand and supply margin is 15%, lower than the standard 20%, only in the year 2009. If TANESCO can tide over that year, the supply-demand situation for the company will improve dramatically since the Ruhudji hydropower plant will be put into operation in 2010. Generally speaking, an electric power system, like the one of TANESCO, can be operated with sufficient margin as long as it has 20% marginal supply capacity. We shall not discuss the marginal supply capacity any longer since studying the supply-demand balance of the Grid System is not the purpose of this study.

4.2.2 Power Demand in Dar es Salaam

(1) Current power demand

Dar es Salaam is the largest city of Tanzania, accounting for 61% of the Grid System's energy sales in 1998. Note, however, that this figure includes the power supplied to Zanzibar by a submarine cable. This is because the power is transmitted via Ubungo S/S and Tegeta S/S that are located in Dar es Salaam as required by the system configuration. At present, in Dar es Salaam, the power supply is stepped down by a 220 kV substation and three 132 kV substations to 33 kV, which is then transmitted to 20 distribution substations within the city after it is further stepped down to 11 kV. Among others, the 220 kV Ubungo S/S that is the only substation in the western suburb of the city has the largest capacity and plays the important role in Dar es Salaam. It is also adjacent to the Ubungo thermal plant and connected with the Ubungo thermal plant and with the large power source area in the southwestern part of the country by a 220 kV transmission line (single circuit, two routes) and a 131 kV line. After these hydropower sources are received by Ubungo S/S, they are stepped down to 132 kV and supplied to its own substation and the three 132 kV substations. Of the three 132 kV substations, Ilala S/S is nearest to city center and an important substation. Tegeta S/S, located in the northern part, is on the route of the submarine cable to Zanzibar. It is adjacent and connected to Tanzania's first IPP power plant that waits to be put into operation. FZ III S/S, located in the southern part of the city, is the newest 132 kV substation that transmits electricity to the airport and the industrial zone in the locality.

The 33 kV distribution substations and feeders that receive power from the above four main substations are as follows (as of 2001).

- Substations receiving power from Ubungo S/S 6 substations
  Mikocheni S/S, Tandale S/S, Alaf S/S (private), Tazara S/S (private), part of Wazo Hill S/S (private), Friendship S/S (private)

- Substations receiving power from Ilala S/S 11 substations
  Oysterbay S/S, Msasani S/S, City Center S/S, Sokoine S/S, Kariakoo S/S, Kurasini S/S, Kigamboni S/S, Tiper S/S (private), Mbagala S/S, Chang'ombe S/S, FZ I S/S

- Substations receiving power from Tegeta S/S 2 substations
  Mbezi S/S, Wazo Hill S/S (private)

- Substations receiving power from FZ III S/S 2 substations
  FZ II S/S, FZ I S/S

Some distribution substations can receive power from two different substations by switching, hence the above substations are not fixed. "Private" means substations owned by private companies.

Power sales in Dar es Salaam for the 18 years from 1980 to 1998 are shown in Annex 4.6 and Fig. 4.4.

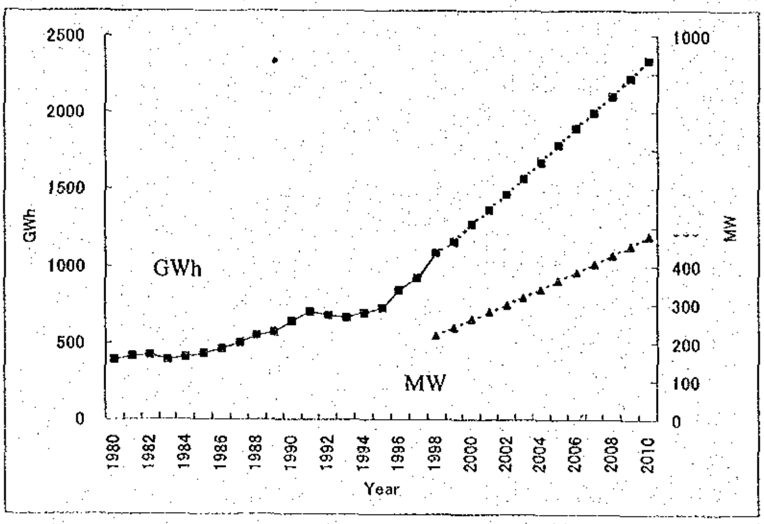

Fig. 4.4 Past and Future Energy Sales and Max. Demand in Dar es Salaam
Source TANESCO

According to the data, the growth of power sales was near zero in the four years from 1992 to 1995 due to dry weather. Nevertheless, the growth rate in the past decade was as high as 7.0% per annum, higher than the average annual growth rate of electric power sales of the Grid System for the same period.

