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Energy Sector Management Assistance Programme

Tanzania

Power Loss Reduction Study

Volume 2: Transmission and Distribution System Reduction of Non-Technical Losses

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ENERGY SECTOR MANAGEMENT ASSISTANCE PROGRAMME (ESMAP)

PURPOSE

The Joint UNDP/World Bank Energy Sector Management Assistance Programme (ESMAP) is a special global technical assistance program run as part of the World Bank's Energy, Mining and Telecommunications Department. ESMAP provides advice to governments on sustainable energy development. Established with the support of UNDP and 15 bilateral official donors in 1983, it focuses on the role of energy in the development process with the objective of contributing to poverty alleviation, improving living conditions and preserving the environment in developing countries and transition economies. ESMAP centers its interventions around three priority areas: sector reform and restructuring; access to modern energy for the poorest; and promotion of sustainable energy practices.

GOVERNANCE AND OPERATIONS

ESMAP is governed by a Consultative Group (ESMAP CG), composed of representatives of the UNDP and World Bank, other donors, and development experts from regions benefiting from ESMAP's assistance. The ESMAP CG is chaired by a World Bank's Vice President, and advised by a Technical Advisory Group (TAG) of four independent energy experts that reviews the Programme's strategic agenda, its work plan, and its achievements. ESMAP relies on a cadre of engineers, energy planners, and economists from the World Bank to conduct its activities under the guidance of the Manager of ESMAP, responsible for administering the Programme.

FUNDING

ESMAP is a cooperative effort supported over the years by the World Bank, the UNDP and other United Nations agencies, the European Union, the Organization of American States (OAS), the Latin American Energy Organization (OLADE), and public and private donors from countries including Australia, Belgium, Canada, Denmark, Germany, Finland, France, Iceland, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Sweden, Switzerland, the United Kingdom, and the United States.

FURTHER INFORMATION

An up-to-date listing of completed ESMAP projects is appended to this report. For further information, a copy of ESMAP Annual Report or copies of completed projects, contact:

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TANZANIA

POWER LOSS REDUCTION STUDY

VOLUME 2:
REDUCTION OF NON-TECHNICAL LOSSES

November 1992

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PREFACE

This report was prepared in 1992 consequent to a study conducted during 1990 to 1992 in association with a distribution planning unit established in the Tanzania Electric Supply Company (TANESCO).

The report is in two volumes; volume 1 dealing with the technical studies conducted on transmission and distribution systems and volume 2 dealing with non-technical loss issues. The Bank team carrying out the study consisted of Messrs. Winston Hay, Chrisantha Ratnayake, and Ms. Paivi Koljonen. Volume 1 was prepared by Mr. Ratnayake and volume 2 by Mr. Hay. The assistance and participation of the distribution planning unit in TANESCO in carrying out the detailed studies on which this report is based is readily acknowledged.

I. EXECUTIVE SUMMARY

Introduction

1.1 The overall energy losses on the public electricity grid of Tanzania Electric Supply Company Limited (TANESCO) presently amounts to some 21 percent of net generation. System losses commonly divide into two sources (a) technical and (b) nontechnical. Technical losses result from a certain percentage of the power flowing through transmission and distribution systems being converted into heat. The amount of energy so converted is dependent on the physical characteristics of the system and the electrical load imposed on it. Nontechnical losses represent unbilled consumption resulting from inaccurate metering, errors in meter reading and billing as well as from consumer fraud (power theft). Losses result in economic burdens for the country, lower revenues for the utility and the need for unproductive investment in generation, transmission and distribution plant.

1.2 Investigations indicated that the technical losses on the TANESCO system did not exceed about 11.5 percent of net generation annually. This implied that, with nontechnical losses being about 9.5 percent of net generation, more than 145 GWh of electricity was being consumed annually without producing revenue for TANESCO. In 1989 the company's average tariff level was 5 Tanzanian shillings (TSh) per kWh. At that rate, nontechnical losses amounted to TSh 725 million, or nearly US$4 million, in lost revenues annually.

1.3 TANESCO requested the Energy Sector Assistance Programme (ESMAP), a joint United Nations Development Programme (UNDP)/World Bank program, to help determine how much the various loss sources contribute to overall losses and assist development of a program to reduce losses to an economic optimum. ESMAP obtained funding for the execution of the study from the Swedish International Development Authority (SIDA) and began the study in late 1989.

1.4 This volume of the study report focuses only on the nontechnical loss reduction activities, conclusions, recommendations and results. The study of technical losses is dealt with in the first volume of the report.

1.5 The primary sources of nontechnical loss are

(a) unmetered supplies. These may be due to consumer theft of power. They can also result from direct connections the utility made during meter shortage and failed to correct when meters became available;

(b) defective metering. This may be the result of tampering. Or the meter may have been connected incorrectly by TANESCO, may have been installed with defective mechanisms or may have developed defects after installation;

(c) meter reading errors. Some meters may be read incorrectly or not at all;

(d) billing deficiencies. For example, the billing department may not prepare some bills because it has not received meter readings; it may calculates some incorrectly; and it may not be able to send others because consumers are not properly recorded on the billing register.

1.6 Unlike technical losses, nontechnical losses can often be reduced with little investment of capital and in relatively short time. In addition, and again unlike technical losses, nontechnical losses can be reduced to levels very close to zero. Successful loss reduction of any nature, however, requires careful development of strategy, thorough implementation of the program decided on and scrupulous attention to detail.

1.7 In mid-1992 as the study neared its end, significant progress had been made in the reduction of nontechnical losses. Joint TANESCO-ESMAP efforts had led to the formation of inspectorate teams in all zones to, inter alia, carry out inspections of consumer service installations, rectify irregularities and prepare invoices for unbilled consumption where such was detected. By TANESCO's estimates the inspectorates have been successful in reducing the level of nontechnical losses by four percent of net generation by the end of June 1992. Invoices for more than 300 TSh had been issued for consumption previously unbilled and of that amount more than 30 million had already been collected. The training which TANESCO staff have received as well as the institutional structures developed for detection and control of nontechnical losses augur well for continued reduction of losses on the Tanzanian grid.

Observations

1.8 During the time spent in the field, the mission observed a number of practices and administrative weaknesses which contribute to the high level of nontechnical losses that TANESCO currently experiences. The more important of these involve service drops, meters and meter reading management, meter reading, billing, and billing administration.

Service Drops

1.9 TANESCO apparently has no uniform standards for the design of service drops. (Service drops are the conductors and other hardware used to connect the utility's distribution system to a consumer's meter). Service crews installing the drops run conductors through the most convenient routes. The results are not only untidy but often present easy opportunities for illegal abstraction of power. The untidiness of the installations increases the difficulty of detecting illegal connections.

Meters and Meter Management

1.10 TANESCO's meters are dust resistant but not weatherproof. They are therefore not suitable for outdoor installation where they would be directly exposed to rain. Electrical connections to all meters are made at the bottom. It is possible to seal the meter's terminal box, but this procedure is not rigorously followed.

1.11 Before installation, each new meter is tested in TANESCO's meter test workshop. There is no program to routinely test meters after installation. Meters are brought in for retesting only if they are known to be damaged or otherwise nonfunctional or in response to consumer complaints. Some of the testing equipment in the workshop (in particular, the rotating substandards) is of doubtful accuracy.

1.12 TANESCO does not assign its own numbers to meters but uses the manufacturers' serial numbers for identification. Since meters are purchased from a number of different manufacturers, each using a different approach to selecting serial numbers, no logical system of classification by meter number can be employed by TANESCO.

1.13 After testing, new and used meters are stored in rooms adjacent to the workshop. The number of meters observed in inventory indicated that lack of meters was not the cause of the relatively slow rate at which new consumers are added to the utility's system, as is sometimes suggested.

1.14 TANESCO's only central meter records are the notebooks in which the test results are registered. The volume of information and the random nature in which it is stored make access to data on specific meters extremely difficult.

Metering Installations

1.15 There appears to be no design standard for metering installations. The untidiness noticed in the installation of service drops is often repeated in metering installations, especially in locations, such as apartment buildings or office blocks, where a number of meters are grouped together. Most meters are unsealed, and the wiring around the meters is generally exposed, again making fraudulent abstraction of power a relatively easy operation.

1.16 Many meters were seen to be stopped, although the premises continued to be supplied with power. TANESCO's own records indicate that in December 1989, the utility had about 7,000 active accounts whose meter readings had indicated zero consumption for six months or more. The majority of these accounts are thought to have defective meters. Also, several hundred meters have been reported defective but have not yet been investigated and corrected. Some or all of these defective meters may be associated with the 7,000 accounts mentioned above.

1.17 Energized but unused and unmetered service conductors were observed in a number of premises. This situation is hazardous and invites fraudulent use of electricity.

1.18 Early in 1990, TANESCO initiated a program to relocate all meters (except those with instrument transformers) to the outer walls of buildings. The objective is to increase the rate of meter reading and reduce fraud. The program is progressing slowly, primarily because of inadequate resources committed to the task.

1.19 Metering installations with instrument transformers are not adequately secured. The transformers are not sealed, and conductors between them and the meters are not run in a tamper-proof manner. The meters themselves are often not sealed.

1.20 Meters for a wide range of installations, from residential to industrial consumers, are often located in locked areas whose keys are kept by the consumer. TANESCO, therefore, cannot gain immediate access to these locations without cooperation from the consumer, who will thus know when TANESCO staff are coming to inspect the metering. Unscrupulous consumers may use this opportunity to remove evidence of fraudulent power abstraction.

1.21 The meters are also frequently installed in areas that make meter reading uncomfortable, difficult and sometimes dangerous. Common problems are (a) the placement of meters so high that a stool or ladder is needed for reading them, (b) the placement of meters so low that they cannot be conveniently read, (c) inadequate space in front of meters for proper reading, (d) stored materials that impede access to meters, and (e) exposed and energized conductors nearby that endanger the safety of personnel.

1.22 TANESCO's general practice for supplies that do not involve metal switchboard panels is to install a fused cutout upstream from the meter. Some, but not all, cutout covers have provision for security seals to fasten the covers to the body of the device. Several different cutout models are in service, and their covers are not always interchangeable. In any case, it is not unusual to find cutouts with the cover unsealed, without a cover, or with fuses removed and replaced by wires. Many installations were observed where the cutout had been completely removed and the wires at each end spliced together. Unsealed cutouts and spliced conductors make it easy to bypass the meter when supplying power to the premises.

1.23 Industrial consumers are required to provide revenue metering equipment in the main supply switchgear of their premises. There are two important disadvantages to this practice.

First, TANESCO cannot provide a level of security which will ensure that only its employees have lawful access to the metering installations. Second, the metering equipment is not standardized, and defective units therefore cannot be readily replaced from TANESCO's inventory. As a result, the energy consumption of a consumer who has defective meters may remain unmetered until spares have been procured from the original supplier.

Meter Reading

1.24 TANESCO's service area is divided into several meter reading zones, with each zone normally being read on a specific day of the month. Individual zones are subdivided into meter reading routes; a route comprises the accounts assigned to a meter reader to be read in a full working day. Meters with demand registers are read by special crews.

1.25 At the beginning of the workday, meter readers are issued hard cover books with a sheet for each customer whose meter is to be read that day. When new, each sheet has space for about two years' readings. The meter reader is expected to take the book along the route and enter meter readings directly onto the appropriate sheets. However, it was observed in Dar es Salaam that in practice, meter readers leave the book in the office, write the readings on a sheet of paper and transcribe them to the book toward the end of the workday. This practice is apparently followed because the sheets are not arranged in the books in the sequence in which the route is followed.

1.26 Because up to two years' readings are maintained on any given sheet, the meter reader will know the previous month's reading for each meter to be read.

1.27 The meter reader also records the reading on a card that is kept near the meter. This card is another source where the reader can obtain the previous month's meter reading.

1.28 In the so-called "unsurveyed areas" where street names and numbers do not exist, routing information is unreliable. In these areas, several meter readers go house-to-house and read all the meters in a specified area. Afterward, the group assembles; one person reads from a computer printout the numbers of the meters that were assigned to be read that day. When a meter reader hears the number of a meter he has read, he supplies the reading, which is then recorded on the sheet. This process is time consuming, especially given the unsystematic assignment of meter numbers, and inaccuracies are common.

1.29 Meter readers are supposed to report the meters they find that are not on the meter reading schedule. Despite this, many meters that are listed as having been issued cannot be located in the field. The previously mentioned lack of a central data base for meter information (paragraph 20) increases the difficulty of solving this problem.

1.30 Sample checks indicated that the accuracy of meter reading is well below what ought to be considered acceptable. This observation is supported by the relatively high number of validation requests ("query reports") that are issued after meter readings are entered into the computer. A validation request is generated whenever the computer's initial calculations indicate inconsistencies between a new meter reading and previously recorded data. Not all validation requests, however, result from meter reading anomalies.

1.31 Meter readers are expected to report irregularities observed during the course of their work. A special form is supposed to have been developed for this purpose, but no example was seen. Some meter readers stated that no action is being taken to correct irregularities that have been repeatedly reported; as a result, they have lost the motivation to continue making reports. TANESCO's records indicated in March 1990 that a backlog of 500 defective meter reports from meter readers was awaiting investigation. (See also paragraph 1.16.)

Billing

1.32 In current practice, meter readings are transferred from the hard cover books to a list that is used for data entry to the billing computer. This means that a reading is transcribed four times--three by writing and one by keying--before it is finally recorded in the computer. Such repetitious transcription increases the likelihood of errors.

1.33 The billing program now in use suffers from a number of serious inadequacies. Important among these are situations where

(a) a consumer's average consumption is not calculated from previous records but from an estimation. An estimate of average consumption is made when the account is first established and remains in use unless manually changed;

(b) no limit exists on the number of consecutive bills that can be issued on the basis of estimated consumption. At the end of 1989, TANESCO had more than 11,000 accounts that had been billed for six or more consecutive periods on this basis;

(c) consumptions higher than average are flagged, but those that are lower are not. Consumption that is lower than average is far more likely to adversely affect utility revenues than consumption that is higher;

(d) the computer is not programmed to recognize when a meter has exceeded the limits of its register and the register has returned to zero.

1.34 It is possible for any staff member with access to the computer and knowledge about data entry to change meter reading records without prior authorization from a designated manager. No explanation needs to be given about why the change is made. Such changes affect only current billing (to reduce the amount invoiced in all instances observed) without any corresponding adjustments being made to previously issued bills.

1.35 A large number of consumers (7,000 in December 1989) are being billed for zero energy consumption over extended periods of time. Since these consumers continue to make the minimum payments stipulated in the service contract, it may be safely assumed that the majority, if not all, of them are in fact consuming energy that is not being recorded by the meters. (See also paragraph 1.16.)

1.36 Computer problems at the time of the field work for this report resulted in irregular bill preparation. It was therefore not possible to determine how much time normally elapses between reading a meter and billing the corresponding consumer.

Billing Administration

1.37 No group within TANESCO is charged specifically with investigating and eliminating the causes of revenue loss. As information about nontechnical losses is transferred from department to department, the sense of urgency becomes diluted. A department tends to assign priority to activities it considers to be its more substantive duties. Task forces (such as the one that recently started investigating irregularities) formed to address specific issues often do not have the expected effect because they depend on other groups, which have different priorities, to act on the findings of the investigation.

1.38 The laws of the Republic of Tanzania expressly include theft of electricity among the criminal offenses punishable by imprisonment. However, no instance was found where TANESCO had taken a consumer suspected of power theft before the court. TANESCO's own penalties for fraud require an offending consumer to pay a fine, the cost of inspection, expenses for disconnection and reconnection, and the cost of repairing any damage done to the utility's equipment. But even these official company procedures are not followed consistently, and the popular perception may well be that TANESCO does not consider unauthorized use of power to be a serious offense.

