CHAPTER 5

CURRENT SITUATION OF POWER SUPPLY BY BEN

CHAPTER 5 CURRENT SITUATION OF POWER SUPPLY BY BEN

5.1 Organization of Baku Electric Network (BEN)

Energy supply to Baku City is managed partly by Azenerji and partly by BEN which had been under the control of the Department of Engineering Communication (DEC) of the Baku City Executive Power (BCEP). As already explained in Section 1.5, when JICA's preliminary and preparatory study team visited, BEN had all necessary functions and comprehensive responsibility for energy distribution business. Re-organization of BEN and its supervising agency DEC was, however, undertaken in May 1999. By this reform, some departments in BEN, which had been originally playing important functions in energy distribution, were separated from BEN. Those who were separated includes the Division for Special Construction (DSC), the Enterprise for Power Supervision and Sale (EPSS), the Transformer Repair Shop (TRS) and so on.

As a result, remaining BEN's role or functions had been downsized to the operation and maintenance of 10 kV, 6 kV and low voltage distribution facilities, replacement of transformers, repair works of underground cables, and laying work of service wires for customers. DSC which had been responsible for any rehabilitation and construction work including construction of transformer stations, renovation of large facilities, laying and replacement of underground cables, was absorbed into the Manufacturing Repair-Construction Installing and Adjusting Enterprise (MRCIAE) under the direct control of DEC. The Auto Transportation Department, which was responsible for the management of automobiles and heavy machinery required for operation and maintenance of distribution facilities, and TRS were also absorbed into DEC. As for DSC which is in charge of selling, billing and collection is transformed and strengthened as the Energy Sales Enterprise (ESE) under the direct control of the First Deputy Mayor of Baku City.

Compared with the "before re-organization", it was resulted that the supervising and controlling lines differ depending on the function, and that so called BEN's division of duties was extensively downsized. However, those separated functions in energy distribution were still under the umbrella of BCEP.

BEN was staffed with 2,303 as of January 1999. Table I.5.1-1 shows breakdowns of staffing by kinds of employee and function.

Table I.5.1-1 Staffing of BEN (before re-organization - as of January 1999)

(1) By kinds of employee		(Female staff)
- Engineers and technicians	508	(72)
- Office staff	508	(124)
- Workers	1,641	(282)
Total	**2,303**	**(478)**
(2) By kinds of function		
a) Functions remained in BEN		
- BEN Headquarter	210	
- Technical Procurement Department	22	
- Central Electric Network	446	
- Suburb Electric Network	463	
b) Separated from BEN, absorbed by DEC		
- Special Construction Erection Department	125	
- Automobile Transport Enterprise	230	
c) Separated from BEN, under direct control of the first deputy mayor of Baku City		
- Energy Sales and Control Department	807	
Total	**2,303**	

(Source: BEN)

It does not seem that a comprehensive planning and design of distribution facilities has been conducted. In one case, the Scientific Research Institute of Energetic and Energy Design (SRIEED) has helped and carried planning and design works as a part of substation construction plan of Azenerji. In another case, BEN or the Design Department of BCEP has worked for planning and designing of new transformer stations.

As shown in Figure I.1.5-2 (the organization chart of BEN after re-organization), BEN divides its own supply area in two, namely as the Central and Suburb Electricity Network, and subdivides each electric networks into 12 and 8 network areas respectively for O&M and repairing activity for distribution facilities.

The Energy Sales Enterprise (ESE) under the direct control of the First Deputy Mayor of Baku City has been responsible for energy sales, installation of meters, checking (once a month), billing and collections, and calibration and repair works of meters. ESE has service branch in each 11 administrative district and some service units for some major customers to conduct the above activities. Branch office in Nasimi district just started its operation on January 1998, accordingly each branch office in Sabail, Yasamal and Narimanov districts had shared the responsibility for Nasimi district until the opening.

In this report, the name "BEN" is used as an organization, which is comprehensively responsible for energy distribution under Baku City's jurisdiction, except for where the name of separated function needs to be particularly differentiated and mentioned.

5.2 Power Supply System of BEN

5.2.1 Medium Voltage Distribution Line

Medium voltage (MV) distribution network consists of 10 kV and 6 kV system, and they are mixed in Baku central. Facility data by network area, as shown in Appendix I.5.2-2, shows that length of 10 kV and 6 kV lines managed by BEN is 790 km and 1,390 km, respectively. Among them, length of underground lines is 610 km (77 %) and 840 km (60 %), respectively.

"The aluminum conductor oil impregnated paper insulated aluminum cable" or "the lead sheathed tape armored cable" is mainly applied to MV underground cable feeders. Specification of the cables applied is shown in Appendix I.5.2-1. Most of the underground cables are buried directly in the ground without any duct or protection tubes. Steel pipes are installed at the roadway crossing portions. Concrete blocks or bricks are laid above the cables to indicate the existence of cables and prevent them from being dug up. The standard practices of cable installation are shown in Figure I.5.2-1. The lay down depth of MV cables is 800 mm under the sidewalk and 1,000 mm under roadway crossings. The rising portions of underground cable to the supports are hardly protected with steel pipe.

"The Aluminum Conductor Steel Reinforced (ACSR) conductor" or "the Hard Drawn Copper Conductor (HDCC)"is applied to overhead MV feeders. Concrete pole, steel latticed pole, steel tubular pole and wooden pole are commonly applied as a support for overhead MV feeders. Although there is no regulation/standard of the supports for overhead line, single poles are usually applied to the straight section, and guy poles and wires are applied to the terminal or angular points, which have strong tension. ACSR conductors including 50, 70, 90 and 185 mm^2 and HDCC 35 mm^2 are used for overhead MV feeders. Overhead earthwires to protect overhead MV feeders from lightning are not installed.

Although a radial system is applied to some portions of the MV distribution system, a loop system is mainly applied. A loop system, however, is operated as a radial system to open the appropriate circuit breakers or disconnecting switches installed in the transformer station. Most of 10 kV feeders are double circuits to secure supply reliability. Most of 6 kV feeders are, however, single circuit except connecting portion to Azenerji's substation. The grounding system of MV distribution network is isolated neutral system.

Table I.5.2-1 shows the number of MV feeders, which are classified by peak currents at delivering points of Azenerji's substation in the Study area in winter. This was surveyed during 4 months from December 1998 to March 1999 in the winter season, when heavy loads occur. As shown in the table, peak current values of each feeder mostly do not exceed allowable current capacity. When a fault occurs on an underground cable or switchgear, however, a number of feeders cannot stand increase of current after changing the system connection. Appendix I.5.2-1 shows the allowable current capacity of underground MV cables applied to

BEN's system.

Table I.5.2-1 Number of 10 and 6 kV feeders according to peak current

Peak current at delivering points	Number of feeders	Composition
Above 301 A	0	0%
251 A – 300 A	12	4%
201 A – 250 A	39	15%
151 A – 200 A	62	23%
101 A – 150 A	47	18%
51 A – 100 A	38	14%
1 A - 50 A	69	26%

(Source: BEN)

5.2.2 Transformer Station

As shown in Appendix I.5.2-3, there are 2,281 transformer stations managed by BEN as of January 1999. The numbers of transformers and total capacity of transformers are 3,166 and 1,360 MVA, respectively. Among them, as shown in Appendix I.5.2-2, there are 1,128 transformer stations in the Study area, and the numbers of transformers and total capacity of transformers are 1,785 and 868,613 kVA, respectively.

Transformer stations in the study area are classified into the following three installation types. The relative proportion of those three types of stations in the study area is 69.6%, 7.3%, and 23.1%, respectively.

- Ground-mounted Type (standing independently and close to building)
- In-Building Type
- Ground-mounted Cubicle Type

A standard ground-mounted type transformer station consists of transformer room, MV switchgear room and LV panel room. To prevent an accident from spreading, those rooms are divided by partition walls. Each facility room is connected by the bare aluminum busbar. On the other hand, in many cases of in-building type transformer stations, facilities are installed in one or two rooms. Typical layout drawings of each transformer station are shown in Figure I.5.2-2. Typical single line diagrams of transformer stations are shown in Figure I.5.2-3.

(1) MV Transformer

MV distribution transformers are installed in the transformer stations described above. The major specifications of existing transformers are as follows.

- Standard voltage : Primary; 10.0 kV or 6.0 kV
  Secondary; 380 V - 220 V (400 V - 230 V)
- Capacity : 100 kVA, 160 kVA, 180 kVA, 250 kVA, 315 kVA, 320 kVA, 400 kVA, 560 kVA, 630 kVA and 1,000 kVA

- Rated Frequency : 50 Hz
- Winding Connection : Y-Y system (YY_N12),
  primary: 3 phases and 3 wires, secondary: 3 phases and 4 wires system
- Cooling System : Oil Natural Air Forced (ONAN) system
- Tap Changer : off-load tap changer
  tap ratio; +2.5 % -2×2.5 %, ±2×1.25 %, ±2×2.5 %, ±5.0 %

Most of the existing transformers were made in the former Soviet Union. Transformers are currently imported from Russia and Belarus with a fifty-fifty ratio.

(2) Switchgear and Protection System

At a delivering feeder of transformer stations, a disconnection switch and a circuit breaker are installed. On the other hand, only a disconnecting switch is installed at a receiving feeder. Although most of existing circuit breakers are minimum oil content type, bulk oil type circuit breakers, which had been installed in 1930s, have been existing in a few transformer stations. Rated current and rated short circuit breaking current of the minimum oil content type circuit breaker are 650 A and 20 kA respectively.

Circuit breakers, which are installed in Azenerji's substation and supplying power to BEN, are coordinated with over-current relay to protect the MV feeders shutting fault-current off automatically. Maintenance staffs of each network area re-close manually an opened circuit breaker by order of Load Dispatching Center.

To protect a distribution transformer from short circuit fault, a cutout fuse is installed at a primary side of transformer. On the other hand, only disconnecting switch is installed at the secondary side of transformer. Current capacities of cutout fuses installed for transformers are shown in Table I.5.2-2. Cutout fuses applied to transformers below 400 kVA are not specified in the table.

Table I.5.2-2 Specifications of MV Cutout Fuses

Voltage (kV)	Transformer Capacity (kVA)	Rated Current (A)
10	400	50
	630	80
	1,000	100
6	400	80
	630	100
	1,000	160

(Source: BEN)

To protect LV distribution feeder from over current, a fuse is installed at the LV panel. Rated current of fuses are 150 A, 250 A and 400 A. A LV panel consists of knife-contact switches and fuses, and connects with LV distribution cables.

(3) Busbar

The single busbar system is applying to all the MV busbars in the transformer stations. MV busbar with a circuit breaker or a disconnecting switch divides the distribution system as described in sub-clause 5.2.1. Material of the busbar is aluminum and rated current and rated short circuit current are 450 A and 3,000 A respectively.

(4) Measuring Devices

Although current transformers (CT) are installed at 2 of 3 phases of MV delivering feeders to measure load current and to protect feeders from overload, an ammeter and over-current relay are hardly installed. In some transformer station, though ammeters are installed in a LV panel, most of them are damaged and not in a working order.

(5) Voltage Regulators

Voltage regulation in the LV side of the transformer is regulated with the no-load tap changer in the primary side of the transformer. Any other voltage regulating equipment is hardly adopted.

5.2.3 Low Voltage Distribution Line

The existing low voltage (LV) distribution feeders are categorized into three types, including overhead wire feeder, underground cable feeder and house flank feeder. In any type of feeder, at least the first section from the LV panel is underground cable. Both aluminum and copper conductors are used for these cables. For overhead feeder, bare conductors are usually used. Total length of overhead feeders including house flank lines is 1,731 km, and that of underground feeders is 700 km.

Wooden pole, steel latticed pole and steel tubular pole and are commonly adopted as support for overhead LV feeders. There is no regulation/standard of the support as in case of the MV feeders. Single poles are usually applied to the straight section and guy poles and wires are applied to the terminal or angular points, which have strong tension.

Various cables are being used for the underground LV line and "the aluminum conductor oil impregnated paper insulated aluminum sheathed tape armored cable" are partially used. The way of installation of LV underground cables is as same as MV cables. For house flank LV feeders, insulated cables are used. Both aluminum and copper conductors are used for these cables. House flank LV feeders are installed on building flank with fittings every 60 cm.

The distribution system of most of low voltage feeder from transformer station adopts a radial distribution system. Some customers, however, are supplied by double circuits or with emergency circuit. The maximum length of LV feeders in the city central and suburb area are 200 m and 300 m, respectively.

5.2.4 Watt-hour Meter

Watt-hour meters are installed at almost all customers, normally to measure active power consumption. Meters are mostly installed inside the building of customers. Rated currents of watt-hour meter are 5, 10, 35, 40, and 60 A for single phase and 5, 10, 50, and 70 A for three phases. The measurements of above rated current are made through current transformer. To protect the meters from over current, miniature circuit breakers are generally installed to most customers. Rated currents of miniature circuit breaker are 5, 10, 15, 20, 30, 50, and 60 A.

Watt-hour meters are calibrated every eight years. Those meters requiring repair are brought into a repair shop and used after calibration.

5.2.5 Load Dispatching Equipment

The main Load Dispatching Center (LDC) of BEN is located on the top floor of its head office. The dispatching room has a floor area of about 17.5 m x 8 m. The entrance of the main LDC is locked making trespassing difficult. The main LDC consists of the following equipment.

(1) Graphic panel

There are two graphic panels in front and behind of the dispatching desk in the dispatching room. Their sizes are 4 m x 21 m and 2.2 m x 5.9 m respectively. These panels consist of mosaic blocks of 4cm sides. The 10 kV and 6 kV distribution network in Baku including the Azenerji's substation is shown on these panels. The 10 kV and 6 kV lines are indicated in red and black on the panels respectively. The switches and mimic switches show the opening and closing position of the switchgears in the network. Because the back wiring of switches on the panels is not connected at present, it is not possible to perform remote control and supervise the distribution network with the panels.

(2) Dispatching desk

There are two dispatching desks in LDC and eight ammeters and two watt-meters are installed between them. These meters are designed to display the current and electric power of any feeder selected by the switches on the desk. This function, however, is not effective now due to disconnected line.

(3) Computer system

There is a desktop type computer on the dispatching desk. In 1990, this computer was installed in order to perform remote control and one-line data management of the distribution network. The distribution network control system is, therefor, functioning in an off-line condition. This computer is now for the use of database for operation and maintenance containing the data such as the number and capacity of the transformers, single line diagrams of each transformer station and Azenerji's substation and specification, installment year and length of the cables.

(4) Telecommunication equipment

Telephones with exclusive lines are installed in parallel on each dispatching desk and they can directly connect to the appropriate points by selection switches on the desks. These telephones also can link to the public telecommunication network. There are 30 numbers of selection switches on the desks and at present 12 and 8 numbers of them are connected to the distribution network and the others respectively. In addition a set of radio equipment is installed for distribution network operation.

5.2.6 Electrical Characteristics of Distribution Network

(1) Measurement of Load

From November 1999 to February 2000, BEN was asked to measure the current value at the secondary side of the transformer in some major transformer stations with the measuring instruments brought by the Study Team. This was in view of confirming the maximum load of transformer in winter season. The result of measurements is shown in Appendix I.5.2-4. The estimated capacity factor of transformers and unbalanced load data are also provided in the same appendix.

Since all measurement was undertaken during daytime, the measured value does not represent the maximum load of the transformers. Accordingly, the maximum load is estimated based on the daily load curve recorded on 16 December 1998 (see Figure I.4.4-1). Then, the capacity factor in the appendix is derived. The daily load curve referred to, however, includes Azenerji's industrial demand, which amounts to its peak during daytime. It can be, therefore, supposed that the estimated peak load derived by the said daily load curve is relatively lower, compared with the case where only the demand pattern of Baku City, (largely lighting purpose) is taken in account.