(2) Demand forecast

According to the demand forecast for 1999-2010, the growth rates of both energy and maximum power demand in the Base Case are 6.7%. They are shown in the form of a graph in Fig. 4.4. The growth rates in Dar es Salaam are lower than those of the Grid System, Arusha, and Moshi, respectively. The reason for this is that due to the electrification of unelectrified areas, rural areas show a higher rate of increase in number of new customers than urban areas. Though the rate of increase is lower, Dar es Salaam shows much greater power sales in absolute terms.

4.2.3 Power Demand in Arusha

(1) Current power demand

Famous for the "Arusha Declaration," Arusha has a number of first-class hotels where international conferences are held. In Arusha which is rich in green forestation, there are wildlife sanctuaries in the vicinity and the city has many visitors. The towns are well planned and the distance between the primary substation and distribution substations is short. The 220 kV Njiro S/S is the only primary substation that supplies electricity to Arusha. It receives electricity from the hydropower source in the southwestern part of Tanzania via Singida S/S in the southwestern part and from the Pangani river system via Moshi by a 132 kV transmission line in the southeastern part. There are four 33 kV distribution substations and several private-owned substations in Arusha (as of 2001).

Mt. Meru S/S, Unga Limited S/S, Themi S/S, Kiltex S/S

The actual energy sales in Arusha for the past decade (1988-1998) are shown in Annex 4.10 and Fig. 4.5. They fluctuated markedly during the 1990-1997 period. This is because load shedding was implemented in 1992 to 1995 due to shortage of water. Even so, it seems that the load shedding was not so frequent as in Moshi because Arusha is an international city where international conferences are held.

(2) Demand forecast

In the past 10 years, the annual power demand in Arusha grew at 6.7% on average. Looking at recent years, however, the growth rate has been much lower due to the effect of shortage of water. Were it not for the shortage of water, the power sales must have been much larger. When the decrease in demand due to water shortage is corrected, the growth rate up until 2010 is a respectable 8.4% in the Base Case. The graph is shown in Fig. 4.5.

The annual growth rate is 9.4% in the High Case and 6.2% in the Low Case.

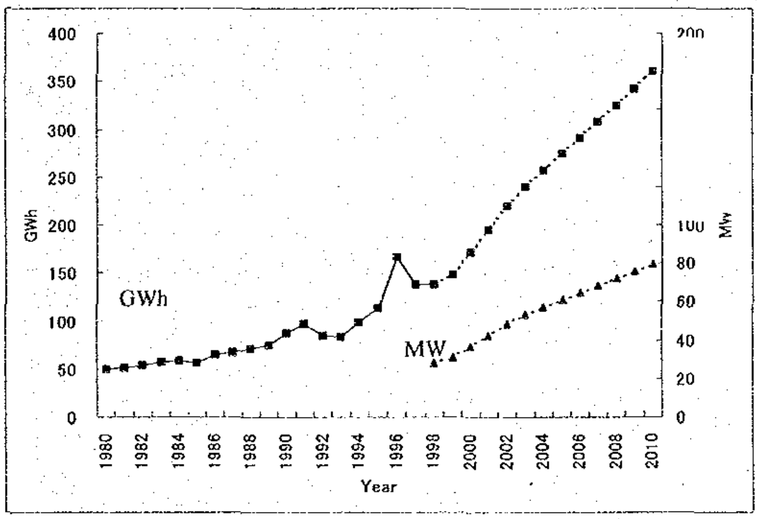

Fig.4.5 Past and Future Energy Sales and Max. Demand in Arusha
Source TANESCO

The annual growth rate of electric power demand up until 2010 is a respectable 9.2% in the Base Case.

4.2.4 Power Demand in Moshi

(1) Current power demand

Moshi has a smaller population than Arusha. Located at the foot of Mt. Kilimanjaro, the land is fertile and wide, producing agricultural products, such as coffee and bananas, and sisal and lumber. Because of this, distribution substations are scattered over a wide area. Some distribution line feeders extend as long as 120 km and the end of receiving voltage is subject to a wide fluctuation. Since the distribution lines thread through wide forest land, grounded faults caused by fallen trees are frequent. In Moshi, power is stepped down by two 132 kV substations (Kiyungi and Same) and Nyumba ya Mungu hydropower plant to 33 kV and transmitted to distribution substations. The distribution substations and feeders that receive power from the three substations/power plant are as follows (as of 2001).