1.39 The bills sent to consumers are imprinted with the following statement:

> "Pay promptly within 21 days otherwise power will be disconnected without further notice"

This warning is manually stamped on the bill. It would be more efficient to have it printed as a standard part of the bill form or to have it printed by the computer when the bill is prepared. Bills are also folded and inserted into the envelopes by hand, again an exercise that seems unnecessarily labor intensive.

1.40 Despite the warning printed on the bill, disconnections are not consistently undertaken. The head office in Dar es Salaam stated that when each new bill is issued, disconnection orders are issued for accounts that are one month's payment in arrears. The Morogoro office reported that disconnections are undertaken on accounts that are three months in arrears. The observed facts did not support either assertion. Many cases were found where active accounts were much more than three months in arrears.

1.41 If a consumer requests his supply to be disconnected, one person is sent to obtain a final reading and another is sent later to disconnect the supply. The procedure is not only labor intensive, but it also increases the probability that a consumer will continue to use energy after a final bill has been issued and his account has been removed from the billing register.

Recommendations

1.42 A wide range of actions is required if TANESCO is to reduce nontechnical losses to a level close to what is economically achievable. The presented recommendations here focus on those actions that can be taken in the relatively short term and that should produce more or less immediate benefits. Succeeding chapters deal with the fundamental issues in greater detail and, while repeating the recommendations of this chapter, provide additional advice on organizational and procedural changes that will further reduce nontechnical losses and keep them at low levels.

First Priority for Consumer Installations and Metering

1.43 TANESCO should establish a task force charged with developing and executing a countrywide program of reducing nontechnical system losses. The program must be directed by a senior level officer with no other substantive duties. The task force must have the authority and resources to

- disconnect supplies where warranted, such as in case of fraud;
- correct irregular installations, such as defective meters;
- reseal meters and cutouts where required;
- record supplies to premises for which there are not registered accounts and specify the location of each;
- calculate lost revenues and penalties for back-billing;

- record the serial number, type (e.g., kVA demand, directly connected, three-phase, single-phase) and location of all meters in the field, whether they are registered or not.

The task force must also monitor the execution of those remedial actions that fall outside its jurisdiction and inform higher management of actions that are not addressed with the required degree of timeliness.

1.44 The task force's first priority in loss reduction must be to ensure that all consumers, connected to TANESCO lines are properly (a) registered on the company's consumer records, (b) metered and (c) invoiced for their energy consumption. It is therefore essential that all consumers are properly recorded and that consumer metering installations be rigorously inspected for metering and other irregularities. These two tasks may proceed concurrently but should be undertaken by different work crews.

1.45 If proper accounting is to be made for all consumers connected to the system, TANESCO must institute a program to patrol the full length of its distribution lines and record every consumer supplied from them. Although recognition of fraud and other irregularities is also important, this must assume second priority if a choice of priorities must be made. Therefore, the work force identifying consumer connections, meter types and serial numbers must not be required to search for irregularities, although they must report the obvious ones. If workers are required to carry out detailed investigations of the connections, the accounting program will proceed with unnecessary slowness and will probably never be completed. To be effective, such a program must be initiated and completed within a reasonable time--not more than six months. The work force involved will need to be trustworthy and diligent and will need some training or experience in what to look for. It is possible that TANESCO cannot provide sufficient staff with the qualifications needed to complete the program in the stipulated period without severely disrupting other important functions. In that event, persons outside the organization will have to be hired temporarily. The potential increase in revenues will justify major expenditures on such a program.

1.46 The program should begin in areas of high consumer density and gradually extend over the whole system.

1.47 The second area needing urgent attention is the investigation of irregularities. Another set of work groups should be established to undertake these investigations. The staff will need to be experienced meter readers and installers or persons given thorough special training. The installations to be examined first should be those with known or suspected irregularities that have been reported but not yet addressed. The work crew must be empowered to take such actions as disconnecting services, installing new meters and resealing meters and cutouts. When the backlog of outstanding inspection requests has been completed, the work groups should investigate other accounts, giving priority to the largest consumers as well as to irregularity reports from the groups identifying connections or from other sources. Special attention should be given to accounts that (a) have indicated zero consumption or have been billed on estimated consumption for several months, (b) have indicated zero or drastically reduced kVA demand (where applicable) and (c) have shown significant reduction in average monthly consumption.

1.48 The investigation teams will need to be able to check on the accuracy of the meters. For directly connected meters, this check can be performed adequately by using a clip-on ammeter and timing the meter for three to five minutes. The teams may use a portable load of a known constant demand, such as a one kilowatt resistive load, to test where premises are unoccupied and there is no consumer demand at the time of inspection. The overall approach requires at least a close approximation of the power factor. That parameter can also be measured by certain types of modern clip-on ammeters. Larger metering installations with instrument transformers should be checked with portable kilowatt and kilowatt-hour measuring devices.

1.49 TANESCO should carefully consider introducing new meter seals when the loss reduction program starts. It appears that control has been lost over existing sealing tools, and the utility should probably change the method of sealing. Tight control will make it possible to know who is responsible for sealing a specific meter or to hold staff accountable for the use of seals issued to them. New seals may also be more difficult to break and can be color coded to identify, for example, accounts with previously reported irregularities.

First Priority for Meter Reading and Billing

1.50 The existing billing program suffers from many inadequacies that make it unsuitable for use by a modern utility. TANESCO recognizes this shortcoming and plans to purchase new billing hardware and software. Annex 1 is a draft specification for a new billing program. It will be some time, however, before a new computer and program can be functioning, and there are at least three areas, discussed in the following paragraphs, where urgent action is needed to begin controlling nontechnical losses.

1.51 At present, any staff member with access to the computer and knowledge about data entry can change meter reading records in the computer. This situation must be changed immediately. Only a restricted number of responsible management staff should be able to change meter reading records that have been entered and validated. The easiest way to accomplish this control is to have a program that requires a password that can be changed frequently and is known only to the authorized persons. Any change in meter reading records, as well as reasons for the change, must be documented. In addition, appropriate modifications to billing already issued should be made after such changes to meter readings.

1.52 The method of calculating estimated consumption needs to be revised. The program should be modified to calculate estimated consumption from actual meter readings stored in the computer, which currently maintains data from the previous six months.

1.53 The program must also be modified to flag abnormal decreases in consumption. Abrupt reductions in the average consumption of a single account often indicate metering problems or fraud. Abnormal increases in average consumption (currently identified in the billing process) are less important to the utility.

1.54 The program changes recommended above may require TANESCO to seek outside assistance. The changes are relatively simple. Consulting costs to have them carried out would be relatively small compared with potential benefits.

Second Priority for Consumer Installations and Metering

1.55 TANESCO must develop, publicize and rigidly enforce standards for service drops and metering installations. Single-phase service conductors should be run from the distribution line to a bracket on the building to be served and then through a metal conduit, attached to the outer surface of the building, to a meter (or meters) mounted at a height where it can be conveniently read. The service line should preferably be of concentric cable to reduce the possibility of making fraudulent connections upstream from the meter.

1.56 Meters must be installed in locations protected from the weather or in weatherproof compartments. The latter must have windows that allow the meters to be read without opening the compartment. It is also recommended that TANESCO consider using weatherproof, socket-type meters like those in normal service in North America.

1.57 Wiring upstream from the meters should not be exposed or easily accessible, and meter terminal boxes and cutouts must be sealed. It is recommended that the cutouts be relocated downstream from the meter to make sealing these devices unnecessary.

1.58 TANESCO must develop and implement a systematic program of assigning and affixing a proprietary company number to each of its meters. Meter suppliers can be required to affix this number, in accordance with TANESCO instructions, to each meter purchased by the company. The number should be displayed inside the meter case where it is easily visible through the glass window. The numbers will have to be affixed on existing meters by TANESCO, itself. This can be best accomplished by replacing existing meters with ones that have been tested and had numbers affixed to them in the company's meter workshop.

1.59 A computerized data base of all company-owned meters, including those in inventory, should be developed. These records will encompass all relevant data, such as manufacturer's name, serial number, company number, phases, range and location history. Ideally, this data base would be maintained on the mainframe computer used for consumer billing. But microcomputers can be used if that avenue is quicker.

1.60 All revenue metering equipment should be TANESCO property and conform to uniform standards. The current practice of requiring large industrial consumers to purchase metering equipment with their supply switchgear should be discontinued.

Second Priority for Meter Reading and Billing

1.61 Meter reading sheets should be arranged in the order in which a reader encounters the meters as he walks the route. The sheets should be modified so that a reader will not know the value of previous readings. Also, the practice of maintaining a reading card near the consumer's meter should be discontinued.

1.62 The sheets on which meter readers enter the readings should be used, without transcription, for keying the data into the computer. This routine will not only expedite bill preparation (and therefore revenue collection) but will also reduce the number of errors that currently develop between reading the meter and keying the data into the computer. A carbon copy of the readings can be made when they are first recorded.

1.63 TANESCO needs to develop a method for describing a service drop in an "unsurveyed area" so that it can be located by TANESCO staff without much difficulty. Persons unfamiliar with local conditions cannot make many useful recommendations for developing such a method. But this task, if given adequate priority, is certainly within TANESCO's capabilities. One approach might be to display the location on maps drawn to an appropriately large scale. Another possibility is to number the poles in the unsurveyed areas and use the pole number as an identifying address. This pole-numbering scheme should be made generally applicable to the TANESCO-wide system, even if the scheme is initially implemented only in unsurveyed areas.

1.64 Bills for industrial consumers in Dar es Salaam should be prepared and hand-delivered within one day of the meter reading. For zones outside Dar es Salaam, readings should be forwarded to the head office the day the readings were made. The Head Office, in turn, should forward the bills calculated from those readings to the originating office within one day of receipt for prompt hand delivery.

1.65 TANESCO should investigate the feasibility of contracting meter reading, billing and collection to one or more private organizations.

Disconnections

1.66 The disconnection policy needs to be reviewed, revised if necessary, publicized and consistently enforced. Disconnected supplies need to be periodically reinspected if regular supply is not reestablished.

1.67 The disconnection warning that is currently hand-stamped on each bill should be printed on the bill form or printed automatically by the computer. TANESCO should plan to purchase an automatic bill-inserting machine along with other new billing hardware.

Fraud

1.68 Penalties should be rigorously applied where fraud is discovered. They should include charges for all costs incurred in investigating and rectifying the irregularity as well as for revenue losses resulting from the theft of energy. A substantial deposit on account should be required before service is restored, and the metering installation must be conspicuously identified as one where fraudulent abstraction of power has occurred.

1.69 TANESCO is understandably reluctant to bring consumers charged with fraud before the courts, as permitted under the laws of Tanzania. Nevertheless, if theft of power continues to be a problem, prosecution of serious offenders will discourage the practice, especially if successful prosecutions are well publicized in the press. Staff who investigate power theft will need careful training in the collection and preservation of evidence for presentation to the courts.

Tariffs

1.70 Tariff schedules do not impact losses directly, but they may provide consumers with incentives to defraud. TANESCO's tariffs (those in force in January 1992 are shown in Annex 2) show a number of inconsistencies which need to be addressed in a study to review and restructure tariffs on a more rational basis. The feature most likely to encourage fraud is the steep increase in the incremental unit cost of energy to residential, commercial and light industrial consumers with increasing aggregate consumption. The intention is to encourage energy conservation but the effect may be more likely to increase losses.

Conclusions

1.71 The study has already produced tangible results in reducing non-technical losses on the TANESCO system, as shown in the previous paragraph. The further actions recommended above should bring further reductions in losses and increases in revenues and deserve TANESCO's urgent attention. The following sections deal with the fundamental issues in greater detail and make additional recommendations which enhance achieving the objective of reducing losses to an acceptable minimum.

II. METERING

Meters and Installation Practice

Energy Meters

2.1 The majority of TANESCO meters are of British manufacture. The meter bearings are of good quality; older meters run on jewels, and newer ones use magnetic attraction or suspension. Not many cases of movement seizure due to bad bearings have been reported with these meters, but some magnetic bearing models seem to have more defects than the rest. Japanese meters have been used in the recent Dar es Salaam distribution system rehabilitation project. These meters do not have magnetic bearings. A larger than normal proportion of these meters have been reported to have stopped because of bearing seizure.

2.2 All the meters are dust resistant but are unsuitable for exposed outdoor installations. All the meters are bottom connected. Most have cyclometer (digital) registers with five or six digits, not including the decimal register.

2.3 Nearly all the meters have a decimal register, but many do not conform with the latest construction standards that require noninteger digits to be identified by a color different from the white-on-black numerals used for integer digits. Decimal registers, especially when located on the same line with the other registers, may lead to meter reading errors.

Demand Meters

2.4 When kVA demand readings are required, a combination of two or three meters is used. The three-meter alternative is no longer installed for new supplies, but many of these devices are still found in consumer metering. In the two-meter combination, the instrument that measures kWh also has an unused kW demand register; the meter with the kVA demand register also has an unused display for reactive energy. The kVA demand mechanism (30 minute integrated demand) is very complex. Its driving motor and reset coil are not very reliable.

2.5 TANESCO does not own any meters that read kWh and kVA demand in one enclosure. These meters have been available in North America for at least 30 years.

2.6 Most of the meters are bottom connected. Some of the three-meter combinations are switchboard type, with the terminals at the back of the instrument.

2.7 The cyclometer indication for meters used with current or current/voltage transformers is already adjusted by the application of the multiplier factors for the respective instrument transformers. However, many of the cyclometer indications are not in kilowatt hours (the only units of energy accepted by the computer for billing purposes) and must therefore be corrected by a multiplier before being entered on the meter-reading sheets.

Meter Mounting and Installations: Existing, Directly Connected Meters Mounted on Walls

2.8 An outdoor service line terminates at a bracket on the outside wall of a consumer's premises. Wiring from that bracket to the cutouts is usually by a two- or four-core cable with vinyl protective coating. In three-phase installations, two two-core cables in parallel are often used instead of four conductor cable. These cables are frequently inaccessible to inspection because they run under roofs or are embedded in the walls.

2.9 Energized but unused and unmetered service conductors were observed inside several premises. This practice is hazardous and invites unauthorized abstraction of electricity.

2.10 The supply voltage to directly connected meters is 230/400 V. In meter installations not involving metal panels, TANESCO standards require installation of single-pole, fused cutouts on the live lines on the supply side of the meter. Most cutouts have a compartment for the neutral link. Several models of cutouts are employed, and their covers are not always interchangeable. Some, but not all, cutout covers have provisions for a lead seal to fasten them to the body of the device. Most connectors in each pole of the cutouts have provisions for two conductors, but usually one of these spaces is unused.

2.11 It is not uncommon to find either a cutout without a cover and with a bridge between its terminals or signs that a cutout had burned, was removed and the wires spliced together.

2.12 Many meters are mounted inside customer premises, and permission must be obtained from the occupants to gain access to them. Occasionally, one or more meters are mounted inside a wooden box with a small slit, which is presumably sufficient to allow normal meter reading. Frequently these boxes are closed with a padlock, the keys being kept by the customer. One case was observed where the keys could not be located when requested by TANESCO employees.

2.13 Unwritten standards require that new installations have an earthing electrode to which all the earthing conductors are connected. This specification is not always followed, resulting in a variety of earthing practices that sometimes conflict with each other and are not suited for the equipment being used. Earthing is important for protection of personnel against electric shock.