(2) Overloaded transformer

Among the transformers listed in Appendix I.5.2-4, the transformers of which capacity factor exceeds 100 % are picked out in Appendix I.5.2-5. As in the appendix, those transformers amount to 31 out of 99 sets (31%). Though the transformers exceeding 150 % of capacity factor amounted to 2 units (320 and 400 kVA), it is been considered fortunate, from the reason above, that they have been not fired by overload.

Since it is supposed that the capacity factor of the transformers, which supply power to the area with higher lighting load, is actually higher than that shown in Appendix I.5.2-5, it is recommended that the transformer of which capacity factor exceeds 140 % be replaced by the transformer with larger capacity to prevent the fire accidents from occurring. It should be also followed that the peak load of other transformers be monitored during winter season, and that they be replaced in case of exceeding 150 % of capacity factor.

(3) Unbalanced load

Most of the customers connected to 3 phased distribution lines are those who need loads for lighting purpose and small capacity single phased motors. Since, in Baku City, Azenerji supplies the customers including large-scale factory and commercial complex, the ratio of single phased load is expected to be higher in BEN's customers than as is normally observed. Most important problem incurred by the unbalanced load among the phases is that the distribution loss takes place more largely compared to when the load is balanced. In accordance with the number and movement of customers, a regular monitoring and switching connection to customers are required to balance the load in each phase.

As the index to indicate the level of unbalance in load, "Unbalanced factor" is normally adopted, and calculated with the following formula. Preferable range of the index can be less than 30 %.

$$UnbalancedFactor = \frac{\mathrm{Max(Ia,Ib,Ic) - Min(Ia,Ib,Ic)}}{\frac{\mathrm{(Ia + Ib + Ic)}}{3}} \times 100(\%)$$

Though unbalanced load at the secondary side of transformer does not necessarily represent one in the medium voltage distribution network, the transformers of which unbalanced factor is recorded at more than 30 % amounts to around 30 % as shown in Appendix I.5.2-4 and 5.2-5. BEN has recognized this situation, and endeavored to balance the load. This result has been considered as related to the low voltage network as explained below. Such extent of unbalanced factor, however, does not severely affects the loss in distribution network of BEN, and gradually improves as sufficient material and equipment is supplied.

The current values of low voltage feeders of No. 55 transformer station was measured in September 1999, and shown in Appendix I.5.2-6. As far as the unbalanced factor is concerned, the load balance among the phases has been judged extensively poor. Measured value in the circuit, which indicates very poor unbalanced factor, is very small, and some show zero value. Likely reason of such small current value is considered that the load occurring at far distant from cable cut point has been conveniently transferred when the cable is cut for some reasons, without transferring all loads into newly laid cable line. As a result, the balance maintained was lost, bringing about a large unbalanced load. This practice has been forced due to the lack of repairing material, and will be avoided as sufficient material will be supplied and existing thin and numerous cables are cleared.

(4) Power factor of load

Initially, the voltage drop was considered to be caused by low power factor of load incurred from usage of motors by small and medium-scale industry. However, it turns out to be needless to address by the following reasons. The measuring result by BEN, indicating 90-98 % of power factor of load has also accounted for this. Therefore, the power factor compensator including static capacitor is not required for the distribution network of BEN.

(a) As more than 80 % of total demand by BEN's customer is presently required by residential (lighting purpose), power factor in load itself has been higher than as is normally observed in other distribution system.

(b) As most of the power lines that constitute the distribution network are the cable lines with large capacitance, they function as the source of reactive power supply and lessen the supply from the power source.

5.3 Power Supply and Demand

5.3.1 Power Supply to Baku

The ESE's branch units for billing and collecting electricity charges are established in each district. However, for the central area of the city comprising Sabail, Yasamal, Nasimi, Narimanov and Binagady administrative districts, only total amount of energy purchased from Azenerji is available. Among the Study area, therefore, a breakdown of purchased energy amounts in Sabail, Yasamal, Nasimi, and Narimanov are not clear.

Table I.5.3-1 shows the amount of energy purchased by area in the past 6 years. Appendix I.5.3-1 also shows the same in detail with loss data. Table I.5.3-2 presents the rate of increase against the previous year.

Table I.5.3-1 Amount of purchased energy (Unit: GWh)

Area	1993	1994	1995	1996	1997	1998	1999	Rate of change (1993-99 : %/year)
City Area	1,248.1	1,255.3	1,213.9	1,389.2	1,515.0	1,680.1	1,773.3	6.0
Nizami	134.8	146.8	143.7	161.5	191.0	210.9	213.4	8.0
Khatai	218.5	223.7	221.9	245.6	261.8	311.5	356.1	8.5
Others	658.3	719.2	718.0	849.4	980.4	1,163.9	1,274.2	11.6
Total	2,259.6	2,345.1	2,297.5	2,645.7	2,948.2	3,366.4	3,617.0	8.2

(Source: ESE)

Table I.5.3-2 The rate of increase in energy purchased against last year (%)

Area	1994	1995	1996	1997	1998	1999
City Area	0.6	-3.3	14.4	9.1	10.9	5.5
Nizami	8.9	-2.1	12.4	18.3	10.4	1.2
Khatai	2.4	-0.8	10.4	6.6	19.0	14.3
others	9.3	-0.2	18.3	15.4	18.9	9.5
Total	3.4	-2.1	15.2	11.4	14.2	7.4

(Source: ESE)

Appendix I.5.3-2 and Figure I.5.3-1 show the monthly fluctuation in energy purchased by Baku from 1995 to March 2000.

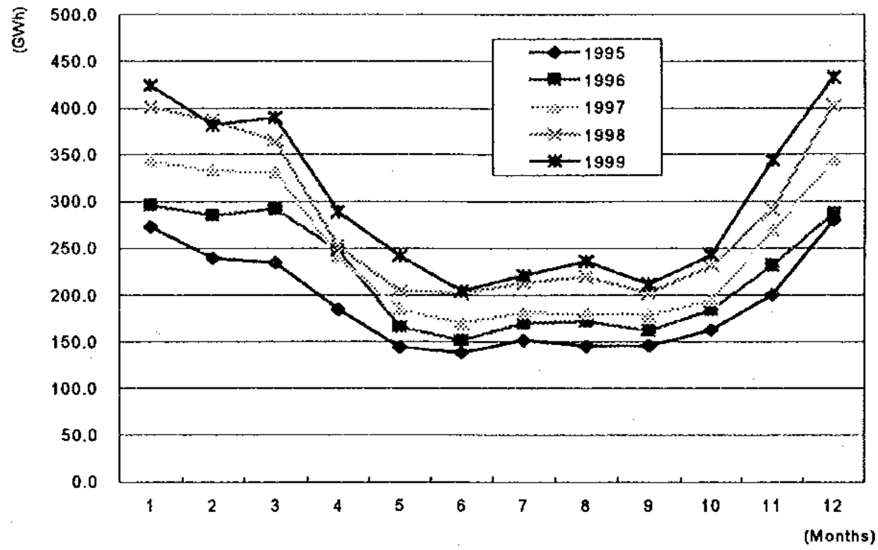


Figure I.5.3-1 Monthly fluctuation of energy purchase from Azenerji

The following points are observed from Figure I.5.3-1.

(a) In each year, energy purchase begins to rise sharply in November, reaches the peak in December or January and starts declining in April. In all the years except in 1999, monthly amount between April and October stays at a similar range. These clearly show a seasonal pattern of energy purchase (high in winter and low in summer).

(b) Since 1995, the amount of energy purchase has risen against previous years in all the months throughout the year, except in April 1996 and February 1999. Annual average growth rates between 1995 and 1998 are especially high in January (13.7%/year), February (17.3% p.a) and March (15.9% p.a) in the winter period and in August (14.8% p.a) during the summer period.

(c) The ratio of purchase level in the highest month to that of the lowest month has been maintained at around 2.0.

(d) In 1998, August seemed to start becoming a secondary peak month. This tendency is observed more clearly in 1999. An increased use of energy for air conditioners in the hottest and most humid month in a year would be the cause of this tendency.

An overall increase of energy consumption by BEN customers can be explained by deterioration of the central heating system and resultant heavier dependence on electric stoves during winter. An improvement in the living standard also contributes to an increased use of energy for various purposes.

Focusing on the January to March period for which data in 2000 are available, the purchased amount grew more slowly in 1999 than until 1998. In 2000, however, the rates of increase in January, February and March again rose to more than 10% as shown in Table I.5.3-3.

According to ESE, energy consumption from January to March in 2000 rose quickly from the 1999 level due to lower heat supply by the Baku City Heat Supply Department. The fact that this level of increase in electricity use happened despite the planned blackout started in January 2000 indicates a rapid increase in energy use for heating purpose outside the blackout time. Decline in heat supply volume by the Heat Supply Department was confirmed by the following data provided by them.

Table I.5.3-3 Growth rates of energy purchase

(unit: %/year)

Month	月	1993-98	1998-99	1999-2000
January	1月	13.7	5.7	12.8
February	2月	17.3	-1.3	11.3
March	3月	15.9	6.7	11.3

Table I.5.3-4 Heat supply volume in Baku in winter

(unit : Gcal)

Month	1999	2000	(%/year)
January	104,808	70,009	-33.2
February	88,104	72,599	-17.6
March	70,367	61,259	-12.9

5.3.2 Energy Consumption of BEN's Customers

(1) Electricity supply by BEN by type of consumers

The total amount of electricity consumption in Baku is shown in Appendix I.5.3-3 and summarized below.

Table I.5.3-5 Energy consumption by type of consumers in Baku

Category	Amount of energy (GWh)			Rate of change (%/year)	
	1995	1998	1999	1995-98	1998-99
Energy purchased	2,297.5	3,366.4	3,617.0	13.6	7.4
Energy sold	1,704.9	2,802.5	3,001.7	18.0	7.1
Industry	180.3	157.3	130.5	-4.4	-17.0
Non-industry	345.6	285.9	304.3	-6.1	6.4
Agriculture	19.5	11.4	5.1	-16.4	-55.3
Transportation	23.0	7.6	6.2	-30.9	-18.2
Commerce	35.0	85.0	82.2	34.4	-3.3
Absheron Regional Water Com.	-	7.5	18.0	-	140.6
Subtotal	603.4	554.7	546.4	-2.8	-1.5
Household	1,101.5	2,247.8	2,455.3	26.8	9.2
Loss					
In GWh	592.6	563.9	615.3	-1.6	9.1
In %	25.8	16.8	17.0	-	-

Note: Energy use by budget organizations and railroad in 1999 is included in " Non-industry".

The following points are observed.

(a) Total power sale has been sharply rising since 1996: 17.8% in 1996, 13.8% in 1997, 14.2% in 1998, and 7.1% in 1999, with an average growth at 15.2% per year between 1995 and 1999.

(b) Household and commercial categories have led the fast growth with average annual growth rates between 1995 and 1999 at 21.6 % per year and 23.2 % per year respectively. Especially the residential consumption had a great influence, due to its dominant share.

(c) As a result, the share of residential consumption rose from 65% in 1995 to 80% in 1999. The shares of industrial and non-industrial consumption, on the contrary, fell in the same period from 11% to 4% and from 20% to 10% respectively.

(d) This rapid increase in residential power consumption would be the result of an increasing use of electricity by rapidly prevailing electricity appliances, especially electricity stoves in winter (due to a rise in income level and decline in the service level of heat supply facilities). A rise in income level of workers as shown in Table I.2.2-5 as high as 2.18 times in 1998 as compared to 1995 contributed to this. The following Table I.5.3-6 shows trends in the import of electricity appliances from Turkey, a good indication of rapid penetration of various electricity appliances.

Table I.5.3-6 Import of electricity appliances from Turkey

Commodity	1995	1998	Ratio 1998/1995
Electric stove	541	17,646	33
Microwave	38	9,893	260
Electric water boiler	74	7,345	99
Electric oven	21	211	10

(e) The residential electricity consumption by households rose by 9.2% in 1999, still at a high rate, though lower compared to 26.8% per year during the previous 5 years. According to ESE, there were following three factors to explain this rapid increase in residential electricity use.

- There have been changes in categorization of the customer. Some government officers and factory workers, formerly contracting with BEN for energy supply through their places of work, are presently categorized as residential user as a result that they have been made directly re-contracted with BEN for energy supply.
- The rapid influx of refugee into Baku City has been leading to a rise in electricity use in residential category.
- The city heat supply system has become poorer to be presently out of operation, leading to a rise in electricity use for heating purpose.

(2) Energy supply by BEN by district

Appendix I.5.3-4 and Table I.5.3-7 below show the amount of electricity consumed by BEN customers by district from 1993 to 1999. Nasimi district had been covered by the BEN's Yasamal, Sabail and Narimanov district offices until April 1998. In May 1998 the Nasimi district was established, separated from these surrounding three districts.

Table I.5.3-7 Amount of energy consumed by BEN consumers (Unit : GWh)

District	Energy sold (GWh)				Rate of change (%/year)		
	1993	1997	1998	1999	1993-97	1997-98	1998-99
Study area	747.9	1,191.3	1,407.6	1,450.2	12.3	18.2	3.0
Sabail	174.0	263.9	250.3	212.2	11.0	-	-15.2
Yasamal	129.6	252.9	278.2	249.6	18.2	-	-10.3
Nasimi	-	-	151.5	250.7	-	-	65.5
Narimanov	153.5	284.0	271.3	234.2	16.6	-	-13.7
Nizami	111.4	164.8	186.1	195.5	10.3	-	5.1
Khatai	179.3	225.8	270.2	308.0	5.9	-	14.0
Outside Study area	567.4	916.3	1,220.2	1,398.1	12.7	33.2	14.6
Inspection	322.1	177.3	174.7	153.4	-13.9	-1.5	-12.2
Total	1,637.4	2,284.9	2,802.5	3,001.7	8.7	22.7	7.1
Composition (%)	100.0	100.0	100.0	100.0	-	-	-
Study area	45.7	52.1	50.2	48.3	-	-	-
Outside Study area	34.7	40.1	43.5	46.6	-	-	-
Inspection	19.7	7.8	6.2	5.1	-	-	-

The following points are observed.

(a) The amount of electricity used in the Study area grew at a rate of 12.3% per year between 1993 and 1997, while the growth rate outside the Study area in the same period was 12.7% per year, both of which are quite high.

(b) In the Study area, Yasamal and Narimanov districts, especially, showed a high growth, at 18.2% per year and 16.6% per year respectively.

(c) Outside the Study area, the power consumption in Azizbayov district grew rapidly at a rate of 21.8 % per year between 1993 and 1997.

(d) The increase of the amount of electricity sold in Nasimi district and the decrease in the three districts of Yasamal, Sabail and Narimanov in 1999 were due to the creation of Nasimi district and resulting changes in the boundaries. The amount of electricity sold of the four districts combined fell from 951.3 GWh in 1998 to 946.7 GWh in 1999, by 0.5%.

(3) Number of BEN customers and consumption per customer

In terms of the number of customers, households accounted for 95% of all the BEN's customers in 1999. In terms of the amount of energy used, households' share rose from 65% in 1995 up to 82% of the total energy sale, a reflection of fast growth in residential electricity use. Energy consumption per customer by others amounted to 28,858 kWh in 1995, nearly 9 times larger than households at 3,229 kWh per customer. The difference shrank to 4.3 times by 1999, 29,609 kWh per other customer and 6,829 kWh per household. Appendix I.5.3-5 and I.5.3-6 and Table I.5.3-8 below show the details.

Table I.5.3-8 Number of BEN customers and consumption per customer

Item		1995	1998	1999
Number	Household	341,095	357,623	359,569
	Other	20,909	22,765	18,453
	Total	362,004	380,388	378,022
Number, %	Household	94.2	94.0	95.1
	Other	5.8	6.0	4.9
	Total	100.0	100.0	100.0
Consumption, GWh	Household	1,101.5	2,247.8	2,455.3
	Other	603.4	554.7	546.4
	Total	1,704.9	2,802.5	3,001.7
Consumption, %	Household	64.6	80.2	81.8
	Other	35.4	19.8	18.2
	Total	100.0	100.0	100.0
Consumption per Customer, kWh/year	Household	3,229	6,285	6,829
	Other	28,858	24,366	29,609
	Total	4,710	7,367	7,941

Since the Study area, covering the central part of Baku, is an urbanized area, the area would be almost 100% electrified. However, because of the form of residence, like a double-family home and a rented house, the number of households and the residential customers does not match and the calculated electrification rate is not 100% in some areas.