- Substations receiving power from Kiyungi S/S 5 substations
  Boma Mbuzi S/S, Trade School S/S, Machame S/S, Lawate S/S, KIA (Kilimanjaro International Airport)

- Substations receiving power from Nyumba ya Mungu hydropower plant 1 substation
  Mwanga S/S

- Substations receiving power from Same S/S 2 substations
  Same S/S and Gonja S/S

Actual power sales in Moshi for the decade from 1988 to 1998 are shown in Annex 4.4 and Fig. 4.6. Though the average annual growth rate in the past is a mere 4.0%, 1996 and 1997 showed a remarkably large growth rate. This is considered due to the abundant water supply. In the demand forecast, however, those growth rates were treated as extraordinary. *In 1992 to 1994, energy sales dipped due to frequent load shedding to* overcome shortage of water. In 1998, the energy sales dropped 34% from the year before. This is considered due to the consumption of abundant water supply in the previous year. Looking at the decade from 1987 to 1997, annual energy sales grew as much as 11.4% on average.

(2) Demand forecast

The power sales for the future decade in Moshi is forecast to be 9.0% vs. 7.7% of the growth rate for the Grid System, and the maximum demand is forecast to be 9.3% in the Base Case. The reason for this is that as mentioned earlier, the proportion of electrification of unelectrified villages is large. However, these figures are too large compared with the microscopic forecast described in 4.3. Therefore, the Team lowered both the forecast power sales and maximum demand for 1998-2010 by TANESCO by 0.5 percentage point and used the modified case as the Base-J Case (Base JICA plan). The entry of few large industries is one of the reasons for the downward revision

- Annual growth rate of energy sales 9.0% was revised to 8.5%.
- Annual growth rate of maximum demand 9.3% was revised to 8.8%.

The results of the demand forecast are shown in Fig. 4.6.

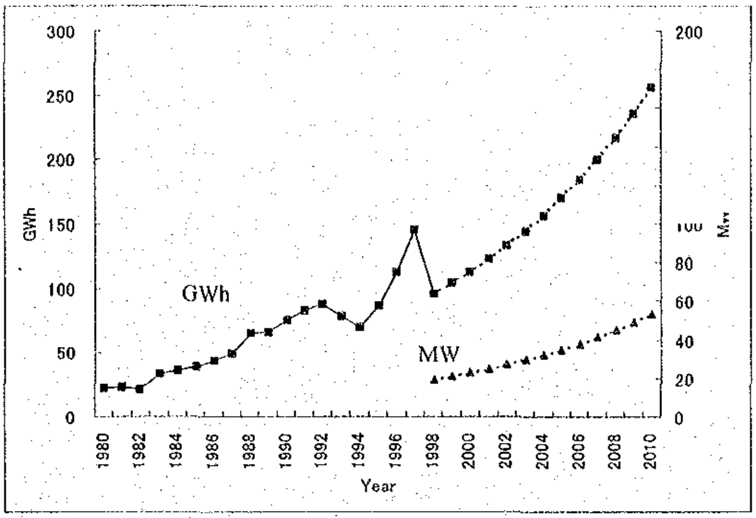

Fig. 4.6 Past and Future Energy Sales and Max. Demand in Moshi
Source TANESCO

4.2.5 Summary of Macroscopic Forecast

In the macroscopic forecast, the rates of growth of the Grid System, Dar es Salaam, Arusha, and Moshi were grasped macroscopically to forecast electric power demands for the period from 1999 to 2010.

In the Base Case, in which GDP growth, etc. were assumed to be moderate, the Grid System showed a high rate of growth of maximum demand (7.9%). It is expected that the maximum demand that was 367.5 MW in 1998 will increase to 2.5 times, 918.3 MW in 2010. Energy sales that were 1,822 GWh in 1998 will grow at 7.7% annually to 2.4 times, 4,454 GWh in 2010. Thanks to the Lower Kihansi hydro plant (180 MW) that was put into operation in 2000, the current demand is met sufficiently. However, if there are no additions to the supply capacity in the future, the robust electricity demand will exceed the 180 MW in 2004, four years from now.

The results of the demand forecast for the Grid System, Dar es Salaam, Arusha, and Moshi, respectively, are shown in Table 4.5. Figures for Dar es Salaam and Arusha are those in the Base Case, and for Moshi, the Base-J Case represents realistic figures. For optimistic forecast (High Case) and pessimistic forecast (Low Case) for the Grid System and the three cities, see Annexes 4.4, 4.5, 4.8, 4.9, 4.12, 4.13, and 4.16.