2.14 Early in 1990, TANESCO initiated a program in Dar es Salaam to relocate meters (except those with instrument transformers) on the outer walls of buildings in order to reduce opportunities for fraud and to expedite meter reading. TANESCO supplies all materials. The work comprises supply and installation of

- insulated cables from the incoming bracket or an existing service cable to an area where several meters are located;
- insulated cables from the meter load terminals to the conductors that were previously connected to the load side of the original meter;
- mounting boards or wooden boxes or other necessary equipment;
- cutouts, junction boxes or other necessary equipment; and
- new meters to replace those previously installed.

Meter Mounting and Installations: Directly Connected, Low-Voltage Meters on Metal Panels or Boxes

2.15 These installations are found primarily in multistory buildings. The meters (and cutouts when provided) are mounted on the front of a panel or box. The main portion of the wiring is usually hidden inside the panel or box, and only a short length of the lead to the meter or cutout is accessible from the front.

2.16 No identification of circuits that serve particular offices or apartments in the building is readily available.

2.17 The space provided in front of the meters is generally restricted, and other equipment is often placed directly in front of the panel or box. The rooms where the meters are located are sometimes used for storing tools, other objects and even trash. Panels are frequently covered with dust and cobwebs that could contribute to insulation failure.

2.18 The wiring at the back of these panels lends itself to fraudulent installations.

Meter Mounting and Installations: Low-Voltage Installations Using Current Transformers

2.19 Current transformers are used when the ampere rating of directly connected meters is less than the consumer's load. When current transformers are needed, the load is high enough to place the consumer in a tariff category that requires a demand meter.

2.20 Most of these installations are located in a room or cubicle provided by the consumer. Frequently the available space is shared by non-TANESCO equipment, and the space in front of the meters is insufficient to allow them to be read or checked safely. Doors to the meter cubicles are often locked by the consumers. TANESCO employees lose much time trying to obtain the keys and often have to make a second visit because the keys were not made available on the first.

2.21 The current transformers now used are of the "window" or "doughnut" type, which requires the power conductors to run through a central hole. If one of the transformers needs to be changed, the power conductor must be cut, the transformer replaced and the conductor respliced together. Service must be interrupted for several hours for this task. Since the transformer windows are quite small, passing the power conductors through them is often difficult, particularly if more than one conductor per phase is used.

2.22 The terminals of the secondary circuits of current transformers are easily accessible to unauthorized persons who can thereby alter the meter registrations. Most existing installations lack the means to temporarily short-circuit the secondary windings of the current transformers when wiring to the meter must be opened. If the secondary circuit of a current transformer is left open, high voltages will develop across its terminals, jeopardizing the safety of personnel as well as the transformer itself.

Meter Mounting and Installations: Medium-Voltage Installations Using Current and Voltage Transformers

2.23 These installations are for consumers supplied at 11 kV and 33 kV. All of these consumers are billed for energy (kWh) and demand (kVA). TANESCO requires the consumer to supply indoor switchgear with a main incoming breaker equipped with overcurrent and ground protection, three ammeters, one voltmeter and switch, three current transformers and three voltage transformers. Consumers also purchase and install the meters - a two-element kWh meter and a kVA demand meter. The indications of these meters should already have been adjusted to reflect turn ratios of the voltage and current transformers.

2.24 The specification for this equipment is based on British standards and does not appear to have been updated for many years. The switchgear purchased by the consumers is not usually of British manufacture and may follow other construction standards.

2.25 The quality and maintenance of the installations vary widely, but all display the following weaknesses:

- There is very little space in which to work when inspecting or testing the meters.

- Most installations are in locked rooms, and the consumer keeps the key. Much time is lost gaining access to the meters.

- The current and voltage transformers are used for metering and protection. The control and meter wiring is readily accessible to the consumer, making it easily possible for the meter wiring to be tampered with. Instrument transformers, which are the draw-out type, can be easily disconnected. Evidence was seen of voltage transformers having been "racked out" by the consumer, thereby preventing the meter from registering.

- Instrument transformers form part of the switchgear and are probably not interchangeable between the installations of different consumers. Therefore when transformers fail, replacement units with the appropriate ratios may not be readily available and must be ordered from the manufacturer, with consequent high cost and long delivery time.

- Current transformers used for metering will not necessarily have winding ratios appropriate for use for protection and vice versa. The switchgear usually does not have separate current transformers for metering and for protection. Readings from several demand meters suggest that the transformer ratios are often too high for good metering, indicating that the transformer was probably chosen to satisfy protection requirements.

- Very few installations have switches to accommodate meter testing. When test switches are provided, they are not always of the same design, and the installations use several wiring schemes. The lack of standardization prevents a large number of the plugs from being used for testing, which is one of the features intended to justify the use of test switches.

- The wiring connecting the meter to the instrument transformers is usually composed of individual conductors, and no attempt is made to color-code them. The conductors are often installed in a disorderly manner that makes following their connections difficult. The cabling between instrument transformers and meters is seldom shielded. Good practice requires these cables to be shielded by a metallic conduit or outer metallic sheath to minimize errors or damage due to external electric or magnetic fields.

- The meters are preprogrammed for specific instrument transformer multipliers, a situation which reduces the interchangeability of meters and increases the probability that a suitable meter will not be available to substitute for one which must be removed from a consumer's premises for repairs.

Meter Testing

Workshop

2.26 TANESCO's meter workshop in Dar es Salaam calibrates new meters before installation and inspects, repairs and recalibrates used meters as needed.

2.27 The workshop has three test benches: one modern single-phase unit with a 110/230-V electronic substandard and two adequate three-phase units with the following rotating substandards:

(a) three-phase rotating standards 110/230 V

(b) three-phase rotating standard 110 V

(c) Several three-phase rotating standards 230 V

Some substandards are also used for field testing. The workshop has no high-precision "transfer standard" that could be used to check the accuracy of the substandards.

2.28 Part of the workshop area is used to clean and repair meters, which are then sent to the calibration benches. Ultrasonic equipment to clean the meters has been received but not yet installed. This equipment should accelerate the repair process because it cleans the meters without requiring disassembly. It is claimed that 120 single-phase meters can be calibrated in a day.

2.29 The testing routine for new meters is unnecessarily thorough and therefore time consuming. New meters are calibrated at the factory using equipment much more accurate than TANESCO's, and their construction is sturdy enough to withstand the relatively minor transportation shocks usually encountered between the factory and TANESCO's meter workshop. Compliance testing, for instance, at 100 percent load and unity power factor should be sufficient for meters that show no obvious sign of damage during transportation. If the meter passes this test, it will probably be within acceptable limits of accuracy throughout its operating range. Meters that show evidence of rough handling during transportation (damaged cartons, for instance) and used meters should undergo the complete testing routine.

2.30 The three-phase rotating substandards used for meter testing appear to be far out of calibration. An electronic single-phase substandard (considered the most accurate in the shop) was used to separately test each of the rotating substandards' phases. Such tests are not the most precise but provide reliable indication of the accuracy of the substandards. The results strongly indicated that the substandards have large errors, which may be negative or positive. The error indicated for two phases of three substandards ranged from -1.20 to +3.31 percent.

2.31 The acceptable error for these substandards should not exceed ±0.1 percent.

Field Testing Installed Meters

2.32 There is no routine program of testing installed meters in the field or of rotating installed meters to the workshop for testing. Installed meters are returned for testing only if consumers complain, but this situation occurs infrequently. Records of the "as received" accuracy of such meters would provide useful information about meter performance, but such records are currently not maintained. Therefore, there are no data to determine whether the performance of the meters deteriorates with use.

2.33 In 1987-88, TANESCO embarked on a program to field test 300 installations with demand meters in the Dar es Salaam area. Fifteen percent of these were found to be outside the accepted limits of accuracy. The program is continuing for the remaining installations, but serious obstacles are delaying it. For example,

- lack of adequate transportation;
- divided responsibilities for the maintenance, testing and repair of the installations. Theoretically, these responsibilities belong to the regional offices, but they lack the technical knowledge and specialized equipment to perform the work. On the other hand, work is not large enough to service all the installations adequately and frequently;
- much time is wasted in gaining access to the sites, checking the wiring and performing the tests;
- Two substandards must be carried - one for three-phase, four-wire, 230/400-V installations and another for three-phase, three-wire, 110-V (secondary) installations. These substandards are not always available, so the logical scheduling of work is hampered; and
- proper testing of demand registers requires a constant power level to be applied to the meter for a considerable fraction of the meter demand period (supposedly 30 minutes). These conditions are not always possible in the field; the field calibration of demand registers is therefore questionable. Calibration is much better if carried out in the workshop.

Meter Data Base

2.34 The only records TANESCO has of its meters are the notebooks in which the test results are registered. The information contained in these voluminous books is almost impossible to interpret and therefore nearly useless for providing data about the meters.

2.35 Modern computer techniques allow the creation and upkeep of meter data bases, which are used not only to manage the meters but also for billing and accounting.

Recommendations

Meter Installations

2.36 It is of urgent importance that TANESCO develop and institute an inspection program of all service and metering installations to ensure that their energy consumption is being properly metered for revenue purposes. This program will require a number of experienced or well-trained, trustworthy staff members to carry out these inspections as their only assigned duties. They will have to be provided with all reasonable resources to carry out these duties thoroughly and efficiently. They will also need to be authorized and competent to disconnect services, seal meters and cut-outs and take remedial measures in cases where the installations pose a hazard to personnel safety. The program should begin with installations that already show evidence of irregularities. The next highest priority should be the larger consumers.

2.37 In the longer term, attention needs to be paid to the standards and procedures that govern the provision of service to consumers and the metering of their consumption. TANESCO does not have standards for service drops and meter installations. The lack of standards has resulted in a variety of makeshift installations. These installations are hazardous, create favorable conditions for fraud and other irregularities and make discovery of these irregularities more difficult.

Service Drops

2.38 The service drop is the set of conductors and supporting hardware that leads from the utility's distribution system to the load terminals of the meter.

2.39 TANESCO's present standards specify that the portion of the service drop from the overhead distribution system to the house bracket should consist of bare conductors supported by hardware and insulators. However, this design provides easy opportunities for illegal abstraction of electricity. To reduce this risk all conductors in the service drop should be insulated. Where TANESCO currently uses insulated conductors, the sheaths are made of vinyl. But cross-linked polyethylene is better suited for outdoor use. The insulated sheathed conductor is more expensive than bare conductors of equal cross-section, but the price difference may be offset by several factors:

- Because of mechanical considerations, the cross-section of the insulated conductor cable may be smaller than that of its equivalent bare conductors.
- The hardware needed to support the insulated cable is considerably cheaper than the insulators and brackets needed for the bare conductors.
- The design of the overhead lines is simpler because the insulated cable does not have to maintain the clearances from buildings and trees needed for bare conductors.

2.40 Regardless of the construction type employed, a portion of the service drop will always be on the exterior walls or inside the building, where an insulated cable must be used. The use of concentric cable is recommended as being more difficult to tap for fraudulent purposes. The standards must establish how the insulated cable should be installed in the exposed and unexposed portions. It is desirable that the conductors be run in conduits when in contact with building surfaces and that the conduits be run, to the fullest extent possible, on the exterior surface of building walls. The conduit will not only protect the conductors from physical damage but also make fraudulent connections more difficult. It may be necessary for part of the service drop to be routed where it cannot be seen, in which case the hidden portions must run through a conduit supplied by the customer. Before providing service, TANESCO should carefully inspect the conduit and the rest of the installation to ensure that no fraudulent connections have been made.

2.41 TANESCO should standardize its cable use by selecting two sizes for service drops providing single-phase, two-wire services and two sizes for three-phase, four-wire services. The sizes to be used in a particular location would be determined by the rating of the consumer's main interrupting device (fuse or circuit-breaker).

Location of Meters

2.42 TANESCO should develop, publicize and insist on adherence to clear standards that specify how meters are to be installed. The main requirement would be that the meters be installed where TANESCO employees can have access to them at all times without having to ask permission to enter. No locking devices supplied by the customer should be allowed to restrict access to the meter and its wiring. The meters currently used, however, are not weatherproof, and their location is limited to places sheltered from rain. Thus, the meters would have to be located on areas of exterior wall surfaces protected from the weather or in specially constructed enclosures designed to provide that protection. The use of weatherproof meters built to North American standards should also be considered for future use. These meters offer many other advantages but are more expensive than the meters now purchased.

2.43 Meters should also be mounted so that they are readily accessible for meter reading and inspection without the use of a stool or a ladder.

2.44 The regulations should establish that a working area with a radius of not less than one meter must be provided around the instrument itself so that personnel have adequate space to install, maintain and remove meters.

Sealing of Meters, Instrument Transformers and Cutouts

2.45 It is of urgent importance that all meters, instrument transformers and cutouts (if these are located upstream from the meter) be sealed. TANESCO should acquire new proprietary seals that can be easily and positively identified as being different from those now in use. If the new seals require the use of sealing tools, procedures must be established to strictly control access to and use of these tools and to ensure that the employee responsible for sealing any device can always be positively identified. Certain newer seal types do not require sealing tools but can be identified by a unique number. These latter seals can also usually be color coded to indicate, for instance, whether a given installation has had previous instances of fraud.

2.46 The sealing of instrument transformers should receive special attention which it does not currently get from TANESCO. Sealing irregularities have the potential to be a significant source of revenue losses.

Meter Boxes and Switchboards

2.47 TANESCO should produce and publish a specification for meter switchboards and boxes. this specification should provide at least the following guidelines:

- Wiring should be accessible from the front.
- At least one meter of free space should be provided in front of each switchboard to provide easy meter reading, testing and general maintenance.
- When the capacity of any single incoming conductor is above 200 amperes, a three-phase, four-wire bus must feed each meter. Each phase must be clearly color coded.
- Conductors from the bus to the meters must be supplied when the switchboard is built. Each wire must be connected to its respective bus with pressure type or bolted connectors. The meter side of each conductor must have an insulated termination (not just insulating tape). All conductors must be color coded with the same colors as the bus.

- A standard method of mounting meters should be specified, including dimensions, holes for mounting screws, positions for the wiring, and cutout location. Standardized blanking plates must be available for each meter position so they can be sealed in place when there is no meter for the circuit.

- A standard method of mounting cutouts (or better, circuit breakers) must be specified, including how they are to be wired to the respective meters.

- A connector strip for all the earthing wires from the customer circuits must be provided. I must be in solid electrical contact with the switchboard frame.

- A connector strip for all the neutral wires form the customer circuits must be provided. It must be insulated from the switchboard frame.

- The conductors from the meter load terminals must be clearly tagged to identify the premises to be served.

- The side, top and back panels of the switchboard should be welded to its frame. Any removable front panels for access to wiring compartments should have provisions for sealing.

- The methods for the entry and connection of the incoming supply cables should be specified.

2.48 Similar specifications should be developed for meter boxes. The big difference between switchboards and boxes will probably be that the boxes do not need incoming buses.

Cutouts

2.49 The probability of fraud and the cost of sealing would decrease if the fused cutouts were installed after the meter instead of before. The probability of fraud would be reduced because

- the service-drop insulated conductor would be routed directly to the meter, where it would be adequately protected by the meter terminal cover. At present, the insulated conductor cable is brought to the supply side of the cutout, and a single conductor is used between each cutout and its meter terminal. The construction of the cutout lends itself to installing bypasses. With the cutout on the load side of the meter, the consumer has no incentive to install a bypass;

- with the cutout on the meter load side, there would be no need to seal it under normal circumstances. This arrangement would also reduce the cost of sealing.

- whenever a fuse is blown under the current arrangement, TANESCO staff must replace the fuse if the cutout is to be resealed. However crews responding to emergency calls are not normally equipped to reseal the cutouts. In addition, many consumers have no compunction about breaking the seals and undertaking the relatively minor operation required to replace the fuse themselves and get rapid restoration of service rather than waiting for TANESCO's service call. These factors together account for many of the cases where the seals are first broken. Once the security of the seals has been breached, it is seldom re-established. And broken seals often lead to further irregularities.