It is, therefore, impossible to estimate the rate of electrification by comparing the number of residential customers and that of households by district.

To estimate the electrification rate of the Study area, the number of household data by district is necessary. No recent data, however, were available in Baku. The Study Team, therefore, estimated the electrification rate applying the national average number of household members (4 person/family). Table I.5.3-9 shows the result. As shown in the table, the electrification rate of Sabail is exceeding 100% substantially. In Yasamal and Nasimi, the electrification rates are fairly low value and are 69% and 77% respectively. This is caused by the simple reason of population statistics. Population itself, which Baku City grasps, is conceivable that it is not reflecting the present condition. Furthermore, since Baku City does not grasp the influx of refugees into Baku, it is considered that the gap between actual condition and statistics is large.

Table I.5.3-9 Electrification rate assumed by population and the number of household members

Items	Sabail	Yasamal	Nasimi	Narimanov	Nizami	Khatai	Total
Population (1,000)	74.3	221.5	195.8	147.9	159.1	215.5	1,014.1
Households assumed (1,000)	18.6	55.4	49.0	37.0	39.8	53.9	253.5
Residential customer (1,000)	26.9	38.0	37.9	30.9	35.6	52.6	221.9
Electrification rate (%)	144.8	68.6	77.4	83.6	89.5	97.6	87.5

(4) Amount of energy consumption by tariff category and district

Appendix I.5.3-7 presents the amount of electricity consumed by BEN customers in 1999 by type of consumer and district. The residential electricity consumption accounts for 78% in Sabail up to 86% in Khatai of the total electricity consumption. On average, 86% of the total consumption is made by residential use both in the Study area and outside the Study area.

5.3.3 Energy Consumption by BEN and Azenerji's Customer Combined

Table I.5.3-10 presents the amount of energy consumed in 1998 in the Study area on BEN and Azenerji consumers combined. Energy consumption by the Azenerji consumers was allocated to the Study area based on the proportions of industrial output within and outside the area for industrial power consumption and the proportion of population distribution within and outside the area for other types of energy consumption except agriculture use. It is assumed that all the agriculture energy consumption takes place outside the Study area.

It is found that 90% of industrial power consumption is met by power supply by Azenerji. BEN fulfills, on the contrary, 92% of the residential demand in the Study area. BEN and Azenerji cover other types of power consumption equally. In total, BEN supplies 60% of all the demand with the remaining met by Azenerji.

Table I.5.3-10 Energy consumption in 1998 by BEN and Azenerji's customers (Unit : GWh)

Category		BEN	Azenerji			Total
			CHPNE	AHPNE	Sub-total	
(Amount of electricity)	Industry	74.0	388.0	289.9	677.9	751.9
	Residential	1,145.7	75.3	22.0	97.3	1,243.0
	Other	188.4	126.1	42.7	168.8	357.2
	Total	1,408.1	589.4	354.6	944.0	2,352.1
(Composition)	Industry	9.8%	51.6%	38.6%	90.2%	100.0%
	Residential	92.2%	6.1%	1.8%	7.8%	100.0%
	Other	52.7%	35.3%	12.0%	47.3%	100.0%
	Total	59.9%	25.1%	15.1%	40.1%	100.0%

Note: Energy supplied to apartments by Azenerji is regarded as " Residential " in this table.

5.3.4 Losses

The details of energy losses per areas are given in Appendix I.5.3-1 and the ratios of the losses per area are shown in Table I.5.3-11, both of which are based on differences between yearly amounts of purchase of energy and sales.

Table I.5.3-11 Loss ratio of energy per areas (unit : %)

Area	1993	1994	1995	1996	1997	1998	1999
City Area	25.6	23.8	25.4	22.8	20.1	15.2	19.2
Nizami	17.3	8.1	8.9	11.2	13.7	11.7	8.4
Khatai	17.9	13.3	16.9	13.2	13.7	13.3	13.5
Sabunnchi	39.4	42.7	41.3	42.8	44.5	28.9	15.2
Sulakhany	23.6	16.5	17.6	12.2	15.0	12.3	14.3
Garadah	19.6	9.1	11.1	10.8	11.1	11.1	13.5
Azizbayev	44.0	24.2	35.6	32.5	25.1	17.8	19.4
Total	27.5	23.5	25.8	24.1	22.5	16.8	17.0

(Source: ESE)

In the above table, it is found that the largest loss ratio had been observed in Sabunnchi and Azizbayev area had been the second in recent years. Although the loss ratios of other areas are not necessarily judged as minor, the losses in the above two areas raise the level of the loss ratio by BEN.

5.4 Power Tariff and Collection Performance

The power tariff regime explained in Section 3.4.1 is applied throughout the country, and the same tariff regime is applied to customer of BEN, which purchases energy from Azenerji and sells energy through its own network. BEN's weighted average sales price from 1995 to 1999 is shown in Table I.5.4-1.

Table I.5.4-1 Weighted average of sales price of BEN (AZM/kWh)

Year	1995	1996	1997	1998	1999
Unit sales price	80.00	79.34	92.88	98.68	90.71

The drop in weighted average unit price from 1999 can be explained by the fact that energy supply to refugee and the other privileged, which were not claimed under the policy (not treated as losses in terms of energy amount mentioned above) had been increasing. If this non-claimed supply is charged, weighted average price rises to AZM 104.7/kWh (Total sales revenue: about AZM 314,300 million).

BEN's collection performance in the past 5 years is shown in Table I.5.4-2. The collection performance has been worse though moderate. Baku City has regarded the unpaid charge as a grave issue. However, the performance has not been improved as yet, since the concept of beneficiary-to-pay has not been sufficiently penetrated. The factors including high unemployment rate and low level of household income on average has also accounted for this problem. Since the concept of beneficiary-to-pay has not been sufficiently penetrated, customers have less incentive to use energy properly, then brought about waste of energy, and can not afford to pay with low household income. Occurrence of such a vicious cycle is conjectured as far as the domestic use is concerned.

According to ESE, which is actually in charge of revenue collection, the residential sector shows the worst collection rate ranging from 25 to 27 % in recent years. On the other hand, commercial enterprises show the best rate amounting to some 86 to 90 % with industrial and non-industrial enterprises following.

Table I.5.4-2 Collection performance for electricity charge (million AZM)

	1995	1996	1997	1998	1999
Claimed Amounts	138,000	159,989	212,102	276,553	272,290
Paid Amount	44,255	54,487	78,339	77,041	76,866
Ratio of Paid/Claimed (%)	32.1	34.4	36.9	27.9	28.2

5.5 Operation and Maintenance System

5.5.1 General

The Load Dispatching Center (LDC) of BEN is responsible for overall control of management of facility maintenance system of BEN. LDC is conducting, under the cooperation 20 network area offices under the control of BEN, administration of maintenance of the distribution facilities of BEN. LDC is handling the recording book named "Special Record Book" in which all histories and records concerning troubles and maintenance of all facilities. Table I.5.5-1 shows number of faults of medium voltage distribution facilities in the past five years and Appendix I.5.5-1 shows number of faults of facilities during the same period.

Table I.5.5-1 Number of faults of MV distribution facilities in the past five years

Year	1994	1995	1996	1997	1998
Number of faults	1,702	1,601	1,839	3,623	3,441

The above table clearly shows that the number of faults has been rapidly increased in 1997 and 1998. The underground cable faults were in very high level as 65% and 84% in the total number of faults in 1997 and 1998, respectively.

Number of faults on the underground cables in the past five years expressed in monthly summary corresponding to the network areas are shown in Appendix I.5.5-2. As clearly indicated, the occurrences of faults in winter season were more than that in summer season. This observation is remarkable in 1997 and 1998 when number of the underground cable faults was rapidly increased. This indicates that one of the reasons of rapid increases in the number of the faults is based on the fact that the faults were caused not only by progress of deterioration of the underground cables, but also by shortage of the transmission capacity of cables against recent rapid increases of loads because of lack of the renewal of old cables to new cables and lack of changeover of loads.

Appendix I.5.5-3 shows the number of transformers repaired in 1998 and breakdown of the numbers divided in contents of repairs. In such numbers of contents of repairs and maintenance, the numbers of repairs for deterioration of insulation and rewinding of coils caused by damages on the windings by short circuit faults are most and counted as 38%. Subsequently, oil purification for deteriorated insulation oil caused by ingress of water is counted as 13.1%.

5.5.2 Detection of Fault Location and Process of Repair

In the number of faults, the number of faults on the underground cables is the largest. Majority of faults on the underground cables are simple grounding and/or short-circuit faults mainly due to deterioration of cable insulation, or damage on insulation by overloading, or burning out and damage to insulation by poor workmanship at cable joints. If compared with the fault on the overhead lines, the fault locations on the underground cable can be relatively easy to be identified.

When a line fault occurs on the underground cable, LDC identifies fault area, cuts faulted lines and conducts switching operation to restore supply to associated lines and supports fault locator teams to identify the fault location. The fault locator teams have 12 numbers of Special Laboratory Vehicles (SLV), each provided with a fault locator made in the FSU. The newest SLV was imported from Russia in 1998. Type and performance of this SLV are the same as previous models. Number of staff of the fault locator teams is 15. In winter time when faults occur frequently, they are extremely busy to cope with faults.

The LDC has leadership for the processes from detection of faults to completion of repairs for distribution facilities including the underground cables. In case of faults on the underground cables, the following procedures are conducted:

i) LDC detects a fault.
ii) Location of fault area is identified and fault area is separated by operation of circuit breakers.
iii) SLV carrying measuring instruments identifies location of the fault point.
iv) LDC instructs the network area office to conduct repairs.
v) Repair work and testing by the network area office
vi) Acceptance test conducted by an inspector of LDC
vii) Restart of supply by closing switches

5.5.3 Facility Maintenance and Management System of BEN

Design, construction, operation and maintenance of the distribution facilities are conducted in accordance with the regulations established during FSU period.

Supervisors of each network area control operation and maintenance work for facilities. The Large-scale work or dangerous works are conducted to follow the order document. Other normal and regular works are conducted to follow instruction of the supervisors that indicate in the every morning.

The regular inspections for facilities are basically conducted once a six months by two technicians from each network area office. In case of necessity, inspections are conducted once a month. The underground cables are inspected once in two months. Inspection results are recorded in the Record Books.

The documents of the facilities, such as drawings and records are controlled by engineers and specialists of the Technical Manufacture Department (TMD) of BEN, under the control of Chief Engineer of BEN. The spare parts are controlled and stored by the Division for Technical Provision (Supply) (DTP). The spare parts are supplied on demand, after recorded in record books controlled by the House Keeping Department (HKD).

Accountant's office maintains and records inventory cards for all equipment and materials procured. The inventory cards record such information for each item procured as inventory number, model number, type, drawing number, date of procurement, contract price, date of manufacture, manufacturing number, name of manufacturer, date of commissioning, record of reconstruction for repair, accounting record, depreciation amount, etc.

Use of computers for the operation and maintenance system is very limited.

5.5.4 Maintenance and Management for Circuit Breakers

Although the bulk-oil circuit breakers, which were manufactured in 1930s, still partly exist in the distribution network in Baku, most of the circuit breakers installed are minimum-oil type. A maintenance-free circuit breaker such as vacuum type and SF_6 type, which is used globally, has not been installed yet. Although both minimum-oil and bulk-oil circuit breaker have a good performance, the constructional problem is that oil inside gets dirty by cut fault current off and the insulation performance falls off as the result. Therefore, the replacement and/or washing of oil inside are necessary after the cut large current off several times.

According to the hearing from BEN, the oil exchange of the bulk-oil circuit breaker is carried out every 5 times of cut fault current off, although the recommendation of the manufacture is 3 times. Total inspection for circuit breakers is carried out once in a year, and then the oil exchange of all the circuit breakers is carried out, even for the circuit breaker of which the number of cutoff is within the established value. For minimum-oil circuit breaker, BEN is judging the exchange timing by the color of oil, although the recommendation of the manufacture is after 3 to 5 times cutoff.

5.5.5 Transformer Repair Shop

The Transformer Repair Shop (TRS) formerly belonged to BEN. After the reorganization of the Department of Engineering Communication (DEC) of BCEP in May 1999, TRS was absorbed to MRCIAE (section responsible for construction works of public facilities) of DEC. The main functions of TRS are (a) testing and inspection of new transformers; (b) testing of transformers in operation; and (c) repair work for transformers. The repair work includes both such minor works as replacement of insulators and tightening of bolts and such major works like replacement and rewinding of coils burnt by grounding or short-circuit faults and overheating due to overloading. Material of coils is aluminum made in Azerbaijan. TRS has two insulation paper wrapping machines.

Table I.5.5-2 below shows the number and capacity of transformers repaired by TRS since 1997 to 1999 (August). Appendix I.5.5-4 presents a detail

Table I.5.5-2 Number and capacity of transformers repaired by TRS

Year	1997	1998	1999 (1-8)
No. of units	181	366	175
Capacity (MVA)	84.1	177.7	104.9

(Source: BEN/TRS)

As seen in the above table, the number of transformers repaired greatly increased in 1998. This tendency remains unchanged in 1999. Of all the transformers (3,166 units, 1,358.8 MVA) currently in service, 11.6% in terms of the number and 13.1 % in terms of capacity were sent to TRS in 1998. Similarly as the case of the faults on the underground cables, the number of faults on the transformers increases in winter season. This is considered to be due to rapid increase of the heating demand in wintertime.

TRS is located at the headquarters in the vicinity of BEN. It has 30 staffs, 25 men and 5 women, comprising the chief of workshop, one engineer, one mechanic and 27 workers. The repair shop is 12 meter wide, 80 meter long and 8 meter high and equipped with major facilities such as the winding machine, insulation paper machines, insulation oil treatment devices, metal cutting machines and overhead cranes, etc.

5.5.6 Calibration and Repair of Watt-hour Meters

When new customers receive electricity supply, each customer, at his (or her) cost, needs to prepare a watt-hour meter. Each meter is to be inspected by the Energy Meter Laboratory (EML) of ESE. The meter is installed under the responsibility of ESE. At this point, the property of the meter is transferred from the customer to ESE. After that, EML conducts periodical calibration (as of today, once per 7-8 years for single phase meters and once per 3 years for three phase meters) and repair of meters, in case there is something wrong. EML has the calibration facilities, which can calibrate 83 units of single phase meters and 4 units of three phase meters at the same time. In the calibration work, technicians of ESE conduct checking and adjustment under the presence of the supervisors from the State Standardization Committee, they confirm accuracy of meters and seal them with lead. The calibration method is not to compare the accuracy of meters for tests with that of precise accuracy class standard meters, but to confirm visually by the inspectors using stop watches applying pre-determined input current and voltage revolution speed of the induction disks. They said that the accuracy of the calibration is 2.5%, however, we considered that the accuracy of 2.5% of the above-mentioned calibration method to be groundless.

The repair work of meters covers repair of almost all parts, including rewinding of coils of magnets. Confirmation of the accuracy of repaired meters is conducted with the different test facilities other than the above-mentioned calibration facilities. Numbers of calibrated and repaired meters in the past five years are shown in Table I.5.5-3.

Table I.5.5-3 Calibration and repair of watt-hour meters

	Year	1994	1995	1996	1997	1998
Calibration	Single phase	9,685	10,554	10.890	9,203	9,275
	3 phase	1,492	1,636	1,538	3,082	2,405
Total		**11,177**	**12,190**	**12,428**	**12,285**	**11,680**
Repair	Single phase	10,955	10,808	10,997	9,386	9,421
	3 phase	1,572	1,703	1,564	3,217	2,577
Total		**12,527**	**12,511**	**12,561**	**12,603**	**11,998**

(Source: ESE)

5.6 Financial Situation of BEN

Financial performance of BEN from 1995 to 1999 has deteriorated. The details are presented in Table I.5.6-1 and 5.6-2. Profits (total revenue minus total expenditure booked in each year) during the period from 1995 to 1998 were AZM 43.6 billion (1995), 11.5 billion (1996), -23.7 billion (1997), and -43.6 billion (1998) and –26.8 billion (1999). Taking into account the fact that the ratio of distribution losses was improved from 25.8% in 1995 to 17.0 % in 1999, the financial performance of BEN has been getting worse.

Table I.5.6-1 Financial performance of BEN (in billion AZM: unless otherwise mentioned)

	1995	**1996**	**1997**	**1998**	**1999**
Energy purchased (GWh)	2,297.5	2,647.5	2,948.2	3,366.4	3,617.0
Energy sold (GWh)	1,704.9	2,008.2	2,284.9	2,802.5	3,001.7
Losses (GWh)	592.6	639.3	663.3	563.9	615.3
Losses (%)	25.8	24.1	22.5	16.8	17.0
Revenue and Expenditure (VAT exclusive)					
Averaged retail tariff (AZM/kWh)	(80.0)	(79.3)	(92.9)	(98.7)	(90.7)
Revenue (10^9 AZM)	152.8	159.4	212.2	276.5	272.3
Averaged wholesale tariff (AZM/kWh)	n.a	n.a	(73.7)	(81.1)	(72.0)
Expenditure to purchase electricity	109.2	147.9	217.4	272.9	260.4
Other expenditure			18.5	47.2	38.7
Cost of electricity (AZM/kWh)	(63.9)	(73.7)	(103.2)	(114.2)	(99.6)
Profit (10^9 AZM)	43.6	11.5	-23.7	-43.6	-26.8
Balance Sheet	**1995/12**	**1996/12**	**1997/12**	**1998/12**	**1999/3**
Total Assets	n.a	240.2	444.0	752.7	858.2
- Current assets	n.a	213.0	413.8	711.8	816.3
(Accounts receivable in the above)	n.a	(209.4)	(402.4)	(567.5)	(642.8)
- Fixed assets	n.a	27.2	30.2	40.9	41.9
Total Liabilities	n.a	206.2	410.1	714.6	817.9
(Accounts payable in the above)	n.a	(204.2)	(403.5)	(691.3)	(785.5)
Total Equity	n.a	34.0	33.9	38.1	40.3

(Source: BEN/ESE and JICA Study Team calculation)

Table I.5.6-2 Comparison between booked and actual cash flow amounts (in billion AZM)

	1995	1996	1997	1998	1999
Revenue (Invoiced sales)	152.8	159.4	212.2	276.5	272.3
Actually collected (1)	52.2	60.2	96.6	84.6	76.9
Ratio of collection (%)	34.2	37.8	45.5	30.6	28.2
Expenditure (booked cost)	109.2	147.9	235.9	320.1	294.7
Actually reimbursed (2)	36.4	45.2	87.5	90.0	n.a
Ratio of reimbursement (%)	33.3	30.6	37.1	28.1	n.a
Profits on incoming accounts *1	15.8	15.0	9.1	-5.4	n.a
Other profits according to BEN	3.0	0.5	0.0	0.0	0.0
Ratio of (2) against (1) (%)	69.7	75.1	90.6	106.4	n.a

(Source: BEN/ESE)

Note *1: BEN also calculates the balance between the actually collected and the reimbursed as profit in the incoming accounts.

Balance sheet and above table clearly tells that the sluggish performance in revenue collection and payment to the creditors. Only 35.2% of the total invoiced revenue were collected during the period from 1995 to 1999. This has resulted in increasing accumulation of account receivable in BEN. Of the total expenditures, on the other hand, BEN has only reimbursed 31.9% (most of the expenditure is of energy purchase charge due to Azenerji) which resulted in accumulated accounts payable. As a result of such practice, actual cash incoming BEN's account has been recorded until 1988. It is considered that from this profit in the "incoming account" on cash flow basis, small amount of funds have been shifted to rehabilitation investment work.

Revenue by tariffs category (Appendix I.5.6-1) shows that revenue from "non-industrial enterprises" has declined from 51% in 1995 to 22% in 1999 (including budget enterprises). On the other hand, the revenue from "residential (domestic)" has increased from 16.4% to 53.0% during the same period. It is observed that electricity sales have become more dependent on domestic use, but less dependent on non-industrial enterprises and industrial enterprises. Therefore, BEN's financial operation has been more difficult, considering that the residential user tariff is politically kept lower than other tariff group.

The expenditure in Table I.5.6-1 includes those for energy purchase, material purchase, repairing work, O & M expenses, and salary. Most expenditure is for electricity purchase from electricity supplier Azenerji. According to BEN, material purchase and repairing works in running expenses take place only at minor and accidental occasions. A detail in 1998 is as follows:

Table I.5.6-3 Detail of expenditure (in billion AZM)

Total	Expense for electricity purchase	Materials	Repairing	O & M	Salary
320.1	272.9	13.1	17.0	8.3	8.8

(Source: BEN)

As already mentioned in Section 5.1, following the reorganization of BEN dated in May 1999, sales/collection section (ESCD), construction section (SCED), and transformer repair shop (TRS) were separated from BEN. Since then, an electricity purchaser from Azenerji has been replaced by ESE, which also covers the billing and collection. According to BEN, ESE currently pays for BEN's operation and maintenance expenses. Then, BEN pays for transformer repairing service to TRS. Billing and collection activity by ESE expects to be strengthened and improved under the direct initiative of the first deputy mayor of Baku City.

5.7 Existing Power Demand Forecast for Baku

Neither BEN nor ESE makes a long-term projection of power demand forecast in Baku. ESE, however, prepares a short-term projection of power demand in Baku every three months for the following three-month period. ESE makes this quarterly projection based on the latest weather information collected from the meteorological center and the latest tendency in electricity consumption in Baku. The projection results are reported to the Deputy Mayor of Baku City and Cabinet of Ministers. Usually the difference between the projected values and actual values is 15 % to 20%.

5.8 Environmental Aspect

(1) Environmental Issues in Azerbaijan

The following two documents were collected concerning the environmental aspect.

(a) Handbook for the Environmental Impact Assessment Process in Azerbaijan (State Committee on Ecology and Control of Natural Resources Utilization, or " ASCE " hereafter, 1996)

(b) National Environmental Action Plan (ASCE 1998)

According to the ASCE handbook, ASCE of the USSR prepared the" Guidelines on Procedures for the EIA Process while Developing Feasibility Studies of Projects of National Economy " in 1990 to be valid until 1992. Due to the collapse of the USSR, the government of Azerbaijan has never endorsed this guideline. The Government of Azerbaijan, however, has applied the principles in this guideline. The government is now undergoing a procedure of developing a new Environmental Assessment Process.

According to the ASCE's action plan, the following issues are regarded important in the environmental aspect in Azerbaijan.

(a) Severe pollution damage caused by industries, oil exploration and production and energy

(b) Threat of irreversible collapse of the sturgeon stock triggered by loss of reproductive capacity, pollution and over-fishing

(c) Deteriorating water quality, especially of drinking water, both in rural and urban areas, causing increase of water-borne diseases

(d) Loss of fertile agricultural land from erosion, salinization, pollution with heavy metals and chemicals, and deteriorating irrigation systems; loss of forestry cover, mainly in war-affected-area; and threats to protected areas leading to losses in biodiversity

(e) Damage to Caspian coastal zone caused by flooding from sea level rise and pollution

(f) Deterioration of the cultural heritage, due to natural causes, aggravated by modern environmental problems such as acid rain and uncontrolled development

Actions are proposed to be taken in the following directions to tackle these problems.

(a) Legislative improvements: revising the legal and regulatory framework for environmental management and ratification of priority conventions

(b) Streamlining the environmental management system to improve its ability to develop and implement environmental policy, to increase the efficiency of the authorities, to avoid overlap among agencies, and to separate environmental regulations and control of production activities

(c) Raising the status of the State Committee on Ecology and Control of Natural Resources Utilization to a Ministry of Environment

(d) Investment in enforcement capacity in monitoring and laboratory equipment and staff training, upgrading the pollution charges and strengthening the local authorities

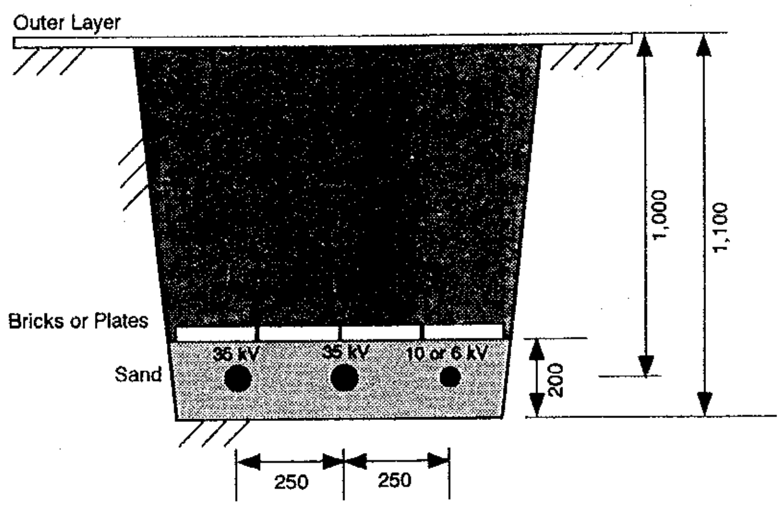
(2) Environmental issues concerning power distribution system

In general, serious damage is hardly caused by the operation or development of power distribution system. The following two problems, however, sometimes occur.

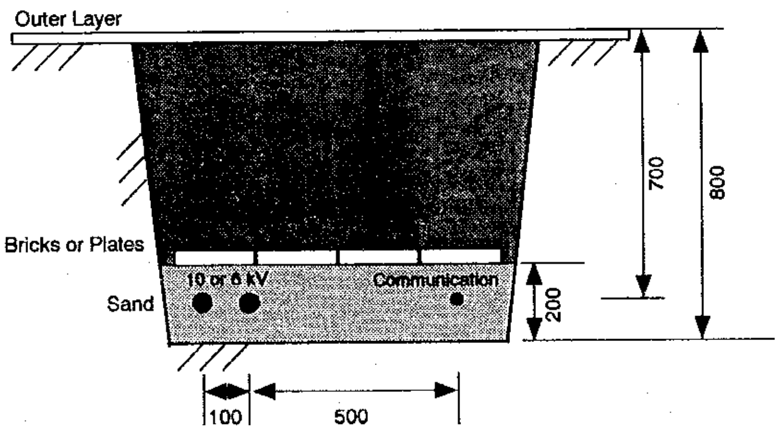
(a) Soil and water contamination due to leakage of oil from transformers

(b) Noise problem by switching equipment

The power distribution facilities in Baku are mostly installed indoors in the concrete substation buildings except some cubicle-type transformers. In the event that oil leaks from the transformers, it is discharged into ducts and does not leak out of the building. Almost no complaint to BEN has been reported concerning noise of transformers. The noise produced by transformers is mostly contained in the concrete buildings. The Study Team considers there will be almost no environmental problems occurring as a result of the rehabilitation and expansion of the power distribution system to be proposed.

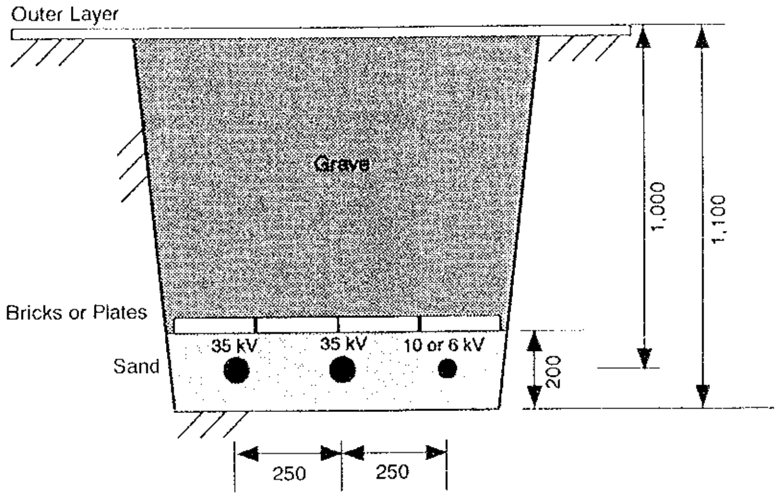


(a) Medium Voltage Cable with High Voltage Cables

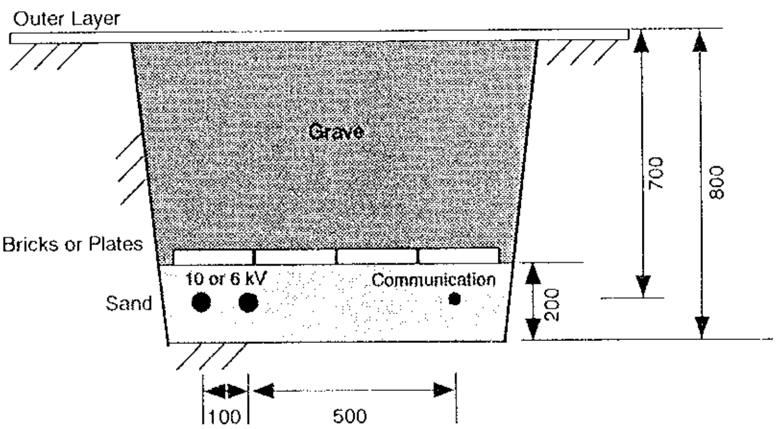


(b) Medium Voltage Cables with Communication Cable

Master Plan Study on Rehabilitation and Reconstruction of Electric Supply in Baku Изучение Генерального Плана Восстановления И Реконструкции Электроснабжения Города Баку		Figure / Схема 1.5.2-1 Title / Название Рисунка Standard of Cable Installation
Baku Electric Network ПО "БАКЭЛЕКТРОСЕТЬ"	Japan International Cooperation Agency Японское Агентство Международного Сотрудничества	
Joint Venture Nippon Koei Co., Ltd. & KRI International Corp. Совместное предприятие НИППОН КОЕИ и KRI Интернешнл Корп.		