2.50 Admittedly, meter changing would be slightly more difficult if the cutouts are on the meter load side, since no cutout would be available to de-energize the circuits to the meter. This would not be much of a problem if meter gangs are equipped with proper tooling and trained to do the changeover safely.

Earthing

2.51 TANESCO should thoroughly study the effect different earthing practices may have on its various types of metering equipment and establish and enforce appropriate standards.

Demand Meters for Low-Voltage Consumers

2.52 No approved standards currently exist for installations that meter the demand and energy consumption of consumers supplied at 230/400 V. TANESCO should develop standards for future installations, based on using a box for the current transformers (and possibly cutouts) and connecting the current transformer to the meter by an eight-conductor, color-coded cable. The box should have provisions for being securely sealed against unauthorized access

2.53 Meter installers should be instructed to ensure that the power conductors are centered within the windows of the current transformers to maximize the accuracy of metering.

2.54 Supply installations should be designed to simplify the replacement of current transformers and reduce or eliminate the time during which the premises are without supply while a transformer is changed. This goal may be achieved by establishing the standard use of wound current transformers with a terminal bar at each end that allows easy attachment or detachment of the power conductors as required. This practice would simplify the entire process of installing these transformers, which are generally more accurate than the window type, since the centering of the conductor in the hole is automatically provided. In installations where window-type transformers continue in use, the power conductors should be cut (inside the security box mentioned above) and reconnected by an approved screw-type pressure connector. The point of reconnection must be carefully reinsulated.

2.55 About 600 of these installations exist, serving consumers supplied under tariff categories 4 and 4A. TANESCO should insist on being able to gain access to these meters at all times.

2.56 <u>Secondary Conductors for Current Transformers.</u> The window-type current transformers that TANESCO uses are suitable for a burden of 5 VA or 15 VA. The conductor normally used is 1.5 mm^2 (15 AWG). If the allowable burden is not to be exceeded, the maximum secondary cable length with this size conductor and the 5-VA transformer should be 6 meters. But this length is often exceeded in TANESCO installations. Most utilities would use 5.3 mm^2 (10 AWG) under these circumstances. The conductors should have an outer metallic sheath or run in a metal conduit. The objective is not only to shield the conductors against the influence of stray electromagnetic fields but also to provide greater security against tampering.

2.57 <u>Test Blocks.</u> A standardized test block should be provided for each meter, with sufficient poles for use with three-element, three-phase, four-wire meters and two-element, three-phase, three-wire meters. All test blocks should be fully interchangeable and suitable for use with the same plug-in testing units.

2.58 Voltage Indication. Each meter should have three high-resistance neon lights suitable for operation at 110 V or 230 V to indicate the existence of voltage at the meter itself.

2.59 Earthing. Since the meter boxes are metallic, installation practices should ensure that they are properly earthed without interfering with the recommended meter wiring. Proper earthing is particularly important with solid-state meters.

Demand Meters for Medium-Voltage Consumers

2.60 The recommendations above for current-transformer metering of low-voltage supplies apply as well to medium-voltage metering. The current practice of requiring the consumer to supply revenue-metering equipment with the switchgear should be discontinued. Revenue metering for all consumers should be solely TANESCO's responsibility and done with equipment specified, owned and installed by the utility. Only by these means can TANESCO achieve complete control over the equipment. The most effective deterrent to fraud is to ensure that the consumer does not have right of access to any part of the metering installation. Ideally, the metering installation should be located close to the point where the service lines enter the consumer premises and accessible, without impediment, to TANESCO staff. The utility should also consider mounting outdoor-type instrument transformers on the distribution pole from which the consumer is supplied and having secure cabling from the secondaries of the transformers to the meter. This alternative is applicable only in cases where the consumer is supplied by an underground cable from the overhead 11-kV or 33-kV network. The best place to mount instrument transformers is above the overhead line, a location that makes access by unauthorized persons difficult. This mounting is practical only if the utility has hydraulic bucket trucks for servicing the assembly.

2.61 Until this revised policy can be fully implemented, instrument transformers supplied with the consumer switchgear should be required to meet specifications that provide greater security for the metering circuits. The switchgear installed should be fitted with compartments that contain instrument transformers used exclusively for revenue metering. These compartments must be capable of being sealed to ensure that only TANESCO personnel can gain access.

Meter Specifications

2.62 TANESCO should begin to evaluate meters with designs that differ from those of meters currently in use. The two types recommended for special consideration are:

(a) socket meters, such as those commonly used in North America. These meters plug into a specially designed socket. Their design makes them easy to install and seal and, since there is no exposed wiring, increases the difficulty of bypassing them. In addition, they are weatherproof and can be installed outdoors without special enclosures. Large consumers can be monitored for both demand and energy consumption with a single instrument; and

(b) electronic, or solid-state, meters. These meters may be bottom connected or socket type. Tampering with meters of this design is more difficult as well as easier to detect. A single electronic meter, like a single socket type, can be used for both demand and energy-consumption measures.

Socket and electronic meters are more expensive than the current TANESCO standards, but the advantages they offer may well offset the higher costs.

Meter Testing: Workshop

2.63 The procedure whereby every new meter is routinely tested for accuracy in the workshop before installation should be discontinued. If there is no evidence of mishandling during shipment and handling, a statistically sound, random sample of the meters in each package should be tested. If all meters in the sample meet the accuracy standards, the complete package can be accepted. If some meters in the sample fail the test, only then should the complete package be tested.

2.64 The workshop's three-phase rotating substandards appear to be far out of calibration. The Tanzania Bureau of Standards claims to be able to check and calibrate these units. This assertion should be investigated. If the claim is found to be valid, then the standards should be recalibrated in the Bureau's laboratories. Newer standards of the electronic type, however, are much less subject to damage from vibration and shock. It is therefore recommended that TANESCO purchase new single- and three-phase electronic substandards, two of each type.

2.65 It is also recommended that a three-phase voltage transformer be acquired to make one of the existing benches suitable for testing two-element meters.

Meter Testing: Field

2.66 Given the present level of technical losses on the TANESCO system, it is better to achieve a high rate of testing and be assured that most metering installations provide reasonably accurate indications of power consumption than to strive to achieve a high degree of accuracy with a relatively small number of meters. Single-phase meters can be checked in the field for accuracy by using a clip-on ammeter and timing the rotation of the meter disk. A reasonable approximation of the power factor must be known if this method is to be applied. If necessary, the power factor can also be measured by lightweight portable instrumentation. This approach can also be employed for directly connected, three-phase meters if the phase currents are reasonably well balanced. To check meters with unbalanced phases or meters with instrument transformers, a portable, high-quality kilowatt-hour meter with clip-on transducers should be installed and left connected in parallel with the fixed meter for about four hours.

Meter Data Base

2.67 The process of accounting for all meters on the TANESCO system makes the establishment of a computerized data base virtually essential. The data base should contain information on all meters the utility has now or ever had and for which the relevant data is obtainable. Such records will not only assist in monitoring the movement of meters and evaluating their performance but can also help identify problematic consumer accounts.

2.68 The key to a meter data base is the assignment of a unique company number to each meter. TANESCO does not now assign its own meter numbers but uses the manufacturers' serial number for meter identification. This practice prevents the development of any logical system of classification by meter number, since each manufacturer assigns serial numbers on its own basis.

2.69 Before gathering information for a meter data base, the company needs to

- develop simple systems to keep the data base updated;

- decide what type of computer the data base should be developed on. The data base should end up in the mainframe computer used for billing and other commercial functions. However, if the present data processing facilities are incapable of dealing with it, the new data base could be started on a microcomputer;

- determine how the meter numbers will be affixed and obtain the necessary materials to affix them;

- decide what information is to be included in the data base and how it is to be collected and validated; and

- establish programs for the orderly collection and registration of this data.

Conclusion

2.70 The lack of consistent technical standards for consumer supply and revenue metering installations and the absence of uniformly applied procedures in these areas contribute to the relatively high level of nontechnical losses that TANESCO currently experiences. To realize its goal of reducing nontechnical losses to more acceptable levels, TANESCO will have to pay meticulous attention to creating conditions that make irregularities (especially fraud) less likely to occur and improve the accuracy of revenue metering.

III. METER READING AND CONSUMER BILLING

Introduction

3.1 The many urgent operating problems facing senior managers in the average electric utility often prevent them from devoting enough attention to tasks as seemingly mundane as meter reading. Reliable meter reading, however, is essential to the accurate invoicing of consumers who, in turn, often base their opinion of the utility on how fairly they think the utility's bills reflect their energy consumption. Meter reading and billing are therefore important not only for protecting the utility's revenue base but also for maintaining good customer relations.

3.2 Meter readers play an important role in the detection of unmetered consumer connections and other irregularities that cause revenue losses for the utility. These irregularities include consumers who are legitimately connected to the system but not billed because they are not included in the billing register. The effectiveness of meter readers in detecting irregularities depends largely on their training and experience, as well as on the incentives that motivate them.

3.3 The meter reading and quality control procedures currently practiced by TANESCO could be improved, and the reliability and speed of the invoicing process can be increased.

Meter Reading

Meter Locations

3.4 Meters are generally located inside a customer's building. Gaining access to them is not only time consuming but also puts the meter reader in direct contact with the consumer, a situation that can lead to inappropriate meter-reading practices or reporting.

3.5 TANESCO recently started a program to move meters in multiple-dwelling buildings in downtown Dar es Salaam from inside the premises to patios or outside walls of the buildings. This program should be accelerated so that all meters are eventually placed where they can be reached at any time without asking for entry permission.

3.6 Having the meters outside should also accelerate the reading rate and might double the present productivity. In addition, this practice will considerably reduce the number of readings that must be estimated owing to lack of meter access and should have a major impact on nontechnical loss reduction.

Meter Reading Process

3.7 At TANESCO, the meter reading process generally follows these steps:

- Hard cover books are made up with one sheet per customer. Each sheet has space for about two years of readings. Computer-produced labels identifying the customer are pasted on each sheet. Sometimes when advance information is available that a new customer is receiving service, a new sheet is typewritten and inserted in the proper sequence. The book cover has a key lock that must be opened to insert or remove sheets. The key is kept by authorized personnel, but the lock is so elementary that it can be opened by any person with average dexterity.

- The field supervisors decide daily which book is to be assigned to each meter reader. The readers are said to be rotated so that they do not work the same book two months in a row. Arrangements are made for transporting readers to the start of each route.

- Supposedly, each meter reader is given a book and follows its route. Observations suggest, however, that readers do not take along the books. All readings on each sheet examined had the same handwriting, and there were no dirt or rain marks to suggest the book was taken to the field. Instead, the readers write the meter readings and numbers on a sheet of paper and later transcribe them into the books. Readers prefer this method because the sequence in the books is usually incorrect.

- The meter reader also marks the reading on a card near the meter. It was difficult to ascertain from the cards examined whether different readers had been at the site in consecutive months.

- After the readings have been transcribed from the sheet of paper to the meter book, the reader signs the book opposite the line where each reading was transcribed.

- Field supervisors reportedly make occasional spot checks on the work of the reader by reading the same route immediately before or after the reader works it. There was no data to gauge whether this procedure is effective or determine if it is followed.

- Meter readings are copied from the books onto computer lists that show all the customers for which the computer has a record. Readings from the lists are keyed into the computer.

- When routing information is not reliable, four or five readers go house-to-house to identify and read all the meters within a small area. After the area has been read, the group assembles. One person calls out the meter numbers on the computer sheets. When a meter reader hears the number of a meter he has read, he supplies the corresponding reading, which is transcribed onto the computer sheet. The meter numbers are the manufacturers' serial numbers and not a TANESCO number assigned in any logical way. The time required for a meter reader to check whether he has read the meter number called out, therefore, severely restricts the rate at which meter readings can be properly recorded in the computer sheet.

- No effort is made to change the account numbers so that they follow the reading sequence found by the meter readers, even though computer programs exist to help achieve that objective.

Reading Demand Meters

3.8 Demand meters are not read by the personnel who read energy-only meters. These "power" meters are treated as a separate zone for meter-reading purposes in Dar es Salaam. The readings (kWh and kVA) are recorded on sheets of paper and transferred later to their respective books. From there the readings are copied onto a keying sheet for eventual entry into the computer.

3.9 The time required to read each assembly of power meters (installations normally have separate kWh and kVA meters) is considerably more than that needed for energy meters because

- the meters are spread over a large area. High-demand users are often located far from each other;
- whose keys are kept by many meters are located in locked enclosures inside buildings the customer's representatives. Much time is wasted locating the keys; and
- extra time is needed to reseal the demand register, especially since meters are usually in cramped, small, often dirty and inaccessible locations.

3.10 Each book takes several days or weeks to complete. These customers represent a very large proportion of sales; therefore, a considerable loss in cash flow results from delays in processing the readings. Furthermore, because several meter-reading groups are involved, much time is expended in ensuring that all readings are received.

3.11 It was found that for meters requiring a multiplier, the "test" digit or dial is used as a reading. This digit is usually shown in or bordered by a color different from that of the other digits. This particular digit should never be used for billing readings.

Reporting Anomalies

3.12 Meter readers are expected to report anomalies encountered along their routes. There are no special codes assigned to anomalies, nor is there a list of the anomalies that might be encountered. The anomalies are supposed to be reported on a special form, but none was available when requested. Furthermore, meter readers said no action is taken to correct anomalies found month after month. They tend, therefore, to stop reporting them.

Accounting and Billing

Consumer Account Numbers

3.13 The account-number scheme now used by TANESCO comprises 9 basic digits plus a check digit. The check digit is not a fundamental part of the account number but is used only to verify the correctness of each account number entered. The nine basic digits are divided as follows:

AA BB CCCC D

<u>AA: Zone.</u> AA is the number of a zone within a region. (This zone is not to be confused with the seven large territorial zones into which TANESCO has been divided, each

comprising two or three regions.) The two regions into which Dar es Salaam is divided currently have 19 zones numbered 00 to 22, with numbers 12 to 15 not yet assigned. Zone 11 covers all consumers with demand meters. The remaining numbers (up to 99) are assigned to the other 20 regions. In Dar es Salaam, the zonal number normally indicates the working day of the month on which the route will be read.

BB: Book. A book or "route" represents the accounts assigned to a meter reader to be read in one full working day. In Dar es Salaam, TANESCO considers a normal day's work to be 50 accounts in surveyed areas or 40 accounts in unsurveyed areas. In practice, the number of accounts per book averages about 60, with a maximum of 150.

CCCC: Customer Sequence. This group of digits is peculiar to each consumer and should reflect the location of the corresponding meter in the meter-reading sequence. Since this number allows for 9999 consumers per book, space for 150 new consumers can be left between any two existing consumers when the numbers are first assigned to a 60-consumer book. Thus, there is ample room to add new consumers in proper sequence without renumbering accounts. Four digits are obviously more than necessary and increase the work of entering account numbers into a computer when, for example, recording meter readings or payments. Other utilities use fewer digits but have systems to renumber accounts when necessary.

D: Occupant Sequence. This digit is increased by one whenever the name of the registered consumer changes; such a change should occur, for example, when new occupants move into the premises. No instance was observed where this number had exceeded 9. If such a case did occur, the digit would revert to 1.

Determination of Zones in Dar Es Salaam

3.14 In 1985, TANESCO's management established a task force to rezone meter-reading in the Dar es Salaam North and South regions so that the new zones conformed to the distribution network. This arrangement would allow closer assessment and monitoring of distribution losses. The exercise involved inspecting house-to-house, identifying all services and recording the numbers of all meters found, whether or not the service was properly recorded in TANESCO's consumer database. As a result of that exercise, nineteen zones were established, 11 in Dar es Salaam South (zones 00 to 10) and seven in Dar es Salaam North (zones 16 to 22); a separate zone (Zone 11) was assigned to power meters. New account numbers were assigned to all services found in the field.