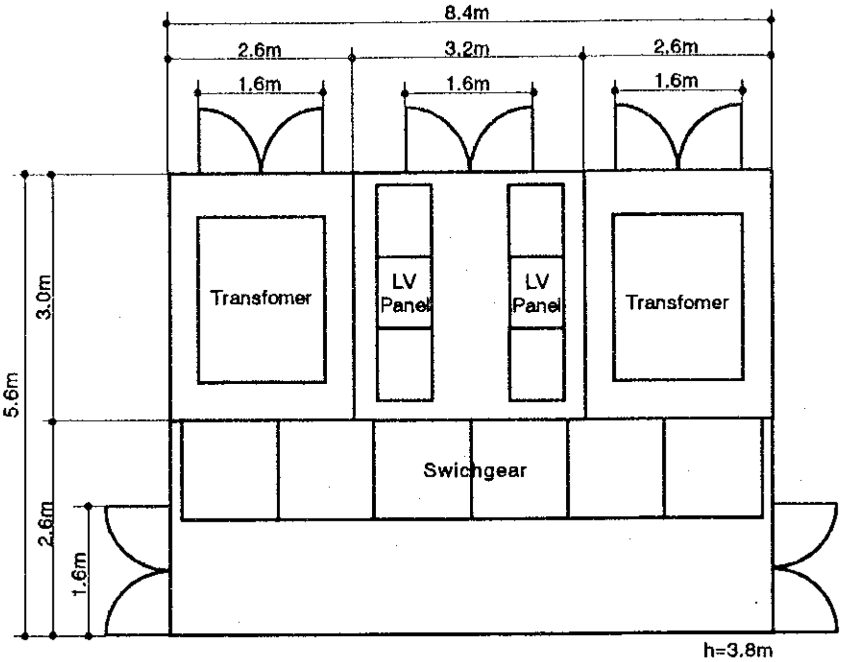


(a) Medium Voltage Cable with High Voltage Cables

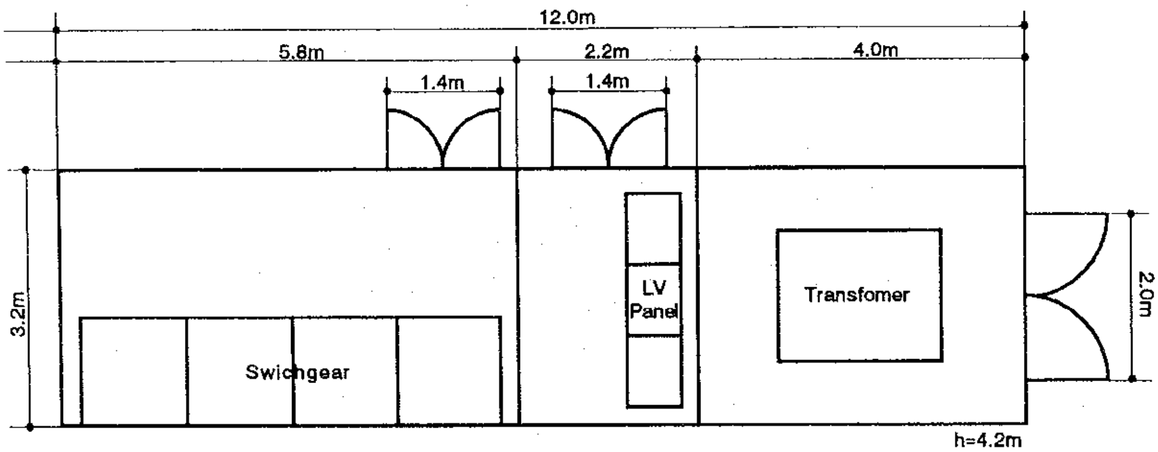


(b) Medium Voltage Cables with Communication Cable

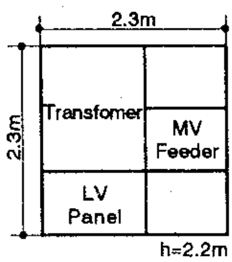
Master Plan Study on Rehabilitation and Reconstruction of Electric Supply in Baku Изучение Генерального Плана Восстановления И Реконструкции Электроснабжения Города Баку		Figure / Схема I.5.2-1 Title / Название Рисунка
Baku Electric Network ПО "БАКЭЛЕКТРОСЕТЬ"	Japan International Cooperation Agency Японское Агентство Международного Сотрудничества	Standard of Cable Installation
Joint Venture Nippon Koei Co., Ltd. & KRI International Corp. Совместное предприятие НИППОН КОЕИ и KRI Интернешнл Корп.		



Ground mounted Type
(Tr No.623)

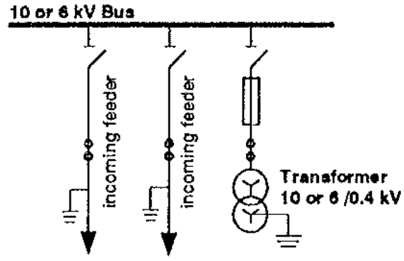


In-building Type
(Tr No.71)

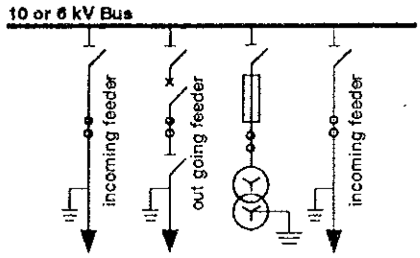


Cubicle Type
(Tr No.328)

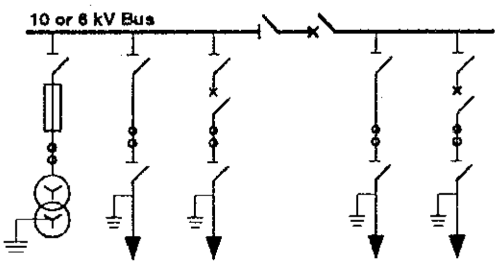
Master Plan Study on Rehabilitation and Reconstruction of Electric Supply in Baku Изучение Генерального Плана Восстановления И Реконструкции Электроснабжения Города Баку	Figure / Схема I.5.2-2
Baku Electric Network ПО "БАКЭЛЕКТРОСЕТЬ" / Japan International Cooperation Agency Японское Агентство Международного Сотрудничества	Title / Название Рисунка
Joint Venture Nippon Koei Co., Ltd. & KRI International Corp. Совместное предприятие НИППОН КОЕИ и KRI Интернешнл Корп.	Typical Layout Drawings of Transformer Station



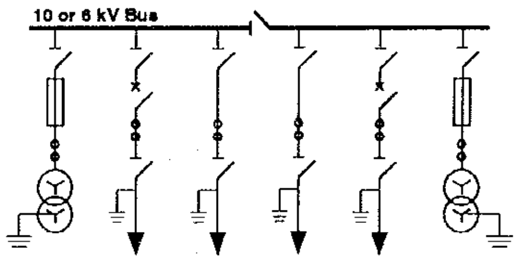
1. One transformer, 3 chambers



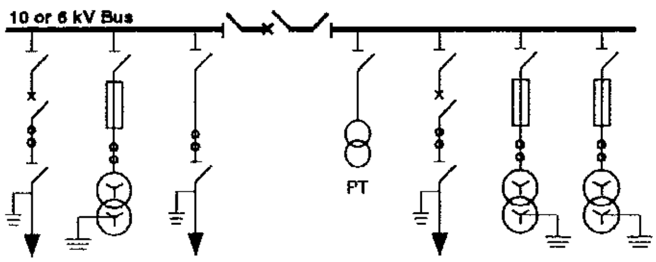
2. One transformer, 4 chambers



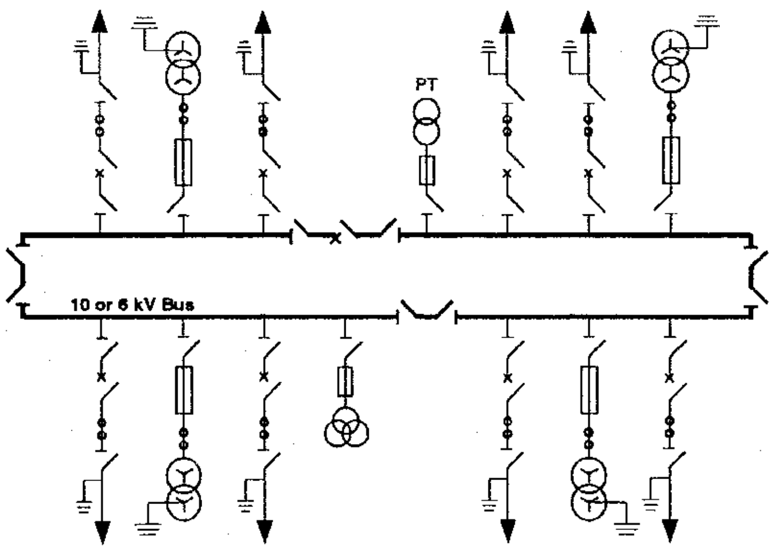
3. One transformer, 6 chambers



4. Two transformers, 6 chambers



5. Three transformers, 8 chambers



6. Four transformers, 16 chambers

Master Plan Study on Rehabilitation and Reconstruction of Electric Supply in Baku Изучение Генерального Плана Восстановления И Реконструкции Электроснабжения Города Баку		Figure / Схема I.5.2-3 Title / Название Рисунка Single Line Diagrams of Typical Transformer Station
Baku Electric Network ПО "БАКЭЛЕКТРОСЕТЬ"	Japan International Cooperation Agency Японское Агентство Международного Сотрудничества	
Joint Venture Nippon Koei Co., Ltd. & KRI International Corp. Совместное предприятие НИППОН КОЕИ и KRI Интернешнл Корп.		

Appendix I.5.2-1 Specification of existing undergroud cables

Code	Voltage	Cross Section	Insulation		Outer Diameter	Curr.Cap.	Resistance	Weight	Max. Temp.
			Material	Thickness					
	(kV)	(mm^2)		(mm)	(mm)	(A)	(ohm/km)	(kg/km)	(°C)
АА б$_{лу}$	Aluminum Conductors Paper Insulated Aluminum Sheathed Steel Tape Armoured Cable								
	6	3 x 240	Oil Paper	2.0	56.2	390	0.129	5,256	65
	6	3 x 185		2.0	52.2	340	0.167	4,424	65
	6	3 x 150		2.0	49.1	300	0.206	3,922	65
	6	3 x 120		2.0	46.4	260	0.258	3,461	65
	6	3 x 95		2.0	43.9	225	0.326	3,082	65
	6	3 x 70		2.0	41.2	190	0.443	2,675	65
	6	3 x 50		2.0	38.9	155	0.620	2,351	65
	6	3 x 35		2.0	36.4	125	0.890	2,036	65
АА б$_{2лу}$	Aluminum Conductors Paper Insulated Aluminum Sheathed Steel Double Tape Armoured Cable								
	6	3 x 240	Oil Paper	2.0	56.2	390	0.129	5,308	65
	6	3 x 185		2.0	52.2	340	0.167	4,531	65
	6	3 x 150		2.0	49.1	300	0.206	3,966	65
	6	3 x 120		2.0	46.4	260	0.258	3,503	65
	6	3 x 95		2.0	43.9	225	0.326	3,121	65
	6	3 x 70		2.0	41.2	190	0.443	2,710	65
	6	3 x 50		2.0	38.9	155	0.620	2,385	65
	6	3 x 35		2.0	36.4	125	0.890	2,066	65
АА б$_{у}$	Aluminum Conductors Paper Insulated Lead Sheathed Steel Tape Armoured Cable								
	6	3 x 240	Oil Paper	2.0	54.7	390	0.129	4,131	65
	6	3 x 185		2.0	50.7	340	0.167	6,073	65
	6	3 x 150		2.0	48.2	300	0.206	5,507	65
	6	3 x 120		2.0	45.3	260	0.258	4,785	65
	6	3 x 95		2.0	42.5	225	0.326	4,181	65
	6	3 x 70		2.0	40.0	190	0.443	3,702	65
	6	3 x 50		2.0	37.8	155	0.620	3,290	65
	6	3 x 35		2.0	35.2	125	0.890	2,773	65
АА б$_{лу}$	Aluminum Conductors Paper Insulated Aluminum Sheathed Steel Tape Armoured Cable								
	10	3 x 240	Oil Paper	2.75	60.0	390	0.129	5,780	70
	10	3 x 185		2.75	56.2	340	0.167	5,026	70
	10	3 x 150		2.75	53.2	300	0.206	4,458	70
	10	3 x 120		2.75	50.3	260	0.258	3,930	70
	10	3 x 95		2.75	47.9	225	0.326	3,526	70
	10	3 x 70		2.75	45.0	190	0.443	3,070	70
	10	3 x 50		2.75	42.7	155	0.620	2,729	70
	10	3 x 35		2.75	10.4	125	0.890	2,429	70
АА б$_{2лу}$	Aluminum Conductors Paper Insulated Aluminum Sheathed Steel Double Tape Armoured Cable								
	10	3 x 240	Oil Paper	2.75	60.0	355	0.129	5,836	70
	10	3 x 185		2.75	56.2	310	0.167	5,076	70
	10	3 x 150		2.75	53.2	275	0.206	4,506	70
	10	3 x 120		2.75	50.3	240	0.258	3,976	70
	10	3 x 95		2.75	47.9	205	0.326	3,567	70
	10	3 x 70		2.75	45.0	165	0.443	3,110	70
	10	3 x 50		2.75	42.7	140	0.620	2,766	70
	10	3 x 35		2.75	40.4	115	0.890	2,464	70
АА б$_{у}$	Aluminum Conductors Paper Insulated Lead Sheathed Steel Tape Armoured Cable								
	10	3 x 240	Oil Paper	2.75	58.5	355	0.129	7,817	70
	10	3 x 185		2.75	54.7	310	0.167	6,889	70
	10	3 x 150		2.75	52.0	275	0.206	6,127	70
	10	3 x 120		2.75	49.3	240	0.258	5,545	70
	10	3 x 95		2.75	47.0	205	0.326	5,061	70
	10	3 x 70		2.75	44.1	165	0.443	4,365	70
	10	3 x 50		2.75	41.6	140	0.620	3,817	70
	10	3 x 35		2.75	39.3	115	0.890	3,438	70

Appendix I.5.2-2 Summary of distribution facilities managed by BEN

item	unit	Network Area																					Total
		Central Network												Suburb Network									
		I	II	III	IV	V	VI	VII	IX	XIV	Garadag	Yasamal	Baladjari	VIII	X	XI	XII	XIII	XV	Khatai	Govsani	
Overhead line																							
10.0 kV	km	4.20	-	1.21	0.25	-	-	2.43	10.71	5.30	-	1.68	-	2.84	36.00	99.00	9.00	7.18	0.48	-	-	180
6.0 kV	km	2.08	2.40	-	-	-	1.40	10.55	4.75	12.10	33.00	-	12.80	-	118.00	270.00	43.00	1.20	19.00	7.40	14.76	552
0.4 kV	km	21.30	15.50	35.00	28.80	17.10	56.90	85.00	40.27	38.00	77.00	11.00	56.00	38.50	272.00	708.80	112.00	9.00	49.00	30.00	30.00	1,731
Underground line																							
10.0 kV	km	6.00	33.00	16.56	8.99	16.50	15.77	27.10	70.20	23.00	2.10	38.13	-	82.27	3.70	61.00	42.30	134.23	29.74	-	-	611
6.0 kV	km	23.50	39.50	23.87	32.93	67.00	91.15	56.70	8.46	43.63	19.00	30.17	204.00	-	76.00	44.60	24.20	1.00	12.80	17.30	21.68	837
0.4 kV	km	18.00	32.00	22.00	26.60	38.00	49.33	75.40	48.30	38.78	26.60	31.40	33.00	96.50	4.50	43.00	56.40	8.50	19.80	12.50	19.58	700
Transformer station																							
	Nos.	40	85	75	90	105	116	137	147	87	61	59	50	107	220	424	155	124	111	43	42	2,278
Transformer																							
	Nos.	60	130	110	133	160	178	204	249	130	80	103	53	180	227	490	205	234	147	44	49	3,166
Transformer Capacity																							
	KVA	26,750	57,150	51,430	57,165	71,000	94,303	90,971	125,972	64,547	30,810	55,630	24,980	86,820	66,168	138,312	72,890	131,722	71,183	19,700	21,330	1,358,833

Appendix I.5.2-3 Summary of distribution facilities in the sturdy area managed by BEN

Facilities		unit	Network Area												Total
			I	II	III	IV	V	VI	VII	VIII	IX	XIII	Yasamal	Khatai	
Overhead line															
	10.0 kV	km	4.20	-	1.21	0.25	-	-	2.43	2.84	10.71	7.18	1.68	-	30.50
	6.0 kV	km	2.08	2.40	-	-	-	1.40	10.55	-	4.75	1.20	-	7.40	29.78
	0.4 kV	km	21.30	15.50	35.00	28.80	17.10	56.90	85.00	38.50	40.27	9.00	11.00	30.00	388.37
Underground line															
	10.0 kV	km	6.00	33.00	16.56	8.99	16.50	15.77	27.10	82.27	70.20	134.23	38.13	-	448.75
	6.0 kV	km	23.50	39.50	23.87	32.93	67.00	91.15	56.70	-	8.46	1.00	30.17	17.30	391.58
	0.4 kV	km	18.00	32.00	22.00	26.60	38.00	49.33	75.40	96.50	48.30	8.50	31.40	12.50	458.53
Transformer station		Nos.	40	85	75	90	105	116	137	107	147	124	59	43	1,128
Transformer		Nos.	60	130	110	133	160	178	204	180	249	234	103	44	1,785
Transformer Capacity		KVA	26,750	57,150	51,430	57,165	71,000	94,303	90,971	86,820	125,972	131,722	55,630	19,700	868,613

Appendix I.5.2-4 Load current value of secondary side of transformer circuit (in winter 1999/2000)

Tr. S. No.	Tr. No.	Tr. Capacity (kVA)	Measured Current Ia (A)	Ib (A)	Ic (A)	Mean Current (A)	Unbalance Factor (*1)	Calculated Load (kVA)	Peak Load (*2) (kVA)	Capacity Factor of Tr.	Observation Date	Time
3	1	1000	1,108	898	905	970	22%	672	770	77%	Dec.10 99	12:00
13	1	400	435	273	297	335	48%	232	272	68%	Dec.10 99	x
14	1	630	340	516	432	429	41%	297	341	54%	Dec.10 99	12:00
14	2	400	400	430	342	391	23%	271	310	78%	Dec.10 99	12:00
17	2	400	170	160	286	205	61%	142	164	41%	Dec.10 99	15:30
17	1	630	381	427	361	390	17%	270	312	49%	Dec.10 99	15:30
18	1	630	283	632	509	475	74%	329	379	60%	Dec.10 99	15:00
18	2	630	700	1,100	1,020	940	43%	651	751	119%	Dec.10 99	15:00
20	1	630	290	331	292	304	13%	211	230	36%	Dec.10 99	16:00
24	1	630	431	400	369	400	16%	277	323	51%	Nov.24 99	13:00
25	2	630	711	658	660	676	8%	469	549	87%	Nov.24 99	11:50
25	1	630	767	713	676	719	13%	498	583	93%	Nov.24 99	11:50
30	1	630	500	483	555	513	14%	355	407	65%	Nov.25 99	12:55
34	1	630	338	330	364	344	10%	238	273	43%	Nov.24 99	12:10
34	2	630	511	528	515	518	3%	359	411	65%	Nov.24 99	12:10
36	1	630	560	765	620	648	32%	449	515	82%	Jan. 26 00	12:00
43	1	630	1,121	1,111	1,115	1,116	1%	773	906	144%	Jan. 19 00	11:30
45	1	630	997	943	940	960	6%	665	779	124%	Jan. 19 00	11:45
46	1	630	572	426	438	479	31%	332	380	60%	Nov.24 99	12:30
46	2	400	376	403	356	378	12%	262	300	75%	Nov.24 99	12:30
55	1	630	765	834	650	750	25%	519	595	94%	Jan. 19 00	12:00
55	2	630	1,212	1,241	1,039	1,164	17%	806	924	147%	Jan. 19 00	12:00
68	1	630	446	531	415	464	25%	321	413	66%	Dec. 28 99	10:30
68	2	630	600	663	600	621	10%	430	552	88%	Dec. 28 99	10:30
70	2	400	533	644	572	583	19%	404	519	130%	Dec. 23 99	10:00
70	1	630	1,066	1,048	868	994	20%	689	884	140%	Dec. 23 99	10:50
76	1	320	780	472	763	672	46%	465	533	167%	Jan. 24 00	12:30
79	1	630	645	400	605	550	45%	381	444	71%	Jan. 24 00	13:00
81	2	320	414	530	356	433	40%	300	344	108%	Jan. 19 00	12:30
81	1	400	743	540	507	597	40%	413	474	118%	Jan. 19 00	12:30
82	2	400	340	700	600	547	66%	379	444	111%	Jan. 27 00	11:30
82	1	400	525	570	575	557	9%	386	452	113%	Jan. 27 00	11:30
85	1	630	595	608	598	600	2%	416	487	77%	Nov.25 99	11:35
87	1	400	712	784	711	736	10%	510	597	149%	Dec. 28 99	11:00
89	1	630	252	260	175	229	37%	159	186	30%	Dec. 28 99	11:30
89	2	630	540	614	553	569	13%	394	462	73%	Dec. 28 99	11:30
133	1	630	440	600	440	493	32%	342	394	63%	Feb. 02 00	15:00
134	1	630	703	640	654	666	9%	461	528	84%	Nov.25 99	12:22
154	1	630	1,142	1,035	854	1,010	29%	700	802	127%	Jan. 27 00	12:00
156	1	630	410	436	408	418	7%	290	332	53%	Jan. 24 00	12:00
158	1	630	716	632	572	640	23%	443	517	82%	Jan. 26 00	13:00
165	1	400	680	640	800	707	23%	490	561	140%	Feb. 02 00	12:30
165	1	400	781	846	839	822	8%	569	731	183%	Dec.23 99	10:50
180	1	400	175	195	166	179	16%	124	142	35%	Jan. 26 00	12:45
182	1	320	238	154	136	176	58%	122	143	45%	Dec. 17 99	11:00
183	1	630	727	740	582	683	23%	473	554	88%	Dec. 17 99	11:50
188	1	630	33	33	35	34	6%	23	27	4%	Dec. 17 99	12:00
212	1	320	135	200	129	155	46%	107	138	43%	Dec. 17 99	10:30
224	2	400	405	274	170	283	83%	196	214	53%	Nov. 23 99	16:30
224	1	400	550	685	500	578	32%	401	437	109%	Nov. 23 99	16:30
225	1	400	643	365	633	547	51%	379	444	111%	Jan. 24 00	11:00
228	1	630	215	170	250	212	38%	147	168	27%	Jan. 24 00	12:00

Appendix I.5.2-4 Load current value of secondary side of transformer circuit (in winter 1999/2000)

Tr. S. No.	Tr. No.	Tr. Capacity (kVA)	Measured Current Ia (A)	Ib (A)	Ic (A)	Mean Current (A)	Unbalance Factor (*1)	Calculated Load (kVA)	Peak Load (*2) (kVA)	Capacity Factor of Tr.	Observation Date	Time
228	1	630	305	197	315	272	43%	189	189	30%	Jan. 12 00	18:00
228	2	400	180	160	210	183	27%	127	127	32%	Jan. 12 00	18:00
228	2	630	860	780	1,100	913	35%	633	725	115%	Jan. 24 00	12:00
231	1	630	468	334	299	367	46%	254	298	47%	Dec. 28 99	11:25
231	2	630	600	573	578	584	5%	404	474	75%	Dec. 28 99	11:25
271	1	630	483	458	608	516	29%	358	419	67%	Jan. 24 00	11:45
303	1	630	660	825	608	698	31%	483	527	84%	Dec.10 99	16:00
304	2	630	263	282	344	296	27%	205	224	36%	Dec.10 99	16:00
304	1	630	398	372	391	387	7%	268	292	46%	Dec.10 99	16:00
334	1	630	505	650	525	560	26%	388	445	71%	Jan. 26 00	12:30
357	2	630	492	510	484	495	5%	343	396	63%	Dec. 17 99	x
357	1	630	695	613	811	706	28%	489	573	91%	Dec. 17 99	x
363	1	630	314	241	380	312	45%	216	247	39%	Dec. 07 99	12:00
363	1	630	665	809	828	767	21%	532	683	108%	Dec. 28 99	10:30
366	1	630	562	450	551	521	21%	361	463	74%	Dec. 26 99	10:50
366	2	400	337	598	279	405	79%	280	327	82%	Dec. 23 99	x
366	2	400	372	483	507	454	30%	315	404	101%	Dec. 26 99	10:50
366	1	630	860	747	679	762	24%	528	678	108%	Dec. 23 99	x
367	2	630	792	873	892	852	12%	591	689	109%	Feb. 02 00	13:00
367	1	630	1,032	828	1,076	979	25%	678	791	125%	Feb. 02 00	13:00
390	2	400	398	402	340	380	16%	263	338	85%	Dec. 28 99	10:45
390	1	320	393	466	478	446	19%	309	396	124%	Dec. 28 99	10:45
392	1	630	800	1,000	800	867	23%	600	703	112%	Feb. 02 00	11:00
451	1	315	120	160	160	147	27%	102	116	37%	Feb. 02 00	12:40
451	2	400	280	300	340	307	20%	212	243	61%	Feb. 02 00	12:40
472	1	630	650	567	642	620	13%	429	501	79%	Nov.25 99	13:20
498	2	400	118	103	215	145	77%	101	115	29%	Nov.25 99	12:10
498	1	400	332	270	387	330	35%	228	262	65%	Nov.25 99	12:10
500	1	400	520	580	660	587	24%	406	476	119%	Jan. 27 00	11:45
500	2	630	1,100	990	970	1,020	13%	707	828	131%	Jan. 27 00	11:45
515	1	630	414	345	316	358	27%	248	319	51%	Dec. 28 99	10:30
551	1	400	27	66	78	57	89%	39	51	13%	Jan. 17 00	10:30
551	2	630	459	447	447	451	3%	312	401	64%	Jan. 17 00	10:30
620	2	630	530	490	570	530	15%	367	430	68%	Feb. 09 00	11:00
620	1	400	345	470	380	398	31%	276	323	81%	Feb. 09 00	11:00
623	1	630	547	406	543	499	28%	345	399	63%	Jan. 24 00	x
623	2	630	674	544	543	587	22%	407	476	76%	Jan. 24 00	x
637	2	630	736	714	736	729	3%	505	648	103%	Dec. 22 99	10:45
637	1	630	922	899	807	876	13%	607	779	124%	Dec. 22 99	10:45
668	1	320	95	121	148	121	44%	84	108	34%	Dec. 17 99	10:45
701	2	400	460	428	532	473	22%	328	376	94%	Feb. 02 00	12:00
701	1	400	640	800	800	747	21%	517	593	148%	Feb. 02 00	12:00
702	1	630	131	129	130	130	2%	90	116	18%	Dec. 17 99	x
702	2	630	380	382	326	363	15%	251	294	47%	Dec. 17 99	x
708	1	400	323	375	427	375	28%	260	334	83%	Dec. 17 99	10:45
780	1	250	230	228	237	232	4%	161	175	70%	Feb. 09 00	16:00
815	1	320	535	680	470	562	37%	389	456	142%	Jan. 24 00	11:30

Source : BEN's observation records

Remarks :

*1 Unbalance load factor is calculated with a formula, (Max(Ia:Ic)-Min(Ia:Ic))/((Ia+Ib+Ic)/3).

*2 Peak load of transformer is estimated with measured load and daily load curve.

Appendix I.5.2-5 Overloaded Transformers (in winter 1999/2000)

Tr. S. No.	Tr. No.	Tr. Capacity (kVA)	Measured Current			Mean Current (A)	Unba-lance Factor (*1)	Calcu-lated Load (kVA)	Peak Load (*2) (kVA)	Capacity Factor of Tr.	Observation	
			Ia (A)	Ib (A)	Ic (A)						Date	Time
366	2	400	372	483	507	454	30%	315	404	101%	Dec. 26 99	10:50
637	2	630	736	714	736	729	3%	505	648	103%	Dec. 22 99	10:45
81	2	320	414	530	356	433	40%	300	344	108%	Jan. 19 00	12:30
366	1	630	860	747	679	762	24%	528	678	108%	Dec. 23 99	x
363	1	630	665	809	828	767	21%	532	683	108%	Dec. 28 99	10:30
224	1	400	550	685	500	578	32%	401	437	109%	Nov. 23 99	16:30
367	2	630	792	873	892	852	12%	591	689	109%	Feb. 02 00	13:00
82	2	400	340	700	600	547	66%	379	444	111%	Jan. 27 00	11:30
225	1	400	643	365	633	547	51%	379	444	111%	Jan. 24 00	11:00
392	1	630	800	1,000	800	867	23%	600	703	112%	Feb. 02 00	11:00
82	1	400	525	570	575	557	9%	386	452	113%	Jan. 27 00	11:30
228	2	630	860	780	1,100	913	35%	633	725	115%	Jan. 24 00	12:00
81	1	400	743	540	507	597	40%	413	474	118%	Jan. 19 00	12:30
500	1	400	520	580	660	587	24%	406	476	119%	Jan. 27 00	11:45
18	2	630	700	1,100	1,020	940	43%	651	751	119%	Dec.10 99	15:00
45	1	630	997	943	940	960	6%	665	779	124%	Jan. 19 00	11:45
637	1	630	922	899	807	876	13%	607	779	124%	Dec. 22 99	10:45
390	1	320	393	466	478	446	19%	309	396	124%	Dec. 28 99	10:45
367	1	630	1,032	828	1,076	979	25%	678	791	125%	Feb. 02 00	13:00
154	1	630	1,142	1,035	854	1,010	29%	700	802	127%	Jan. 27 00	12:00
70	2	400	533	644	572	583	19%	404	519	130%	Dec. 23 99	10:00
500	2	630	1,100	990	970	1,020	13%	707	828	131%	Jan. 27 00	11:45
165	1	400	680	640	800	707	23%	490	561	140%	Feb. 02 00	12:30
70	1	630	1,066	1,048	868	994	20%	689	884	140%	Dec. 23 99	10:50
815	1	320	535	680	470	562	37%	389	456	142%	Jan. 24 00	11:30
43	1	630	1,121	1,111	1,115	1,116	1%	773	906	144%	Jan. 19 00	11:30
55	2	630	1,212	1,241	1,039	1,164	17%	806	924	147%	Jan. 19 00	12:00
701	1	400	640	800	800	747	21%	517	593	148%	Feb. 02 00	12:00
87	1	400	712	784	711	736	10%	510	597	149%	Dec. 28 99	11:00
76	1	320	780	472	763	672	46%	465	533	167%	Jan. 24 00	12:30
165	1	400	781	846	839	822	8%	569	731	183%	Dec.23 99	10:50

Appendix I.5.2-6 Unbalance factor in low voltage circuit (at No.55 transformer station in September 1999)

Trans-former No.	Feeder No.	Measured Current Ia (A)	Ib (A)	Ic (A)	Mean Current (A)	Unbalance Factor	Remarks
No.1	1	57.2	86.0	92.9	78.7	45%	Voltage
(630kVA)	2	3.0	16.2	14.2	11.1	119%	Va : 392V
	3	33.6	0.0	14.8	16.1	208%	Vb : 388V
	4	0.0	10.2	6.1	5.4	188%	Vc : 393V
	5	50.6	68.2	115.0	77.9	83%	
	6	0.0	1.3	0.0	0.4	300%	
	7	11.4	6.9	61.2	26.5	205%	
	8	21.5	59.5	44.3	41.8	91%	
	9	15.5	23.2	23.7	20.8	39%	
	Total	192.8	271.5	372.2	278.8	64%	
Measured on Jan. 19, 2000		765.0	834.0	650.0	749.7	25%	
No.2	1	0.1	0.1	90.1	30.1	299%	Voltage
(630kVA)	2	24.3	23.5	37.7	28.5	50%	Va : 435V
	3	16.2	55.4	20.3	30.6	128%	Vb : 426V
	4	2.3	8.7	1.0	4.0	193%	Vc : 426V
	5	52.1	16.4	33.2	33.9	105%	
	6	40.8	39.4	27.6	35.9	37%	
	7	0.0	0.0	23.1	7.7	300%	
	8	86.3	125.0	167.0	126.1	64%	
	9	75.6	71.6	88.5	78.6	22%	
	10	23.4	16.4	32.3	24.0	66%	
	11	95.9	61.4	68.6	75.3	46%	
	12	6.1	0.0	15.4	7.2	215%	
	13	55.9	31.9	45.2	44.3	54%	
	Total	479.0	449.8	650.0	526.3	38%	
Measured on Jan. 19, 2000		1212.0	1241.0	1039.0	1164.0	17%	

Appendix I.5.3-1 Amount of electricity purchase by BEN by district between 1993 and 1999