3.15 During the field investigations, more than 3600 meters were found that had no corresponding account number or billing records, and several accounts recorded as suspended were found to be active. In addition, several duplicate accounts and other irregularities were discovered. The impact of these investigations on nontechnical losses has not yet been fully assessed.

3.16 The revised zoning arrangements and consumer account numbers became effective in August 1988.

Computer Keying and Validation of Meter Readings

3.17 As stated above, meter readings are transcribed from the meter book to a list from which they are keyed into the computer. During the study period numerous problems were experienced with the computerized billing system. These range from hardware breakdown to staff turnover. These difficulties prevented TANESCO's normal keying schedule from being followed, making it impossible to assess the effectiveness of the methods by which this work is scheduled and controlled.

3.18 The digits that are keyed are validated on line by the computer. The adequacy of the validation criteria is beyond the scope of this report, but the following weaknesses were observed:

- The computer is unable to recognize when the meter has "gone around" and starts to register again from zero;
- Average consumption is estimated when the account is opened and can be changed only by hand. The computer is not programmed to periodically recalculate this average from actual consumptions;
- The computer flags consumptions that are higher than the average for a billing period but not those that are lower. The latter are more likely to adversely affect TANESCO's revenues;

3.19 The validation process should be quite successful in detecting keying errors, provided the person doing the work follows the instructions that appear on the screen.

3.20 Prior to billing, the computer produces a list (query report) of accounts for which the meter-reading data keyed do not comply with the validation criteria. Code numbers on the list indicate the nature of the anomaly for each account. The code number can also be used to suggest possible causes and corrective actions. Query reports are sent to the Finance Directorate's Billing Data Section, which handles

- manual calculation of consumption for meters that have gone around to zero;
- adjustments, based on actual readings, to the estimated consumption that appeared in previous bills. This adjustment is required when the estimated average consumption figure stored in the computer is considerably below actual average consumption. A credit memo and a corrected (supplementary) invoice for the customer's account are then issued;
- correction of errors in the customer's balances;
- correction of keying errors;
- queries of high consumption;

The majority of accounts listed in the query report are those whose readings have been estimated for six or more consecutive periods or whose indicated consumption has remained the same for three or more months. Usually no action is taken in response to these queries.

3.21 A serious weakness of existing control procedures is that no specific authorization is required to change meter readings stored in the computer. Anyone with access to the keyboards and knowledge about data entry can change these readings and erase previous data that may be perfectly valid.

Recommendations

Consumer Records

3.22 TANESCO needs to positively identify all consumers connected to its system and ensure that all are registered on its consumer records, properly metered and regularly invoiced. This goal can be achieved only by thoroughly inspecting all distribution lines and adding unregistered consumers to the utility's customer list. Toward this end, TANESCO must establish several groups to patrol the lines and record the location of consumer connections and the number of any meter installed. Persons patrolling the lines should report obvious irregularities, such as unmetered connections, but should not be expected to search for these irregularities, a task that would slow the main objective of upgrading consumer records. The data generated by these groups should be processed by others. Persons in line patrols as well as those processing the data should have no other assigned duties. The personnel and other resources committed to this program should be sufficient to allow its completion in six months or less. The program should begin in areas of high consumer density and be gradually extended over the whole system.

Suggested New Account-Numbering Scheme

3.23 The proposed scheme, which requires one alphanumeric and eight numeric digits (not including any check digit that might be incorporated), is

A BB CC DDD'E

AA: Region. This is an alphanumeric digit representing the regions in TANESCO's seven territorial zones. Up to 34 regions can be represented by a single digit by using the numbers 0 to 9 and all letters of the alphabet except I and O, which could be confused with the numbers 1 and 0. This allows for growth, since a maximum of 20 regions now exist in any one zone.

BB: Zone. This code should use the zonal concept currently used in Dar es Salaam to define the day on which meter readings are to be made. The number should allow for no more than 24 working days per monthly billing cycle, and the working days should be numbered by counting from the beginning of the cycle. For example, 03 would represent the third working day of the month, regardless of the region.

CC: Book. This number could be the same as the existing number.

DDD: Customer Sequence. This number identifies each customer and, in any one book, follows the sequence in which the meters should be read. Essentially, it is the same as the existing scheme but uses three digits instead of four.

E: Occupant Sequence. This is the same digit now used to identify a new customer at an existing address.

Meter Reading Routes

3.24 A meter reading "route" here is defined as a sequentially arranged group of consumers whose meters can all be read by one meter reader in one day. A "hard cover book" contains a series of sheets, each assigned to a single customer, that together cover a route. Several months' readings are recorded in a hard cover book. This is the system currently used by TANESCO. A "meter reading list" is a computer printout on which the meter readings for a given route for one cycle (one month, at TANESCO) are recorded.

The ideal meter reading route will fulfill these criteria:

- The customers are listed according to the meter-reading sequence, which should be in consecutive geographical order;
- The quantity of meters to be read represents a fair day's work for the meter reader;
- The listing of accounts on the route can be modified easily to insert, delete or correct the position of customer listings;

TANESCO should immediately start a program to reroute all meter reading so that hard cover meter-reading books can be replaced by "reading sheets" produced by the computer. This move will:

- greatly reduce the time between meter reading and reading validation, which should be completed in two days plus transportation time;
- eliminate errors produced by the triple transcription of the readings;
- increase the number of accounts that a meter reader can handle in a day; and
- provide a means to report anomalies and produce an accurate record of the customers that really exist.

3.25 Meter-reading lists for "power" customers should be reorganized so that readings can be entered into the computer within one day of being taken. This deadline may mean that some lists will contain only a small number of consumers.

3.26 Because the majority of routes in Dar es Salaam were revised in 1988, many may still retain the correct meter-reading sequence. But many others cover areas where changes have occurred, so sizable modifications will probably be needed to correct them. Routes for the rest of the regions and areas are probably inadequate because the account numbers are not arranged in meter-reading sequence or the number of accounts in a route do not represent a reasonable day's work for a meter reader.

Guidelines for revising the meter reading routes include

- making the routing flexible enough to allow the addition of some customers and the transfer of others to adjoining books;
- developing logical procedures for establishing the meter-reading sequence. These will depend on terrain, local custom and the way the customers are located. Some possible considerations are that
    - in densely populated surveyed areas, the route should follow one side of the street to the end, then turn right or left at the nearest street intersection or continue on the same street - on the opposite side;

- in unsurveyed areas with little vehicular traffic and narrow roads, the reader should crisscross the road;
- when meters are mounted on panels or in rows, a logical reading sequence must be developed, such as reading each row left-to-right and the highest row first;
- establishing rules for spacing account numbers. Spacing should depend on the number of accounts on each route, the probability of establishing new account numbers between existing accounts, and other factors;
- using maps to determine the approximate area covered by each route and to route the entire service area; and
- preparing a single map to show the streets and path the reader will follow after determining the areas to be covered by each route.

Meter-Reading Lists

3.27 Meter-reading lists must be produced monthly and replace the hard cover books now supplied to the meter readers. Each list should cover only one route. Meter readers must be instructed to record every reading directly onto these lists. Policies should be established for taking immediate, effective disciplinary action against any reader who does not obey these instructions.

The meter-reading sheets will

- show the zone and route numbers (printed by the computer) at the top left corner of the first page;
- have a space for the meter reader's name and five-digit employee number. This information would be used to evaluate the reader's performance;
- have room for the date when meter reading starts; and
- provide for each customer
  - the account number,
  - the customer's name and address,
  - a space for instructions to locate the address or meter,
  - a column space for the demand (kVA) reading (if needed),
  - a column space for the energy (kWh) reading, and
  - column spaces for up to three anomaly codes.

Previous readings must not be available to the meter reader. The absence of previous readings will reduce the possibility of readings being estimated without a site visit. Use of the card that is presently left near each meter should also be discontinued.

3.28 At least one blank space should be left between consecutive consumer listings to allow insertion of accounts that are out of sequence.

3.29 Data for any one consumer should not be divided between pages. The meter-reading sheets should be designed for use on a clipboard covered by a piece of plastic to protect them from rain and dirt.

Anomalies

3.30 Ideally, the task of meter readers should be limited to

- identifying the meter to be read;
- reading the meter; and
- reporting situations that might present hazards to persons or property, affect the safety or easy performance of their work as well as obvious irregularities that might lead to loss of revenue.

Asking meter readers to search for and report on real or suspected irregularities increases the risk of slowing the performance of their substantive duties.

3.31 Meter readers should therefore be expected to report only those anomalies that are easily observed and need immediate resolution. Below are suggested four conditions important enough for meter readers to include with their reports on consumption readings:

- listed meters that cannot be found;
- unlisted meters (and their sequence) that are found;
- the correct position of meters that are out of sequence;
- any obvious meter damage, missing or broken seals, or apparent attempt at fraud. Meter readers should not be asked to look specifically for these problems.

Consumer Addresses

3.32 TANESCO needs to develop a system to positively identify the service location of accounts in unsurveyed areas where conventional street names and numbering do not exist. The simplest method may be to provide the relevant staff with maps of sufficiently large scale for individual houses to be identified and on which the location of each account has been marked. Another approach is to number power-line poles and identify the one from which each service connection is made. If such a system were initiated in one unsurveyed area, the pole-numbering scheme should permit logical extension eventually to the whole TANESCO system.

New Billing Program

3.33 The billing program now used by TANESCO is unable to offer many of the more modern amenities offered by the utility's counterparts. TANESCO is procuring new hardware and software that will greatly enhance the performance of billing and the availability of related information. Annex 1 is a draft of billing-software specifications that list the more important characteristics that ought to be included in the new software.

3.34 It will be some time before new hardware and software can be acquired and put into service. In the meantime, several actions discussed below can be taken to improve billing performance.

3.35 Changes to Meter Reading Records. The authorization and ability to change meter-reading records stored in the computer should be restricted to a small number of responsible persons, preferably not more than three. Access to the computer to make these changes should require a password known only to the authorized persons. Each time the records are changed, the changes, the reasons for them and the person responsible should be recorded in writing. In addition, other changes that would logically result from the initial change must also be evaluated. For instance, if the meter reading for one month is changed, it will affect the consumption and billing calculations not only for the month preceding the change but also for the month following.

3.36 Estimated Consumption. If a meter reading is not obtained for any billing period, the computer currently calculates the bill on the basis of an estimated consumption which is provided in the consumer data file. This estimate is usually the one prepared when the account was first activated. In some instances, this initial estimate has been revised, but it is always a value fed into the computer. The current method of estimation is more likely to produce an underestimation rather than an overestimation of consumption, since energy usage by the typical consumer tends to grow for some time after service first begins. The program needs to be changed so that the estimate of consumption is calculated from actual meter readings stored in the computer, which currently holds data for six months.

3.37 Changes in Average Consumption. The billing program should also be modified to flag decreases in average consumption instead of or in addition to flagging increases. Lower average consumption may signal meter malfunction or other irregularities, whereas higher average consumption is unlikely to indicate a source of revenue loss.

3.38 If TANESCO is unable to make the program changes recommended above with its own staff, consultants should be hired to make them.

Validations

3.39 The validation process should be reorganized to significantly reduce the period between the reading of a meter and the indication by the computer of an apparent error in the meter reading. Not all validation criteria that now appear in the query report (see paragraph 2.20. above) are related to meter reading. Reports that require meter-reading checks need immediate response if the promptness of billing and, therefore, revenue collection are not to be affected. Other queries could be resolved less speedily without affecting the billing.

3.40 The main problem TANESCO faces in expediting the validation of meter readings is the two-way flow of information between the computer and the outlying groups that investigate the query reports. It was not possible within the time constraints of this study to evaluate the available options and arrive at reliable conclusions on the best way to accelerate this information flow. Nevertheless, validation queries should be investigated by the organizational group that provided the questionable data. This approach has the advantage of assigning responsibility for correcting errors to those who generated the data and gives them an incentive for producing accurate data the first time.

3.41 Quick validation of meter readings depends on how fast the (a) meter-reading sheets can be keyed, (b) validation checks can be performed in the field and (c) results can be communicated to the computer.

3.42 The entry of meter-reading data into the computer can be expedited by reducing the number of digits to be keyed for each reading. This may be accomplished, for example, by eliminating the need to key the four account-number digits representing the zone and book each time a reading is keyed. If that were done, the number of keystrokes to enter a reading would be reduced by about 30 percent. Also, improved lighting in the work area would increase the rate at which keystrokes are performed.

3.43 Validation should take into account that under the recommended plan, meter-reading data errors would have two possible sources:

- keying the wrong number and
- recording the meter reading incorrectly.

3.44 The number of validation queries would be reduced if operators were required to rekey a questionable reading instead of having the option of instructing the computer to accept the original input and flag the reading, as is now the case. In addition, the operator should be required to enter some normally redundant information, such as the meter number, after keying a given number of accounts to ensure that the correct line sequence is being maintained.

3.45 Meter reading errors can be corrected only by rereading the meter, a task that should be done shortly after the original reading.

Security of Meter-Reading Sheets

3.46 After keying and validation, the meter-reading sheets should be returned to the outlying offices that completed them and filed by billing cycle in the numerical order of the route number.

Bill Preparation and Delivery

3.47 Since high voltage (Tariff 5) consumers represent a significant percentage of TANESCO's revenues, it is important for improved cash flow to reduce the interval between meter reading and bill delivery to a minimum. This may be achieved by preparing all bills for Tariff 5 consumers within one day of the meter being read and hand delivering these promptly to the consumers.

3.48 Currently, bills are hand stamped with a disconnection warning. This should be printed on the bill (with appropriate highlighting) or printed by the computer.

3.49 Bills are now manually folded and inserted into envelopes. TANESCO should include a bill insertion machine in its shopping list for new billing hardware.

Disconnections

3.50 The debt/disconnection policy needs to be reviewed, revised where appropriate, publicized and consistently enforced. The computer should produce a daily list of consumers in arrears and liable for disconnection, with priority given to consumers who owe the most and, other things being equal, have the longest outstanding debts. After disconnection for arrears, the consumer should be required to pay all outstanding debt or agree on a schedule of debt payments. A penalty should be applied to cover all TANESCO costs resulting from the nonreceipt of payments as well as from disconnection and reconnection activities.

3.51 Consumers who have been disconnected for debt and have not arranged for reconnection after a reasonable period of time (about two months) should have their installations periodically checked to ensure that they have not been fraudulently reconnected.

3.52 When a consumer requests disconnection (usually because of changing address), TANESCO sends one person first to read the meter for final billing and another person later to disconnect the service. Consumption can therefore occur after the final bill is sent and it would be more efficient and a better guarantee against unmetered consumption for one person to perform both tasks.

Conclusion

3.53 This report describes some of the factors contributing to the relatively high level of nontechnical losses plaguing the TANESCO system. It also recommends actions that could reduce these losses. Mission observations indicate that fraudulent abstraction of power accounts for a significant part of overall nontechnical losses. Although some recommendations will help detect such fraudulent usage, the utility also needs to provide strong disincentives for this practice. TANESCO's penalties for fraudulent connections are a necessary aspect of any program of disincentives. But penalties alone are unlikely to be entirely effective.