No.	Area	1993			1994			1995			1996			1997			1998			1999			Growth Rate	
		Purchased (MWh)	Sold (MWh)	Loss (%)	Purchased (MWh)	Sold (MWh)	Loss (%)	Purchased (MWh)	Sold (MWh)	Loss (%)	Purchased (MWh)	Sold (MWh)	Loss (%)	Purchased (MWh)	Sold (MWh)	Loss (%)	Purchased (MWh)	Sold (MWh)	Loss (%)	Purchased (MWh)	Sold (MWh)	Loss (%)	Purch. (%)	Sold (%)
	Inspection		322,080			263,098			187,243			173,619			177,321			174,720			153,400			-11.51
1	Sabail		174,034			193,579			210,275			232,499			263,888			250,278			212,200			7.54
2	Yasamal		129,586			171,179			179,138			219,644			252,906			278,192			249,600			16.51
3	Nasimi 1)	-	-		-	-		-	-			-			-			151,510			250,700			
4	Narimanov		153,534			188,000			183,720			250,294			283,957			271,265			234,200			12.06
5	Binagady		148,799			140,464			145,819			196,756			232,324			298,158			332,800			14.91
	Total of City	1,248,059	928,033	25.6	1,255,293	956,320	23.8	1,213,926	906,195	25.4	1,389,166	1,072,812	22.8	1,514,993	1,210,396	20.1	1,680,099	1,424,123	15.2	1,773,300	1,432,900	19.2	6.13	8.94
6	Nizami 2)	134,761	111,446	17.3	146,826	134,975	8.1	143,657	130,937	8.9	161,535	143,430	11.2	191,005	164,753	13.7	210,877	186,118	11.7	213,400	195,500	8.4	9.37	10.80
7	Khatai	218,455	179,336	17.9	223,699	193,919	13.3	221,873	184,408	16.9	245,642	213,330	13.2	261,789	225,807	13.7	311,480	270,193	13.3	356,100	308,000	13.5	7.35	8.54
8	Sabunchi	264,503	160,356	39.4	292,825	167,741	42.7	285,200	167,436	41.3	338,317	193,612	42.8	391,503	217,399	44.5	455,619	323,797	28.9	508,500	431,300	15.2	11.49	15.09
9	Surakhany	122,179	93,392	23.6	137,701	114,923	16.5	139,399	114,875	17.6	137,107	120,425	12.2	158,734	134,898	15.0	192,557	168,821	12.3	220,000	188,500	14.3	9.52	12.57
10	Garadagh	51,940	41,766	19.6	52,054	47,321	9.1	49,856	44,322	11.1	56,104	50,059	10.8	68,686	61,085	11.1	84,497	75,088	11.1	97,000	83,900	13.5	10.22	12.45
11	Azizbayov	219,702	123,074	44.0	236,669	179,486	24.2	243,592	156,790	35.6	317,847	214,556	32.5	361,504	270,591	25.1	431,280	354,358	17.8	448,700	361,600	19.4	14.44	23.55
	Total	2,259,599	1,637,403	27.5	2,345,067	1,794,685	23.5	2,297,503	1,704,963	25.8	2,645,718	2,008,224	24.1	2,948,214	2,284,929	22.5	3,366,409	2,802,498	16.8	3,617,000	3,001,700	17.0	8.30	11.35
	Settlement (Undermentioned values are included in the above table)																1,163,953	922,064	21	1,274,200	1,065,300	16		
1	Mashtaga (Sabunchi)	107,020	44,174	58.7	130,217	42,377	67.5	126,801	39,558	68.8	155,336	42,838	72.4	188,138	47,094	75.0	227,045	122,314	46.1	247,300	201,800	18.4	16.23	22.59
2	Khatai																20,288	17,247	15.0	62,000	52,900	14.7	-	-
3	Balajary (Binagadi)																31,421	26,450	15.8	93,100	77,400	16.9	-	-

Note: 1) Records of Nasimi are available since Jan. 1998. Before that time, this area managed by Yasamal, Sailyil and Narimanov branch offices.

2) Nizami district had been under the management of JV Bakenergo since October 1999. The values in 1999 include 57.5 MWh purcahed by JV Bakenergo from ESE and sold to consumers.

Appendix I.5.3-2 Monthly electricity purchase by BEN

(Unit : GWh except ratio)

Month	1995	1996	1997	1998	1999	2000	Average growth rate between 1995-99 (%/year)
January	272.8	296.2	343.2	401.0	424.0	478.1	11.7
February	239.2	284.8	332.1	386.1	381.2	424.4	12.4
March	234.5	291.7	331.8	364.9	389.3	433.3	13.5
April	184.2	247.6	240.7	252.0	288.8	270.4	11.9
May	144.0	165.6	184.7	205.0	242.0	-	13.9
June	137.9	151.6	169.5	201.4	204.1	-	10.3
July	151.3	169.5	181.1	212.9	221.3	-	10.0
August	145.1	171.8	180.4	219.3	235.9	-	12.9
September	145.7	162.0	178.1	201.7	211.3	-	9.7
October	162.5	184.0	194.0	231.1	242.7	-	10.5
November	200.0	231.3	267.5	291.0	343.9	-	14.5
December	279.5	286.9	344.7	402.8	432.5	-	11.5
Total	2,296.7	2,643.0	2,947.8	3,369.2	3,617.0	-	12.0
Highest / lowest ratio	2.03	1.95	2.03	2.00	2.12	-	-
Highest - lowest difference	141.60	144.60	175.20	201.40	228.40	-	-
Monthly average of winter/summer period							
April-October	152.96	178.87	189.79	217.63	235.16	-	-
January-March/November-December	245.20	278.18	323.86	369.16	394.18	-	-
Winter/summer	1.60	1.56	1.71	1.70	1.68	-	-

Source : Energy Sales Enterprise

Appendix I.5.3-3 Amount of electricity sold by BEN by type of customer

(Unit : GWh)

Category	1994	1995	1996	1997	1998	1999
(Amount)						
Power purchased	2,345.0	2,297.5	2,647.5	2,948.2	3,366.4	3,617.0
Power sold	1,794.7	1,704.9	2,008.2	2,284.9	2,802.5	3,001.7
Industry	218.9	180.3	158.1	156.0	157.3	128.0
Non-industry	459.0	345.6	303.5	271.1	285.9	125.7
Agriculture	30.7	19.5	14.2	12.6	11.4	5.0
Transportation	50.3	23.0	17.9	14.0	7.6	6.1
Commerce	31.8	35.0	50.7	71.1	85.0	80.6
Household	1,004.0	1,101.5	1,463.8	1,760.1	2,247.8	2,408.3
Absheron Regional Water Company	-	-	-	-	7.5	17.7
Budget organizations	-	-	-	-	-	172.7
Railroad	-	-	-	-	-	0.1
JV Bakenergo	-	-	-	-	-	57.5
Loss						
in GWh	550.3	592.6	639.3	663.3	563.9	615.3
in %	23.5	25.8	24.1	22.5	16.8	17.0
(Composition in %)						
Power sold	100.0%	100.0%	100.0%	100.0%	100.0%	92.3%
Industry	12.2%	10.6%	7.9%	6.8%	5.6%	4.3%
Non-industry	25.6%	20.3%	15.1%	11.9%	10.2%	4.2%
Agriculture	1.7%	1.1%	0.7%	0.6%	0.4%	0.2%
Transportation	2.8%	1.3%	0.9%	0.6%	0.3%	0.2%
Commerce	1.8%	2.1%	2.5%	3.1%	3.0%	2.7%
Household	55.9%	64.6%	72.9%	77.0%	80.2%	80.2%
Absheron Regional Water Company	-	-	-	-	0.3%	0.6%
(Growth rate in %/year)	(94-95)	(95-96)	(96-97)	(97-98)	(98-99)	(94-99)
Power purchased	(2.0)	15.2	11.4	14.2	7.4	9.1
Power sold	(5.0)	17.8	13.8	22.7	7.1	10.8
Industry	(17.6)	(12.3)	(1.3)	0.8	(18.6)	(10.2)
Non-industry	(24.7)	(12.2)	(10.7)	5.5	(56.0)	(22.8)
Agriculture	(36.5)	(27.2)	(11.3)	(9.5)	(56.1)	(30.4)
Transportation	(54.3)	(22.2)	(21.8)	(45.7)	(19.7)	(34.4)
Commerce	10.1	44.9	40.2	19.5	(5.2)	20.4
Household	9.7	32.9	20.2	27.7	7.1	19.1
Absheron Regional Water Company	-	-	-	-	-	-

Source :

1991-1994 : First Preparatory Mission Report , March 1999

1995-1999 : BEN

Note : Industry does not include the electricity use for elevators and pumps of apartments, which is 60.2 GWh. It is included in household.

Appendix I.5.3-4 Amount of Electricity Sold by BEN by District

District	1993	1994	1995	1996	1997	1998	1999
(Study Area)							
1 Sabail	174,034	193,579	210,275	232,499	263,888	250,278	212,200
2 Yasamal	129,586	171,179	179,138	219,644	252,906	278,192	249,600
3 Nasimi	-	-	-	-	-	151,510	250,700
4 Narimanov	153,534	188,000	183,720	250,294	283,957	271,265	234,200
5 Nizami	111,446	134,975	130,937	143,430	164,753	186,118	195,500
6 Khatai	179,336	193,919	184,408	213,330	225,807	270,193	308,000
Subtotal	747,936	881,652	888,478	1,059,197	1,191,311	1,407,556	1,450,200
(Growth to previous year)	-	17.9%	0.8%	19.2%	12.5%	18.2%	3.0%
(Outside Study Area)							
7 Garadagh	41,766	47,321	44,322	50,059	61,085	75,088	83,900
8 Binagady	148,799	140,464	145,819	196,756	232,324	298,158	332,800
9 Sabunchi	160,356	167,741	167,436	193,612	217,399	323,797	431,300
10 Azizbayov	123,074	179,486	156,790	214,556	270,591	354,358	361,600
11 Surakhany	93,392	114,923	114,875	120,425	134,898	168,821	188,500
Subtotal	567,387	649,935	629,242	775,408	916,297	1,220,222	1,398,100
(Growth to previous year)	-	14.5%	-3.2%	23.2%	18.2%	33.2%	14.6%
Inspection	322,080	263,098	187,243	173,619	177,321	174,720	153,400
Total	1,637,403	1,794,685	1,704,963	2,008,224	2,284,929	2,802,498	3,001,700
(Growth to previous year)	-	9.6%	-5.0%	17.8%	13.8%	22.7%	7.1%

Source : BEN

Note : 1) Data on Nasimi are available only since January 1998. Before 1998, Nasimi area had been managed by Yasamal, Sabail and Narimanov branch offices.

2) The elctricity use in Nizami in 1999 includes the amount that was sold to JV Bakenergo since October to the end of 1999 at 57.5 GWh.

Appendix I.5.3-5 Number of BEN's customers

(Unit : number)

Category	1995	1996	1997	1998	1999
(Number)					
Total	362,004	368,057	369,964	380,390	378,022
Industry and construction	546	440	459	569	679
Non-industry	20,344	21,981	13,102	11,327	3,393
Agriculture	18	18	17	25	25
Transportation	0	0	0	3	3
Commerce	-	-	9,505	10,840	13,207
Household	341,095	345,617	346,880	357,623	359,569
Absheron Regional Water Company	1	1	1	1	1
Budget organizations	-	-	-	-	1,142
Railway	0	0	0	2	3
(Compositio in %)					
Total	100.0%	100.0%	100.0%	100.0%	100.0%
Industry and construction	0.2%	0.1%	0.1%	0.1%	0.2%
Non-industry	5.6%	6.0%	3.5%	3.0%	0.9%
Agriculture	0.005%	0.005%	0.005%	0.007%	0.007%
Transportation	0.000%	0.000%	0.000%	0.001%	0.001%
Commerce	-	-	2.6%	2.8%	3.5%
Household	94.2%	93.9%	93.8%	94.0%	95.1%
Absheron Regional Water Company	-	-	-	-	-
Budget organizations	-	-	-	-	0.302%
Railway	-	-	-	0.001%	0.001%
(Growth rate, %/year)	(1995-96)	(1996-97)	(1997-98)	(1998-99)	(1995-99)
Total	1.7	0.5	2.8	(0.6)	1.1
Industry and construction	(19.4)	4.3	24.0	19.3	5.6
Non-industry	8.0	(40.4)	(13.5)	(70.0)	(36.1)
Agriculture	0.0	(5.6)	47.1	0.0	8.6
Transportation	-	-	-	0.0	-
Commerce	-	-	14.0	21.8	-
Household	1.3	0.4	3.1	0.5	1.3
Absheron Regional Water Company	0.0	0.0	0.0	0.0	-
Budget organizations	-	-	-	-	-
Railway	-	-	-	50.0	-

(Source : BEN)

(Note)The proportion of household customers in 1999 at 95% is that of the BEN customers at 323,477 and JV Bakenergo's customers at 36,092 combined.

Appendix I.5.3-6 Electricity consumption per customer

Category	1995	1998	1999		
			BEN	Bakenergo	Total
(Number)					
Industry and construction	546	569	649	30	679
Non-industry	20,344	11,327	4,377	161	4,538
Agriculture	18	25	24	1	25
Transportation	0	3	3	0	3
Commerce	0	10,840	11,997	1,210	13,207
Absheron Regional Water Company	1	1	1	0	1
Subtotal	*20,909*	*22,765*	*17,051*	*1,402*	*18,453*
Household	341,095	357,623	323,477	36,092	359,569
Total	**362,004**	**380,388**	**340,528**	**37,494**	**378,022**
(%)					
Industry and construction	0.2	0.1	0.2	0.1	0.2
Non-industry	5.6	3.0	1.3	0.4	1.2
Agriculture	0.0	0.0	0.0	0.0	0.0
Transportation	0.0	0.0	0.0	0.0	0.0
Commerce	0.0	2.8	3.5	3.2	3.5
Household	94.2	94.0	95.0	96.3	95.1
Absheron Regional Water Company	0.0	0.0	0.0	0.0	0.0
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
(Electricity Use in GWh)					
Industry	180.3	157.3	128.0	2.5	130.5
Non-industry	345.6	285.9	298.5	5.8	304.3
Agriculture	19.5	11.4	5.0	0.1	5.1
Transportation	23.0	7.6	6.1	0.1	6.2
Commerce	35.0	85.0	80.6	1.6	82.2
Absheron Regional Water Company	-	7.5	17.7	0.3	18.0
Subtotal	*603.4*	*554.7*	*535.9*	*10.5*	*546.4*
Household	1,101.5	2,247.8	2,408.3	47.0	2,455.3
Total	**1,704.9**	**2,802.5**	**2,944.2**	**57.5**	**3,001.7**
(Consumption per consumer in kWh/year)					
Industry	330,220	276,450	197,227	83,328	192,194
Non-industry	16,988	25,241	68,197	36,209	67,063
Agriculture	1,083,333	456,000	208,333	97,650	203,906
Transportation	-	2,533,333	2,033,333	-	2,073,044
Commerce	-	7,841	6,718	1,301	6,222
Absheron Regional Water Company	-	7,500,000	17,700,000	-	18,045,680
Subtotal	28,858	24,366	31,429	7,465	29,609
Household	3,229	6,285	7,445	1,303	6,829
Total	**4,710**	**7,367**	**8,646**	**1,534**	**7,941**

Note:

(1) New categories started to be used in 1999 "Budget organizations" and "Railway" are included in "Non-industry" for the purpose of comparison with the previous years.

(2) JV Bakenergo started to operate the distribution system in Nizami in October 1999. Data on Bakenergo are combined with those of BEN for 1999 for the purpose of comparison with the previous years.