3.54 The laws of the Republic of Tanzania expressly include theft of electricity as a crime punishable by imprisonment. TANESCO has understandably been reluctant to prosecute offending consumers to the full extent of the law. But some form of legal action against offenders will broadcast the clear message that TANESCO considers theft of electricity to be a serious offense. If offenders can be successfully prosecuted, the process should be publicized to discourage others from stealing power. Staff investigating power theft will need to be carefully trained in the collection and preservation of evidence for presentation to the courts.

3.55 TANESCO should consider contracting with private companies for meter reading, billing and collections. Private entrepreneurs will probably introduce new approaches to the various problems now experienced by TANESCO and will be more likely to vigorously pursue metering and meter reading errors and collection of revenues. The ESMAP team was not able to evaluate the suitability of any Tanzanian companies to carry out the required functions but the indications are that there are local organizations capable and desirous of undertaking these responsibilities.

IV. TARIFFS

4.1 Although tariff schedules do not impact non-technical losses directly, they influence consumer behavior and may therefore affect losses. This section reviews TANESCO's tariffs and comments on aspects that contribute to increased losses or otherwise impair revenue collections.

4.2 The TANESCO tariffs in force in January 1992 are attached as Annex 2 to this report. The tariffs are revised at regular intervals (normally half-yearly) and adjusted to compensate for the effects of inflation. The management and Board of Directors together are authorized to implement tariff increases of up to 10%. Increases between 10% and 15% must be approved as well by the Ministry of Water, Energy and Minerals as well as by the Ministry of Finance. Tariff increases of more than 15% must be approved by the Cabinet. In recent years increases of 15% have been applied to all tariff categories every six months.

4.3 Review of the tariff structures shows a number of instances of excessive subsidies and other inefficient features, some of which are discussed below:

- The unit energy rates for residential consumers remain at very low levels (three shillings or less per kWh) up to 1,000 kWh per month. The objective is to ensure that the poor are not deprived of the benefits of electricity. However residential consumption above about 60 kWh per month represents a standard of living which is generally not considered to warrant subsidies.

- Consumption by light commercial and industrial consumers (tariff categories 2 and 3) is subsidized at levels of up to 1000 kWh per month although such enterprises recover their operating costs from sales revenues.

- Contrary to the practice in many countries, supplies to public lighting and places of worship (Tariff 6) are heavily subsidized.

- The incremental unit energy cost to residential, commercial and light industrial consumers increases sharply with increasing consumption. The intention of such a structure is to encourage energy conservation. However it also provides an incentive for the affected consumers to falsify consumption records and raises regulatory and enforcement issues unnecessarily. Conservation by consumers supplied at high voltage (tariff categories 5 and 5A) would probably have greater effect on system demand but unit rates for such consumers decrease with increasing consumption.

- The penalties for low power factor are severe. Typical penalties are a 10% increase in demand charge for each percentage point by which the power factor falls below 90% (in the case of consumers billed on kVA demand) and an increase of 3% in the energy billing for each 1% variation in power factor below 95% for residential, light commercial, and certain other consumer categories. (See Note 3 at the end of Annex 2). These penalties do not appear to have been developed on any rational basis and are not consistently applied. Spot checks made on consumers selected more or less at random are used to determine whether a penalty is to be applied. Such checks are unlikely to indicate the true effects of individual consumers' reactive demand on the operation of the power system and are likely to penalize some consumers unjustly.

- The tariffs for supply to Zanzibar (tariff category 9) are obviously well below the economic costs. Moreover, the fact that these accounts receivable, although heavily subsidized, are not discharged emphasizes the severe disadvantage under which TANESCO operates in providing power to Zanzibar.

4.4 Review and restructuring of its tariffs must form an important component of TANESCO's program to streamline billing and reduce non-technical losses. A tariff study is included in the Power VI Project being negotiated with the International Development Association (IDA).

V. RESULTS

Introduction

5.1 The ESMAP team worked closely with TANESCO counterpart staff to identify conditions that would cause non-technical losses and also to detect actual instances of such losses. These activities began early in the study and concentrated initially on inspection of metering facilities to determine changes in installation standards that would (a) facilitate meter reading; (b) inhibit consumer fraud; and (c) facilitate detection of irregularities. The findings and recommendations resulting from these activities are recorded in Section 2, "Metering." That section also notes that TANESCO initiated a program to relocate meters to the external surfaces of buildings in Dar es Salaam. The program has progressed slowly because of the limited financial and personnel resources committed to it, and it has not yet been formally extended to areas outside of the main city. Where meter relocation has been undertaken however, it has achieved its objectives and has resulted in much neater installations.

5.2 In early 1991, the ESMAP/TANESCO team inspected a number of selected consumer installations to assess the level of non-technical losses and the sources of these losses. The findings indicated that the non-technical losses attributable to almost all sources were very high and that a concentrated program of investigation and rectification of metering irregularities could have significant impact on TANESCO's finances. In April 1991, these findings were presented to TANESCO's senior management, which immediately established a task force charged with (a) investigating metering installations, (b) detecting and rectifying irregularities, (c) calculating any over- or underbilling which may have occurred over the previous seven years, and (d) issuing invoices (or credits where applicable) to the affected consumers. The Director of Distribution and Customer Services was given responsibility for planning, organizing, and controlling the activities of the task force.

5.3 The rest of this section deals with the work undertaken and results achieved by TANESCO from the establishment of the task force in April 1991 until the end of June 1992.

Consumer Selection

5.4 In order to concentrate attention on consumers for whom metering irregularities were likely the task force reviewed billings and records of consumers who fell into one or more of the following categories:

- Consumption estimated for more than three billing periods
- No energy consumption recorded for more than three billing periods, although the account remains active (i.e., the minimum bill continues to be paid)

- Account disconnected for debt more than three months previously, but no application for reconnection received
- Zero energy consumption recorded, although the meter indicates power demand (for consumers with kVA metering)
- No demand indicated, although energy consumption recorded (for consumers with kVA metering)
- Metered consumption less than normal for comparable residences or business premises. This conclusion required familiarity with the location involved.

On the basis of these classifications, the task force selected a number of consumers for priority attention in Dar es Salaam.

5.5 The field investigations by the task force were successful in identifying major sources of revenue loss to TANESCO. Within the first three months of its inception, the task force had identified sources of non-technical losses estimated to result in the improper invoicing of more than 100,000 kWh of annual energy consumption. In addition, the task force forwarded information to the billing department supporting the issuance of invoices for the recovery of more than TS 30 million (then equivalent to about U.S.$150,000). The period covered by the proposed retroactive billing extended up to the previous seven years.

5.6 As a result of the success of the initial efforts in Dar es Salaam in identifying irregularities TANESCO's management decided to establish permanent inspectorates in all zones. The responsibilities of the inspectorates were expanded beyond those of the original task force to include (a) positive identification of the physical location of each meter; (b) assigning a unique TANESCO number to each meter; and (c) establishment of a meter history index. The work done by these inspectorates soon provided clear evidence that the level of non-technical losses was unacceptably high in all zones.

5.7 TANESCO's internal audit department had long included a technical audit, but this unit had not been very active in inspecting consumer metering installations. The internal audit department (including the technical unit) is based in the head office, and the Chief Internal Auditor reports to the Managing Director. The efforts of the newly formed inspectorates stimulated the technical unit to become more active in metering inspections, and a spirit of healthy competition was introduced into the non-technical loss reduction program. The internal audit teams are especially effective in detecting illegal metering manipulations and in estimating previously unbilled consumption. In addition, unlike the zonal inspectorates, the internal audit department is authorized to initiate legal proceedings in instances of illegal diversion of power.

5.8 By the end of June 1992, the combined efforts had identified and rectified irregularities which TANESCO estimates to have increased billing by about 55 GWh annually. This is equivalent to reduction of overall losses by approximately four percent. Invoices had been issued for more than TS 300 million in retroactive billing, over and above the amounts previously invoiced in Dar es Salaam. More than TS 28 million of the new retroactive billing had been collected by the end of the period under review. Unfortunately, these efforts are being less assiduously pursued in Dar es Salaam than in the other zones, although it is obvious that the greatest scope for revenue enhancement and reduction of non-technical losses lies in that city.

Conclusion

5.9 The ESMAP study has achieved tangible success in reducing non-technical losses in the TANESCO system and has contributed significantly to recovery of lost revenues. Although the guidelines for investigation and action to be taken were originally established by ESMAP, TANESCO staff quickly assumed the initiative, and the majority of the irregularities detected thus far have been discovered by TANESCO personnel. All relevant evidence indicates that many irregularities remain to be discovered. During the course of the study TANESCO staff have been trained in the detection and control of nontechnical losses. Changes to the organizational structure have also been initiated to make the utility more effective in the management of consumer affairs. If the momentum is maintained and disseminated nationwide, TANESCO will be able to reduce its non-technical losses to internationally acceptable standards.

DRAFT

TERMS OF REFERENCE

ELECTRIC UTILITY BILLING SOFTWARE

Introduction

Tanzania Electricity Supply Company Limited (TANESCO), the national electric utility of the Republic of Tanzania, is soliciting proposals from data processing consultants for the development, installation and implementation of software to address a wide range of functions of the Consumer Services Department. These functions include, but are not limited to,

- consumer billing,
- receivables reporting,
- statistical reporting,
- consumer file maintenance and
- meter inventory.

Scope of Work

The firm chosen to undertake the work, hereinafter referred to as the "Consultant", will be required to undertake the work in four phases:

(1) program development,
(2) program installation and testing,
(3) personnel training and program shakedown, and
(4) program support.

Phases (1) and (4) will be executed primarily in the consultant's home offices, whereas phases (2) and (3) will be undertaken in TANESCO's offices.

Program Development

The program must be developed for use on TANESCO's Wang WS 80 computer and support data inputs from a maximum of 30 separate terminals. Its minimum requirements in each of the functional areas are listed below.

Consumer billing:

- printing of meter-reading sheets;
- interactive meter-reading entry and editing;
- calculation of estimated readings;
- support of multiple account types, consumer groups and tariff rates
- automatic bill calculation and printing;
- on-line updating of consumer master and historical data;

- step-by-step controlled processing;
- mid-period meter-change processing;
- final bill processing independent of meter reading cycle;
- identification of consumption on suspended accounts;
- detailed statistical and control reports, including
  - (a) consumption proofs,
  - (b) billing register reports and
  - (c) automatic generation of meter-maintenance work orders.

Receivables:
- recording and processing cash receipts from multiple locations,
- recording receipts and refunds of deposits,
- security-controlled, on-line, cash-receipts processing,
- identification of cash and check transactions,
- receipt printing,
- automatic updating of consumer balance,
- detailed end-of-day processing and reporting, including
  - (a) cashier summaries with transaction listings and
  - (b) bank deposit summary listings.

Statistical:
- monthly sales and revenues summaries,
- aged trial-balance and debtors-analysis reports,
- consumer disconnection listings and
- detailed consumption analysis reports,

File maintenance:
- maintenance of security-controlled, on-line consumer master files and rate files;
- controlled file reorganization to disregard obsolete records;
- security-controlled changes to meter-reading records; and
- multicopy-file backup and recovery.

Meter Inventory:
- meter master-file maintenance and reporting,
- interactive meter change facility and
- automatic interface to the billing subsystem.

The program must include an on-line, account-inquiry facility capable of displaying the master-file account and status information together with the last 24 account transactions and consumptions. The search facility must allow the user to identify and display the record of a particular consumer from a minimal amount of information, such as name, address, account number or meter number. Preparation of a duplicate bill must be possible on user request.

Program Installation and Testing

The Consultant will send a competent staff member to Tanzania to install and test the program on TANESCO's computer. TANESCO staff will work with the Consultant during this phase and will be trained in the program's characteristics and operation. Normal billing processes must not be disrupted by any of these activities. After the program has demonstrated satisfactory performance by a minimum of one complete cycle of error-free bill preparation for the entire consumer listing, it will be adopted as the regular billing program.

Personnel Training and Observation of Program Functioning

Some training of TANESCO employees will take place during the installation and testing phase of the project. Nevertheless, the Consultant will be required to keep personnel on site after the program has begun regular operations to train a larger number of TANESCO staff and to ensure that the software is properly understood and operated. The Consultant's representative will also scrutinize the functioning of the program and make any modifications needed to ensure its complete compliance with TANESCO requirements. This period will be until the program's performance is acceptable or a minimum of three months. If problems with the program require the Consultant to extend the stay of his representative beyond three months, the cost of that extension will be borne entirely by the Consultant.

Program Support

Following program installation and observation, the Consultant will provide free (except for calls placed from Tanzania) telephone assistance to resolve problems encountered in the application of the software for 12 months after the departure of his representative from Tanzania. If requested by TANESCO and within seven days of such request, the Consultant will send a representative to Tanzania to assist with any problems that cannot be resolved by telephone. Unless it can be unequivocally demonstrated that the problem resulted from defective software development or installation, the direct cost of the representative's visit to Tanzania as well as his time charges will be borne by TANESCO. The man-hour rates of service representatives will be stated by the Consultant in his proposal.

Program Documentation

The Consultant will submit six copies of manuals providing source listing and detailing the structure of the program, including instructions on its operation and maintenance.

Hardware

The provision of hardware is not included in the Consultant's scope of work.

TANESCO's Responsibilities

TANESCO will provide:

(a) data concerning hardware, tariff rates, consumer groupings, consumer base, and all other information relevant to the satisfactory development and implementation of the project;

(b) office accommodation, clerical and secretarial support, and telecommunication facilities for the Consultant's staff while working on the project in Tanzania;

(c) access to all equipment and locations relevant to the project, provided always that the Consultant shall give a minimum of one day's notice when requiring access to the computer or other equipment involved in the preparation and distribution of consumer bills and that priority will be given to the execution of billing operations. However, TANESCO will not unnecessarily delay the project and will make all reasonable efforts to expedite the Consultant's requests; and

(d) a two-person project team of competent data processing personnel to work full-time with the consultant during his work in Tanzania.

Guidelines for the Proposal

The proposal should provide for implementation of the project as described in the scope of work. It should provide details of the following:

(a) previous experience in similar projects undertaken within the last five years, giving the name of the organization for which the work was performed and, for each organization, the name and title of a person who could be consulted for reference;

(b) curricula vitae of staff who will be assigned important responsibilities for the project in the Consultant's offices as well as in the field, stating the intended role of each individual. During execution of the project, involvement of persons other than those named for specific tasks in the proposal will require TANESCO's prior approval;

(c) a work plan and project schedule, in weeks, indicating the location where each aspect of work is to be performed and the personnel to be assigned;

(d) a statement of man-hour rates for services to be provided subsequent to installation and observed satisfactory operation of the program; and

(e) a proposed schedule of payments that links progress payments to clearly defined and objectively identifiable performance targets.

The consultant's cost and fees proposal is to be included with the rest of the proposal in a separately sealed envelope. The cost elements which are firm are to be clearly indicated and the factors which can affect variable costs are to be stated along with a statement as to the effect which these factors can have on the relevant costs.

Timing

Proposals for performance of the work are to be submitted in sealed envelopes to TANESCO's head office: Samora Avenue, Dar es Salaam, Tanzania, not later than (____________________). Envelopes are to be addressed to the Managing Director and conspicuously marked "Proposal for Billing Software".

TANESCO will complete evaluation of the proposals on or before (____________________) and will begin negotiations with the firm which submitted the most highly evaluated proposal. If mutually satisfactory terms and conditions cannot be agreed on within four calendar weeks, TANESCO may proceed to negotiate with other firms. TANESCO may, at its sole discretion, reject any or all of the proposals received.

The date of contract signing will be considered the starting date of the project and will be used as the bench mark from which the progress of the project will be measured.

Form of Contract

The contract to be awarded to the successful firm will be based on the International Model Form of Agreement Between Client and Consulting Engineer, Number IGRA 1979 P.I., produced and issued by the International Federation of Consulting Engineers (FIDIC).

Inquiries

Firms requiring clarifications of the contents of this document or any further relevant information may write to or telephone the:

Manager, Data Processing

TANESCO

Tanzania Electricity Supply Company Limited

Samora Avenue

P. O. Box 9024

Dar es Salaam

Tanzania

Telex: 41318 TANESCO

Telephone: 51-27281 (Country code 255)

TANZANIA ELECTRIC SUPPLY COMPANY LIMITED

ELECTRICITY TARIFFS WITH EFFECT FROM 1ST JANUARY, 1992 BILLINGS

TARIFF NO. 1 RESIDENTIAL

Applicable to premises used exclusively for domestic and private residential purposes:-

0 - 100	kWh	Shs.	2.00 per kWh
101 - 1000	kWh	Shs.	3.00 per kWh
1001 - 2500	kWh	Shs.	7.00 per kWh
2501 - 7500	kWh	Shs.	35.00 per kWh
Over 7500	kWh	Shs.	45.00 per kWh

Customer Service Charge

0 - 1000	KWh	Shs.	75.00 per meter
Over - 1000	kWh	Shs.	300.00 per meter

TARIFF NO. 2: LIGHT COMMERCIAL

Applicable to shops, restaurants, theaters, hotels clubs, harbors, schools, hospitals, airports, lodging houses, group of residential premises with one meter and on premises where similar business or trade is conducted and where consumption is less than 10,000 kilowatt hours per meter reading period:-

0 - 200	kWh	Shs.	3.50 per kWh
201 - 1000	kWh	Shs.	15.00 per kWh
1001 - 2500	kWh	Shs.	35.00 per kWh
2501 -7500	kWh	Shs.	55.00 per kWh
Over 7500	kWh	Shs.	65.00 per kWh

Customer Service Charge

0 - 1000	KWh	Shs.	200.00 per meter
Over - 1000	kWh	Shs.	1000.00 per meter

TEMPORARY SUPPLIES:

Temporary supplies will be provided under Tariff No. 2.

TARIFF NO. 3: LIGHT INDUSTRIAL

Applicable to premises engaged in production of any article/commodity or in an Industrial process where the main use of electricity is for motive power, or an electrochemical or electrothermal process and where the consumption is less than 7,500 kilowatt hours per meter reading period:-

0 - 1000	kWh	Shs.	5.00 per kWh
1001 - 2500	kWh	Shs.	27.50 per kWh
2501 -7500	kWh	Shs.	45.00 per kWh
Over 7500	kWh	Shs.	55.00 per kWh

Customer Service Charge

All consumers	KWh	Shs.	1000.00 per meter

TARIFF NO. 4: LOW VOLTAGE SUPPLY

Applicable for general use where the consumption is more than 7,500 kilowatt hours per meter reading period:-

a) Demand charge — Shs. 1450.00 per kVA of billing demand (B.D) per meter reading period.

The kVA maximum demand (M.D) indicator shall be reset every meter reading period.

b) Units charge:-

First 150 times B.D (kVA) units, Next 150 times B.D (kVA) units, Remainder of units	Shs. 20.50 per kWh Shs. 16.00 per kWh Shs. 14.00 per kWh

c) Customer service charge Shs. 20,000.00 per meter reading period.	Shs. 20.50 per kWh Shs. 16.00 per kWh Shs. 14.00 per kWh

TARIFF 4A: AGRICULTURAL CONSUMERS

Applicable to Agricultural consumers whose consumption is more than 5,000 units (kWh) per meter reading period engaged in direct raw farm produce production and/or processing.

a) Demand charge	Shs. 650.00 per kVA of billing demand (B.D) per meter reading period

The kVA maximum demand (M.D) indicator shall be reset every meter reading period.

b) Units charge	Shs. 9.50 per kWh
c) Customer service charge	Shs. 20,000.00 per meter reading period.

TARIFF NO. 5: HIGH VOLTAGE SUPPLY

Applicable for general use where power is metered at 11 kV and above.

a) Demand charge	Shs. 550.00 per kVA of billing demand (B.D) per meter reading period.

The kVA maximum demand (M.D) indicator shall be reset every meter reading period.

b) Units charge:	
First 150 times B.D (kVA) units, Next 150	Shs. 18.50 per kWh
times B.D (kVA) units,	Shs. 14.00 per kWh
Next 150 times B.D (kVA) units Remainder of	Shs. 12.00 per kWh
units	Shs. 10.00 per kWh
c) Customer service charge	Shs. 30,000 per meter reading period

TARIFF NO. 5A: HIGH VOLTAGE SUPPLY, ENERGY INTENSIVE CUSTOMERS

Applicable to high tension consumers whose demand is above 5,000 kVA or consumption above 800,000 kWh per meter reading period.

a) Demand charge	Shs. 1150.00 per kVA of billing demand (B.D) per meter reading period.

The kVA maximum demand (M.D) indicator shall be reset every meter reading period.

b) Units charge:-	
First 150 times B.D (kVA) units, Next 150	Shs. 26.50 per kWh
times B.D (kVA) units,	Shs. 12.50 per kWh
Next 150 times B.D (kVA) units	Shs. 10.50 per kWh
Remainder of units	Shs. 8.50 per kWh
c) Customer service charge	Shs. 50,000 per meter reading period

TARIFF NO. 6: PUBLIC LIGHTING

Applicable to public lighting and places of worship
All units Shs. 4.00 per kWh

TARIFF NO. 8: WATER SUPPLY ACCOUNTS

Applicable to all installations of Public Water Supply pumping installations with consumption above 10,000 units (kWh) per meter reading period.

a) Maximum demand charge	Shs. 750.00 per kVA of billing demand (B.D) per meter reading period.
b) Units charge:	Shs. 10.00 per kWh
c) Customer service charge	Shs. 20,000 per meter reading period

TARIFF NO. 9: ZANZIBAR SUPPLY

Maximum demand — Shs. 83.33 per KVA of Maximum Demand during each meter reading period.

The KVA maximum demand indicator shall be reset every meter reading period.

Unit charge: — Shs. 0.20 per kWh

Maximum demand readings are taken at Mtoni substation while the units reading are taken at Ubungo substation.

NOTE:

1. Billing Demand (B.D) is the higher of the kVA Maximum Demand (M.D) during the month and 75% of the highest kVA Maximum Demand for the preceding 11 months; provided that during the first year of operation the billing demand shall be the higher of the kVA Maximum Demand during the month, and 60% of the highest kVA Maximum demand recorded commencing from the month the consumer is connected.

2. The meter reading period is the period of time elapsing between any consecutive readings of the meter and/or maximum demand indicator installed by the Company but with exception of their first and last period; each such period shall be as near to thirty days as possible.

3. These tariffs are applicable only to supply of electricity to consumers with power factors not lower than 0.95 in case of lighting loads or 0.9 in case of other loads. Supply of electricity to equipment having lower power factors than those stated above can only be given on higher tariffs as follows:

    (a) For tariffs where kVA Maximum Demand is charged: the kVA maximum demand readings will be increased by 10% for each 1% variation in power factor below 90%. For consumers with trisector meters or similar reactive load compensated meters, the kVA maximum demand will be increased by 2% for each 1% variation in power factor below 90%.

    (b) For tariffs 1, 2, 3 and 6: the kWh (units) consumed during the month will be increased by 3% for each 1% variation in power factor below 95%.

Joint UNDP/World Bank
ENERGY SECTOR MANAGEMENT ASSISTANCE PROGRAMME (ESMAP)

LIST OF REPORTS ON COMPLETED ACTIVITIES

Region/Country	***Activity/Report Title***	***Date***	***Number***
	SUB-SAHARAN AFRICA (AFR)		
Africa Regional	Anglophone Africa Household Energy Workshop (English)	07/88	085/88
	Regional Power Seminar on Reducing Electric Power System Losses in Africa (English)	08/88	087/88
	Institutional Evaluation of EGL (English)	02/89	098/89
	Biomass Mapping Regional Workshops (English)	05/89	--
	Francophone Household Energy Workshop (French)	08/89	--
	Interafrican Electrical Engineering College: Proposals for Short- and Long-Term Development (English)	03/90	112/90
	Biomass Assessment and Mapping (English)	03/90	--
	Symposium on Power Sector Reform and Efficiency Improvement in Sub-Saharan Africa (English)	06/96	182/96
	Commercialization of Marginal Gas Fields (English)	12/97	201/97
Angola	Energy Assessment (English and Portuguese)	05/89	4708-ANG
	Power Rehabilitation and Technical Assistance (English)	10/91	142/91
Benin	Energy Assessment (English and French)	06/85	5222-BEN
Botswana	Energy Assessment (English)	09/84	4998-BT
	Pump Electrification Prefeasibility Study (English)	01/86	047/86
	Review of Electricity Service Connection Policy (English)	07/87	071/87
	Tuli Block Farms Electrification Study (English)	07/87	072/87
	Household Energy Issues Study (English)	02/88	--
	Urban Household Energy Strategy Study (English)	05/91	132/91
Burkina Faso	Energy Assessment (English and French)	01/86	5730-BUR
	Technical Assistance Program (English)	03/86	052/86
	Urban Household Energy Strategy Study (English and French)	06/91	134/91
Burundi	Energy Assessment (English)	06/82	3778-BU
	Petroleum Supply Management (English)	01/84	012/84
	Status Report (English and French)	02/84	011/84
	Presentation of Energy Projects for the Fourth Five-Year Plan (1983-1987) (English and French)	05/85	036/85
	Improved Charcoal Cookstove Strategy (English and French)	09/85	042/85
	Peat Utilization Project (English)	11/85	046/85
	Energy Assessment (English and French)	01/92	9215-BU
Cape Verde	Energy Assessment (English and Portuguese)	08/84	5073-CV
	Household Energy Strategy Study (English)	02/90	110/90
Central African Republic	Energy Assessement (French)	08/92	9898-CAR
Chad	Elements of Strategy for Urban Household Energy The Case of N'djamena (French)	12/93	160/94
Comoros	Energy Assessment (English and French)	01/88	7104-COM
Congo	Energy Assessment (English)	01/88	6420-COB
	Power Development Plan (English and French)	03/90	106/90
Côte d'Ivoire	Energy Assessment (English and French)	04/85	5250-IVC
	Improved Biomass Utilization (English and French)	04/87	069/87
	Power System Efficiency Study (English)	12/87	--
	Power Sector Efficiency Study (French)	02/92	140/91
	Project of Energy Efficiency in Buildings (English)	09/95	175/95

Region/Country	*Activity/Report Title*	*Date*	*Number*
Ethiopia	Energy Assessment (English)	07/84	4741-ET
	Power System Efficiency Study (English)	10/85	045/85
	Agricultural Residue Briquetting Pilot Project (English)	12/86	062/86
	Bagasse Study (English)	12/86	063/86
	Cooking Efficiency Project (English)	12/87	--
	Energy Assessment (English)	02/96	179/96
Gabon	Energy Assessment (English)	07/88	6915-GA
The Gambia	Energy Assessment (English)	11/83	4743-GM
	Solar Water Heating Retrofit Project (English)	02/85	030/85
	Solar Photovoltaic Applications (English)	03/85	032/85
	Petroleum Supply Management Assistance (English)	04/85	035/85
Ghana	Energy Assessment (English)	11/86	6234-GH
	Energy Rationalization in the Industrial Sector (English)	06/88	084/88
	Sawmill Residues Utilization Study (English)	11/88	074/87
	Industrial Energy Efficiency (English)	11/92	148/92
Guinea	Energy Assessment (English)	11/86	6137-GUI
	Household Energy Strategy (English and French)	01/94	163/94
Guinea-Bissau	Energy Assessment (English and Portuguese)	08/84	5083-GUB
	Recommended Technical Assistance Projects (English & Portuguese)	04/85	033/85
	Management Options for the Electric Power and Water Supply Subsectors (English)	02/90	100/90
	Power and Water Institutional Restructuring (French)	04/91	118/91
Kenya	Energy Assessment (English)	05/82	3800-KE
	Power System Efficiency Study (English)	03/84	014/84
	Status Report (English)	05/84	016/84
	Coal Conversion Action Plan (English)	02/87	--
	Solar Water Heating Study (English)	02/87	066/87
	Peri-Urban Woodfuel Development (English)	10/87	076/87
	Power Master Plan (English)	11/87	--
	Power Loss Reduction Study (English)	09/96	186/96
Lesotho	Energy Assessment (English)	01/84	4676-LSO
Liberia	Energy Assessment (English)	12/84	5279-LBR
	Recommended Technical Assistance Projects (English)	06/85	038/85
	Power System Efficiency Study (English)	12/87	081/87
Madagascar	Energy Assessment (English)	01/87	5700-MAG
	Power System Efficiency Study (English and French)	12/87	075/87
	Environmental Impact of Woodfuels (French)	10/95	176/95
Malawi	Energy Assessment (English)	08/82	3903-MAL
	Technical Assistance to Improve the Efficiency of Fuelwood Use in the Tobacco Industry (English)	11/83	009/83
	Status Report (English)	01/84	013/84
Mali	Energy Assessment (English and French)	11/91	8423-MLI
	Household Energy Strategy (English and French)	03/92	147/92
Islamic Republic of Mauritania	Energy Assessment (English and French)	04/85	5224-MAU
	Household Energy Strategy Study (English and French)	07/90	123/90
Mauritius	Energy Assessment (English)	12/81	3510-MAS
	Status Report (English)	10/83	008/83
	Power System Efficiency Audit (English)	05/87	070/87

Region/Country	*Activity/Report Title*	*Date*	*Number*
Mauritius	Bagasse Power Potential (English)	10/87	077/87
	Energy Sector Review (English)	12/94	3643-MAS
Mozambique	Energy Assessment (English)	01/87	6128-MOZ
	Household Electricity Utilization Study (English)	03/90	113/90
	Electricity Tariffs Study (English)	06/96	181/96
	Sample Survey of Low Voltage Electricity Customers	06/97	195/97
Namibia	Energy Assessment (English)	03/93	11320-NAM
Niger	Energy Assessment (French)	05/84	4642-NIR
	Status Report (English and French)	02/86	051/86
	Improved Stoves Project (English and French)	12/87	080/87
	Household Energy Conservation and Substitution (English and French)	01/88	082/88
Nigeria	Energy Assessment (English)	08/83	4440-UNI
	Energy Assessment (English)	07/93	11672-UNI
Rwanda	Energy Assessment (English)	06/82	3779-RW
	Status Report (English and French)	05/84	017/84
	Improved Charcoal Cookstove Strategy (English and French)	08/86	059/86
	Improved Charcoal Production Techniques (English and French)	02/87	065/87
	Energy Assessment (English and French)	07/91	8017-RW
	Commercialization of Improved Charcoal Stoves and Carbonization Techniques Mid-Term Progress Report (English and French)	12/91	141/91
SADC	SADC Regional Power Interconnection Study, Vols. I-IV (English)	12/93	--
SADCC	SADCC Regional Sector: Regional Capacity-Building Program for Energy Surveys and Policy Analysis (English)	11/91	--
Sao Tome and Principe	Energy Assessment (English)	10/85	5803-STP
Senegal	Energy Assessment (English)	07/83	4182-SE
	Status Report (English and French)	10/84	025/84
	Industrial Energy Conservation Study (English)	05/85	037/85
	Preparatory Assistance for Donor Meeting (English and French)	04/86	056/86
	Urban Household Energy Strategy (English)	02/89	096/89
	Industrial Energy Conservation Program (English)	05/94	165/94
Seychelles	Energy Assessment (English)	01/84	4693-SEY
	Electric Power System Efficiency Study (English)	08/84	021/84
Sierra Leone	Energy Assessment (English)	10/87	6597-SL
Somalia	Energy Assessment (English)	12/85	5796-SO
South Africa Republic of	Options for the Structure and Regulation of Natural Gas Industry (English)	05/95	172/95
Sudan	Management Assistance to the Ministry of Energy and Mining	05/83	003/83
	Energy Assessment (English)	07/83	4511-SU
	Power System Efficiency Study (English)	06/84	018/84
	Status Report (English)	11/84	026/84
	Wood Energy/Forestry Feasibility (English)	07/87	073/87
Swaziland	Energy Assessment (English)	02/87	6262-SW
	Household Energy Strategy Study	10/97	198/97
Tanzania	Energy Assessment (English)	11/84	4969-TA
	Peri-Urban Woodfuels Feasibility Study (English)	08/88	086/88
	Tobacco Curing Efficiency Study (English)	05/89	102/89
	Remote Sensing and Mapping of Woodlands (English)	06/90	--
	Industrial Energy Efficiency Technical Assistance (English)	08/90	122/90

Region/Country	*Activity/Report Title*	*Date*	*Number*
Tanzania	Power Loss Reduction Volume 1: Transmission and Distribution SystemTechnical Loss Reduction and Network Development (English)	06/98	204A/98
	Power Loss Reduction Volume 2: Reduction of Non-Technical Losses (English)	06/98	204B/98
Togo	Energy Assessment (English)	06/85	5221-TO
	Wood Recovery in the Nangbeto Lake (English and French)	04/86	055/86
	Power Efficiency Improvement (English and French)	12/87	078/87
Uganda	Energy Assessment (English)	07/83	4453-UG
	Status Report (English)	08/84	020/84
	Institutional Review of the Energy Sector (English)	01/85	029/85
	Energy Efficiency in Tobacco Curing Industry (English)	02/86	049/86
	Fuelwood/Forestry Feasibility Study (English)	03/86	053/86
	Power System Efficiency Study (English)	12/88	092/88
	Energy Efficiency Improvement in the Brick and Tile Industry (English)	02/89	097/89
	Tobacco Curing Pilot Project (English)	03/89	UNDP Terminal Report
	Energy Assessment (English)	12/96	193/96
Zaire	Energy Assessment (English)	05/86	5837-ZR
Zambia	Energy Assessment (English)	01/83	4110-ZA
	Status Report (English)	08/85	039/85
	Energy Sector Institutional Review (English)	11/86	060/86
	Power Subsector Efficiency Study (English)	02/89	093/88
	Energy Strategy Study (English)	02/89	094/88
	Urban Household Energy Strategy Study (English)	08/90	121/90
Zimbabwe	Energy Assessment (English)	06/82	3765-ZIM
	Power System Efficiency Study (English)	06/83	005/83
	Status Report (English)	08/84	019/84
	Power Sector Management Assistance Project (English)	04/85	034/85
	Power Sector Management Institution Building (English)	09/89	--
	Petroleum Management Assistance (English)	12/89	109/89
	Charcoal Utilization Prefeasibility Study (English)	06/90	119/90
	Integrated Energy Strategy Evaluation (English)	01/92	8768-ZIM
	Energy Efficiency Technical Assistance Project: Strategic Framework for a National Energy Efficiency Improvement Program (English)	04/94	--
	Capacity Building for the National Energy Efficiency Improvement Programme (NEEIP) (English)	12/94	--

EAST ASIA AND PACIFIC (EAP)

Asia Regional	Pacific Household and Rural Energy Seminar (English)	11/90	--
China	County-Level Rural Energy Assessments (English)	05/89	101/89
	Fuelwood Forestry Preinvestment Study (English)	12/89	105/89
	Strategic Options for Power Sector Reform in China (English)	07/93	156/93
	Energy Efficiency and Pollution Control in Township and Village Enterprises (TVE) Industry (English)	11/94	168/94
	Energy for Rural Development in China: An Assessment Based on a Joint Chinese/ESMAP Study in Six Counties (English)	06/96	183/96
Fiji	Energy Assessment (English)	06/83	4462-FIJ

Region/Country	*Activity/Report Title*	*Date*	*Number*
Indonesia	Energy Assessment (English)	11/81	3543-IND
	Status Report (English)	09/84	022/84
	Power Generation Efficiency Study (English)	02/86	050/86
	Energy Efficiency in the Brick, Tile and Lime Industries (English)	04/87	067/87
	Diesel Generating Plant Efficiency Study (English)	12/88	095/88
	Urban Household Energy Strategy Study (English)	02/90	107/90
	Biomass Gasifier Preinvestment Study Vols. I & II (English)	12/90	124/90
	Prospects for Biomass Power Generation with Emphasis on Palm Oil, Sugar, Rubberwood and Plywood Residues (English)	11/94	167/94
Lao PDR	Urban Electricity Demand Assessment Study (English)	03/93	154/93
Malaysia	Sabah Power System Efficiency Study (English)	03/87	068/87
	Gas Utilization Study (English)	09/91	9645-MA
Myanmar	Energy Assessment (English)	06/85	5416-BA
Papua New Guinea	Energy Assessment (English)	06/82	3882-PNG
	Status Report (English)	07/83	006/83
	Energy Strategy Paper (English)	--	--
	Institutional Review in the Energy Sector (English)	10/84	023/84
	Power Tariff Study (English)	10/84	024/84
Philippines	Commercial Potential for Power Production from Agricultural Residues (English)	12/93	157/93
	Energy Conservation Study (English)	08/94	--
Solomon Islands	Energy Assessment (English)	06/83	4404-SOL
	Energy Assessment (English)	01/92	979-SOL
South Pacific	Petroleum Transport in the South Pacific (English)	05/86	--
Thailand	Energy Assessment (English)	09/85	5793-TH
	Rural Energy Issues and Options (English)	09/85	044/85
	Accelerated Dissemination of Improved Stoves and Charcoal Kilns (English)	09/87	079/87
	Northeast Region Village Forestry and Woodfuels Preinvestment Study (English)	02/88	083/88
	Impact of Lower Oil Prices (English)	08/88	--
	Coal Development and Utilization Study (English)	10/89	--
Tonga	Energy Assessment (English)	06/85	5498-TON
Vanuatu	Energy Assessment (English)	06/85	5577-VA
Vietnam	Rural and Household Energy-Issues and Options (English)	01/94	161/94
	Power Sector Reform and Restructuring in Vietnam: Final Report to the Steering Committee (English and Vietnamese)	09/95	174/95
	Household Energy Technical Assistance: Improved Coal Briquetting and Commercialized Dissemination of Higher Efficiency Biomass and Coal Stoves (English)	01/96	178/96
Western Samoa	Energy Assessment (English)	06/85	5497-WSO

SOUTH ASIA (SAS)

Bangladesh	Energy Assessment (English)	10/82	3873-BD
	Priority Investment Program (English)	05/83	002/83
	Status Report (English)	04/84	015/84
	Power System Efficiency Study (English)	02/85	031/85
	Small Scale Uses of Gas Prefeasibility Study (English)	12/88	--

Region/Country	Activity/Report Title	Date	Number
India	Opportunities for Commercialization of Nonconventional Energy Systems (English)	11/88	091/88
	Maharashtra Bagasse Energy Efficiency Project (English)	07/90	120/90
	Mini-Hydro Development on Irrigation Dams and Canal Drops Vols. I, II and III (English)	07/91	139/91
	WindFarm Pre-Investment Study (English)	12/92	150/92
	Power Sector Reform Seminar (English)	04/94	166/94
Nepal	Energy Assessment (English)	08/83	4474-NEP
	Status Report (English)	01/85	028/84
	Energy Efficiency & Fuel Substitution in Industries (English)	06/93	158/93
Pakistan	Household Energy Assessment (English)	05/88	--
	Assessment of Photovoltaic Programs, Applications, and Markets (English)	10/89	103/89
	National Household Energy Survey and Strategy Formulation Study: Project Terminal Report (English)	03/94	--
	Managing the Energy Transition (English)	10/94	--
	Lighting Efficiency Improvement Program Phase 1: Commercial Buildings Five Year Plan (English)	10/94	--
Sri Lanka	Energy Assessment (English)	05/82	3792-CE
	Power System Loss Reduction Study (English)	07/83	007/83
	Status Report (English)	01/84	010/84
	Industrial Energy Conservation Study (English)	03/86	054/86

EUROPE AND CENTRAL ASIA (ECA)

Bulgaria	Natural Gas Policies and Issues (English)	10/96	188/96
Central and Eastern Europe	Power Sector Reform in Selected Countries	07/97	196/97
Eastern Europe	The Future of Natural Gas in Eastern Europe (English)	08/92	149/92
Kazahstan	Natural Gas Investment Study, Volumes 1, 2 & 3	12/97	199/97
Kazahstan & Kyrgyzstan	Opportunities for Renewable Energy Development	11/97	16855-KAZ
Poland	Energy Sector Restructuring Program Vols. I-V (English)	01/93	153/93
Portugal	Energy Assessment (English)	04/84	4824-PO
Romania	Natural Gas Development Strategy (English)	12/96	192/96
Turkey	Energy Assessment (English)	03/83	3877-TU

MIDDLE EAST AND NORTH AFRICA (MNA)

Arab Republic of Egypt	Energy Assessment (English)	10/96	189/96
Morocco	Energy Assessment (English and French)	03/84	4157-MOR
	Status Report (English and French)	01/86	048/86
	Energy Sector Institutional Development Study (English and French)	07/95	173/95
Syria	Energy Assessment (English)	05/86	5822-SYR
	Electric Power Efficiency Study (English)	09/88	089/88
	Energy Efficiency Improvement in the Cement Sector (English)	04/89	099/89
	Energy Efficiency Improvement in the Fertilizer Sector (English)	06/90	115/90

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Tunisia	Fuel Substitution (English and French)	03/90	--
	Power Efficiency Study (English and French)	02/92	136/91
	Energy Management Strategy in the Residential and Tertiary Sectors (English)	04/92	146/92
	Renewable Energy Strategy Study, Volume I (French)	11/96	190A/96
	Renewable Energy Strategy Study, Volume II (French)	11/96	190B/96
Yemen	Energy Assessment (English)	12/84	4892-YAR
	Energy Investment Priorities (English)	02/87	6376-YAR
	Household Energy Strategy Study Phase I (English)	03/91	126/91

LATIN AMERICA AND THE CARIBBEAN (LAC)

LAC Regional	Regional Seminar on Electric Power System Loss Reduction in the Caribbean (English)	07/89	--
	Elimination of Lead in Gasoline in Latin America and the Caribbean (English and Spanish)	04/97	194/97
	Elimination of Lead in Gasoline in Latin America and the Caribbean Phase II - Status Report (English and Spanish)	12/97	200/97
	Harmonization of Fuels Speficifications in Latin America and the Caribbean (English and Spanish)	06/98	203/98
Bolivia	Energy Assessment (English)	04/83	4213-BO
	National Energy Plan (English)	12/87	--
	La Paz Private Power Technical Assistance (English)	11/90	111/90
	Prefeasibility Evaluation Rural Electrification and Demand Assessment (English and Spanish)	04/91	129/91
	National Energy Plan (Spanish)	08/91	131/91
	Private Power Generation and Transmission (English)	01/92	137/91
	Natural Gas Distribution: Economics and Regulation (English)	03/92	125/92
	Natural Gas Sector Policies and Issues (English and Spanish)	12/93	164/93
	Household Rural Energy Strategy (English and Spanish)	01/94	162/94
	Preparation of Capitalization of the Hydrocarbon Sector	12/96	191/96
Brazil	Energy Efficiency & Conservation: Strategic Partnership for Energy Efficiency in Brazil (English)	01/95	170/95
	Hydro and Thermal Power Sector Study	09/97	197/97
Chile	Energy Sector Review (English)	08/88	7129-CH
Colombia	Energy Strategy Paper (English)	12/86	--
	Power Sector Restructuring (English)	11/94	169/94
	Energy Efficiency Report for the Commercial and Public Sector (English)	06/96	184/96
Costa Rica	Energy Assessment (English and Spanish)	01/84	4655-CR
	Recommended Technical Assistance Projects (English)	11/84	027/84
	Forest Residues Utilization Study (English and Spanish)	02/90	108/90
Dominican Republic	Energy Assessment (English)	05/91	8234-DO
Ecuador	Energy Assessment (Spanish)	12/85	5865-EC
	Energy Strategy Phase I (Spanish)	07/88	--
	Energy Strategy (English)	04/91	--

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Ecuador	Private Minihydropower Development Study (English)	11/92	--
	Energy Pricing Subsidies and Interfuel Substitution (English)	08/94	11798-EC
	Energy Pricing, Poverty and Social Mitigation (English)	08/94	12831-EC
Guatemala	Issues and Options in the Energy Sector (English)	09/93	12160-GU
Haiti	Energy Assessment (English and French)	06/82	3672-HA
	Status Report (English and French)	08/85	041/85
	Household Energy Strategy (English and French)	12/91	143/91
Honduras	Energy Assessment (English)	08/87	6476-HO
	Petroleum Supply Management (English)	03/91	128/91
Jamaica	Energy Assessment (English)	04/85	5466-JM
	Petroleum Procurement, Refining, and Distribution Study (English)	11/86	061/86
	Energy Efficiency Building Code Phase I (English)	03/88	--
	Energy Efficiency Standards and Labels Phase I (English)	03/88	--
	Management Information System Phase I (English)	03/88	--
	Charcoal Production Project (English)	09/88	090/88
	FIDCO Sawmill Residues Utilization Study (English)	09/88	088/88
	Energy Sector Strategy and Investment Planning Study (English)	07/92	135/92
Mexico	Improved Charcoal Production Within Forest Management for the State of Veracruz (English and Spanish)	08/91	138/91
	Energy Efficiency Management Technical Assistance to the Comision Nacional para el Ahorro de Energia (CONAE) (English)	04/96	180/96
Panama	Power System Efficiency Study (English)	06/83	004/83
Paraguay	Energy Assessment (English)	10/84	5145-PA
	Recommended Technical Assistance Projects (English)	09/85	--
	Status Report (English and Spanish)	09/85	043/85
Peru	Energy Assessment (English)	01/84	4677-PE
	Status Report (English)	08/85	040/85
	Proposal for a Stove Dissemination Program in the Sierra (English and Spanish)	02/87	064/87
	Energy Strategy (English and Spanish)	12/90	--
	Study of Energy Taxation and Liberalization of the Hydrocarbons Sector (English and Spanish)	120/93	159/93
Saint Lucia	Energy Assessment (English)	09/84	5111-SLU
St. Vincent and the Grenadines	Energy Assessment (English)	09/84	5103-STV
Trinidad and Tobago	Energy Assessment (English)	12/85	5930-TR

GLOBAL

	Energy End Use Efficiency: Research and Strategy (English)	11/89	--
	Women and Energy--A Resource Guide The International Network: Policies and Experience (English)	04/90	--
	Guidelines for Utility Customer Management and Metering (English and Spanish)	07/91	--
	Assessment of Personal Computer Models for Energy Planning in Developing Countries (English)	10/91	--
	Long-Term Gas Contracts Principles and Applications (English)	02/93	152/93

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GLOBAL (Continuation)

	Comparative Behavior of Firms Under Public and Private Ownership (English)	05/93	155/93
	Development of Regional Electric Power Networks (English)	10/94	--
	Roundtable on Energy Efficiency (English)	02/95	171/95
	Assessing Pollution Abatement Policies with a Case Study of Ankara (English)	11/95	177/95
	A Synopsis of the Third Annual Roundtable on Independent Power Projects: Rhetoric and Reality (English)	08/96	187/96
	Rural Energy and Development Roundtable (English)	05/98	202/98

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