Appendix I.5.3-7 Amount of electricity sold by BEN in 1999 by type of customer and district (1/2)

(unit : GWh)

District	Industry	Non-industry	Commerce	Urban transportation	Agriculture	Absheron (water co.)	Railway organization	Budget organizations	Household	Total
(Study Area)										
1 Sabail	2.60	10.40	18.50	0.04	0.00	0.60	0.00	15.00	165.10	212.24
2 Yasamal	2.30	7.80	11.70	0.00	0.02	0.80	0.00	12.20	214.80	249.62
3 Nasimi	0.80	6.70	9.70	0.00	0.00	1.10	0.00	12.30	220.10	250.70
4 Narimanov	3.90	9.92	7.90	0.00	0.30	1.60	0.00	11.10	199.50	234.22
5 Nizami	4.30	4.50	4.00	0.00	0.04	1.60	0.00	8.50	172.60	195.54
6 Khatai	5.30	13.00	5.07	0.00	0.00	1.20	0.00	9.60	273.80	307.97
Subtotal	19.20	52.32	56.87	0.04	0.36	6.90	0.00	68.70	1,245.90	1,450.29
(Outside Study Area)										
7 Garadagh	2.40	5.20	1.00	0.00	0.00	0.00	0.00	12.50	62.80	83.90
8 Binagady	14.40	11.40	6.20	0.00	0.00	1.20	0.00	9.20	290.40	332.80
9 Sabunchi	20.30	11.70	3.70	0.00	2.80	1.00	0.09	23.70	368.00	431.29
10 Azizbayov	5.30	16.35	2.60	0.00	1.80	0.00	0.00	10.60	324.95	361.60
11 Surakhany	6.60	3.80	1.60	0.00	0.06	1.60	0.03	13.90	160.90	188.49
Subtotal	49.00	48.45	15.10	0.00	4.66	3.80	0.12	69.90	1,207.05	1,398.08
Inspection	59.84	24.93	8.63	6.04	0.00	7.00	0.00	34.10	12.90	153.44
TOTAL	**128.04**	**125.70**	**80.60**	**6.08**	**5.02**	**17.70**	**0.12**	**172.70**	**2,465.85**	**3,001.81**

(Source : BEN)

Note :

(1) "Non-industry" includes such consumers as school, hospital university, government offices, institutes, orphans, hostels for orphans and so on, which are organizations producing no products.

(2) " Industrial " consumption includes the power consumed by elevators and pumps of apartments.

(3) " Inspection " consumption means power supplied to high voltage consumers directly from the BEN head office icluding Baku Port, Baku Shipyard, and other three places each with 5 substations.

Appendix I.5.3-7 Amount of electricity sold by BEN in 1999 by type of customer and district (2/2): composition

(unit: %)

District	Industry	Non-industry	Commerce	Urban transportation	Agriculture	Absheron (water co.)	Railway organization	Budget organizations	Household	Total
(Study Area)										
1 Sabail	1.23	4.90	8.72	0.02	0.00	0.28	0.00	7.07	77.79	100.00
2 Yasamal	0.92	3.12	4.69	0.00	0.01	0.32	0.00	4.89	86.05	100.00
3 Nasimi	0.32	2.67	3.87	0.00	0.00	0.44	0.00	4.91	87.79	100.00
4 Narimanov	1.67	4.24	3.37	0.00	0.13	0.68	0.00	4.74	85.18	100.00
5 Nizami	2.20	2.30	2.05	0.00	0.02	0.82	0.00	4.35	88.27	100.00
6 Khatai	1.72	4.22	1.65	0.00	0.00	0.39	0.00	3.12	88.90	100.00
Subtotal	1.32	3.61	3.92	0.00	0.02	0.48	0.00	4.74	85.91	100.00
(Outside Study Area)										
7 Garadagh	2.86	6.20	1.19	0.00	0.00	0.00	0.00	14.90	74.85	100.00
8 Binagady	4.33	3.43	1.86	0.00	0.00	0.36	0.00	2.76	87.26	100.00
9 Sabunchi	4.71	2.71	0.86	0.00	0.65	0.23	0.02	5.50	85.33	100.00
10 Azizbayov	1.47	4.52	0.72	0.00	0.50	0.00	0.00	2.93	89.86	100.00
11 Surakhany	3.50	2.02	0.85	0.00	0.03	0.85	0.02	7.37	85.36	100.00
Subtotal	3.50	3.47	1.08	0.00	0.33	0.27	0.01	5.00	86.34	500.00
Inspection	39.00	16.25	5.62	3.94	0.00	4.56	0.00	22.22	8.41	100.00
TOTAL	**4.27**	**4.19**	**2.69**	**0.20**	**0.17**	**0.59**	**0.00**	**5.75**	**82.15**	**100.00**

Appendix I.5.5-1 Number of faults on 6 kV and 10 kV distribution facilities in past 5 years

No.	Fault Cause	1994	1995	1996	1997	1998
1	Number of automatic cable line rupture	1,359	1,031	1,213	2,830	2,880
2	Overburning of high voltage safety devices (Power fuse)	92	169	176	347	160
3	Damage of transformers	16	24	30	41	19
4	Oil leakage of Transformer	12	29	36	107	33
5	From 0.4 kV side	29	53	63	18	47
6	Damage of electrical devices 6, 10 kV (Switchgear)	71	109	149	157	98
7	Entry of outside things (including animals)	14	41	22	16	31
8	Reason are not determined	109	145	150	107	173
	Total number of current rupture	1,702	1,601	1,839	3,623	3,441

Appendix I.5.5-2 Number of cable faults by networks in past 5 years

	I	II	III	IV/Yas.		V/VI	VII	VIII	IX	XII	XIII	XIV	XV	Hovsan	XVI	Total
1994	**0**	**122**	**60**	**107**	**0**	**66**	**189**	**212**	**159**	**57**	**197**	**98**	**69**	**23**	**0**	**1,359**
January		6	1	5		5	6	11	8	4	7	9	2	2		66
February		5	5	11		1	19	20	27	5	10	14	2	2		121
March		5	3	6		7	16	11	12	7	8	11	6	0		92
April		6	7	5		4	10	21	6	7	12	12	2	0		92
May		18	4	7		2	15	15	12	8	11	5	7	3		107
June		19	7	8		7	12	7	21	6	13	7	11	1		119
July		19	9	14		5	20	19	17	3	22	3	4	0		135
August		5	2	5		4	17	13	10	8	22	2	5	6		99
September		4	1	5		5	12	17	7	4	4	3	10	1		73
October		7	1	9		6	8	12	7	4	13	7	7	1		82
November		8	8	15		6	28	36	16	1	29	12	10	2		171
December		20	12	17		14	26	30	16	-	46	13	3	5		202
	I	II	III	IV	Yasamal	V/VI	VII	VIII	IX	XII	XIII	XIV	XV	Hovsan	XVI	Total
1995	**0**	**105**	**63**	**100**	**0**	**73**	**158**	**180**	**0**	**2**	**166**	**85**	**69**	**30**	**0**	**1,031**
January		17	7	10		9	26	10			26	11	5	17		138
February		8	4	4		4	11	18			14	11	2	0		76
March		7	6	9		6	18	13		1	12	2	5	5		84
April		2	6	7		9	15	11		1	14	9	11	0		85
May		7	2	5		5	13	18			7	5	3	4		69
June		12	7	9		8	9	17			10	11	11	0		94
July		4	5	7		5	14	4			5	4	4	1		53
August		6	4	5		3	6	3			13	2	7	0		49
September		9	1	8		7	8	7			20	5	2	1		68
October		10	3	12		8	12	23			17	6	6	2		99
November		10	4	11		3	10	36			15	4	7	0		100
December		13	14	13		6	16	20			13	15	6	0		116
1996	**0**	**136**	**81**	**76**	**53**	**86**	**164**	**221**	**0**	**55**	**166**	**95**	**71**	**9**	**0**	**1,213**
January		13	11	7	4	6	21	17		3	20	9	6	1		118
February		11	4	3	5	7	13	21		3	11	18	7	0		103
March		7	3	4	7	6	14	13		11	10	8	1	0		84
April		8	4	7	3	8	12	23		4	21	3	8	0		101
May		11	3	7	4	7	18	9		11	11	8	6	1		96
June		12	10	5	4	6	10	26		2	13	5	6	0		99
July		9	5	5	3	11	6	30		3	15	11	4	0		102
August		9	11	6	6	4	14	11		5	5	6	7	2		86
September		20	4	9	6	14	14	29		2	17	6	3	0		124
October		20	12	7	5	10	16	15		2	26	2	6	2		123
November		9	12	10	5	4	9	9		9	5	10	3	1		86
December		7	2	6	1	3	17	18		0	12	9	14	2		91
1997	**0**	**344**	**178**	**133**	**114**	**103**	**459**	**405**	**337**	**35**	**362**	**167**	**164**	**29**	**0**	**2,830**
January		36	14	21	14	7	70	33	39	3	25	15	8	2		287
February		49	26	22	14	15	59	64	55	4	28	35	23	3		397
March		30	18	8	18	7	27	46	27	4	30	17	16	4		252
April		16	8	5	13	7	35	27	20	1	31	13	9	4		189
May		29	10	4	1	6	32	24	27	6	29	11	11	5		195
June		25	5	10	7	11	24	38	19	1	28	11	6	0		185
July		26	13	9	8	4	30	16	17	2	16	8	10	4		163
August		24	11	7	6	7	27	18	23	2	27	8	12	2		174
September		26	16	6	11	9	39	42	26	5	31	7	25	2		245
October		11	14	9	5	4	15	20	24	3	29	7	14	2		157
November		20	17	9	7	10	36	19	27	3	35	6	12	1		202
December		52	26	23	10	16	65	58	33	1	53	29	18	0		384
1998	**55**	**248**	**162**	**151**	**207**	**358**	**311**	**361**	**349**	**95**	**312**	**178**	**119**	**29**	**0**	**2,935**
January		54	33	26	18	65	32	52	45	0	50	36	11	1		423
February		32	28	25	32	71	23	39	59	2	46	34	7	8		406
March		35	6	13	22	26	8	29	20	8	8	15	6	1		197
April		48	10	16	23	34	12	36	24	9	21	25	9	0		267
May	5	12	7	3	12	19	14	27	24	10	21	6	9	0		169
June	4	7	11	7	10	25	21	32	31	8	22	4	3	8		193
July	6	16	7	10	4	16	30	29	24	10	23	6	12	0		193
August	5	8	8	7	3	13	26	37	18	8	19	7	17	1		177
September	10	6	6	6	9	12	22	11	18	8	18	3	15	2		146
October	2	7	4	8	18	15	23	21	19	12	38	10	12	4		193
November	13	17	28	18	30	37	54	14	41	8	19	10	10	1		300
December	10	6	14	12	26	25	46	34	26	12	27	22	8	3		271

Appendix I.5.5-3 Contents of transformer repair in 1998

Network area	Total	Cause of Trouble							
		Impossible to repair	Insulation and winding damaged	Short circuit	Tapchanger Damaged	Damaged by water	Full assembly	Others gasket, oil leakage, etc	Un-repair
1 I									
2 II	18	3	6	2	2	4		1	
3 III	7	1	3	1				1	1
4 IV	13		3		1	4	1	1	3
5 V	20	5	7	5	1	1	1		
6 VI	9		1		1	1			6
7 VII	12		2			1		1	8
8 VIII	15	1	8			1	1	1	3
9 IX	30	3	7	3		6	1	3	7
10 X	32	4	14		2	8		2	2
11 XI	31	4	11	5				1	10
12 XII	23		9		2	6		2	4
13 XIII	56	1	24	7	2	2	11	4	5
14 XIV	19		9	2	2	2	2	1	1
15 XV	18	3	6		3	4	2		
16 Yasamal	12	1	8			2	2		
17 Baladjari	4		1	2					
18 Garadag	3		2		1				
19 Govsany	2	1	1						
20 Bailov	4	1	2			1			
TOTAL	328	28	124	27	17	43	21	18	50
		8.5%	37.8%	8.2%	5.2%	13.1%	6.4%	5.5%	15.2%

Appendix I.5.5-4 Number and capacity of transformers repaired by the Transformer Repair Shop (1996 - 1999)

Month	1996		1997		1998		1999	
	Nos.	kVA	Nos.	kVA	Nos.	kVA	Nos.	kVA
January			15	7,330	25	12,280	2	20,790
February			23	10,750	42	20,450	32	16,680
March			21	9,675	44	21,630	35	17,130
April			17	8,330	19	8,660	20	9,840
May			8	3,130	19	9,500	28	13,480
June			13	6,420	36	17,510	18	8,350
July			13	4,530	25	11,540	24	11,270
August			11	5,250	25	12,370	16	7,310
September			11	5,530	19	9,970		
October			10	4,990	47	22,130		
November	17	7,690	6	2,400	29	13,645		
December	18	8,410	33	15,720	36	18,030		
Total	35	16,100	181	84,055	366	177,715	175	104,850

Appendix I.5.6-1 BEN's revenue by tariff category

Year	Industrial Enterprise	Budget Enterprise*1	Non-industrial Enterprise	Commercial Enterprise	City Transport*2	Absheron Water Company*2	Agricultural Enterprise	Electric Railway*3	Residential	JV Bakanergo*4	Total
1995	180.3	--	345.6	35.0	--	23.0	19.5	--	1,101.5	--	1,704.9
	35,093.2	--	77,882.2	10,529.8	--	2,383.2	1,858.1	--	25,023.8	--	152,770.3
(%)	23.0%	--	51.0%	6.9%	--	1.6%	1.2%	--	16.4%	--	100.0%
1996	158.1	--	303.5	50.7	--	17.9	14.2	--	1,463.8	--	2,008.2
	32,230.2	--	75,705.0	16,802.5	--	2,305.0	1,616.6	--	30,687.0	--	159,346.3
(%)	20.2%	--	47.5%	10.5%	--	1.4%	1.0%	--	19.3%	--	100.0%
1997	156.0	--	271.1	71.1	--	14.0	12.6	--	1,760.1	--	2,284.9
	30,158.3	--	71,741.2	23,961.1	--	1,989.0	1,765.9	--	82,628.0	--	212,243.5
(%)	14.2%	--	33.8%	11.3%	--	0.9%	0.8%	--	38.9%	--	100.0%
1998	227.3	--	285.9	85.0	7.6	7.5	11.4	0.0	2,177.8	--	2,802.5
	39,117.6	--	75,749.6	28,924.6	1,023.2	991.8	1,643.5	5.4	129,098.0	--	276,553.6
(%)	14.1%	--	27.4%	10.5%	0.4%	0.4%	0.6%	0.002%	46.7%	--	100.0%
1999	188.2	172.7	125.7	80.6	6.1	17.7	5.0	0.1	2,348.1	57.5	3,001.7
	30,118.6	27,633.4	33,303.6	27,408.9	801.9	2,339.7	701.9	23.8	145,814.7	4,143.5	272,290.0
(%)	11.1%	10.1%	12.2%	10.1%	0.3%	0.9%	0.3%	0.01%	53.6%	1.5%	100.0%

Note : Above lines in each year represent sold electricity (GWh).

Note*1 : included in "non-industrial enterprise" until 1998.

Note*2 : been recorded altogether until 1997.

Note*3 : not been recorded until 1997.

Note*4 : newly recognized since 1999.

CHAPTER 6

CURRENT ISSUES OF POWER SUPPLY BY BEN

CHAPTER 6 CURRENT ISSUES OF POWER SUPPLY BY BEN

6.1 Deteriorated Facilities of Outdated Model

The most serious problem of the distribution system managed by BEN is old fashioned and deteriorated facilities such as transformers, cables and switchgears.

(1) Underground Cable

The Total length of medium voltage (MV) distribution lines is about 900 km in the study area, of which underground cables accounts for 93 %, with a total length 840 km. As mentioned in Section 5.2.1, "the aluminum conductor oil impregnated paper insulated aluminum sheathed tape armored cables" are applied to all the underground MV lines, and those laid in early the 1900s are still in use.

As of 1995, about 300 km (20% of the total) of the MV underground cables managed by the BEN has been used more than 30 years. The length of the MV and LV underground cables categorized by the number of years in use is shown in Table I.6.1-1 below. The table shows the value for whole Baku managed by BEN including the study area as of 1995. Those cables sometimes bring about electrical breakdown owing to their deterioration. This resulted in fault on cables and cable joints recorded at 2,880 times in 1998. Furthermore, owing to the rapid increase of heating demand in winter and improper execution of the cable joints, faults on the cable line have been increasing.

About 100 km (10% of the total) of low voltage (LV) underground cables has been used more than 30 years. Though there is no records of LV line faults, deterioration of LV cables is considered to be a major factor of faults as well as in case of MV cable line.

Table I.6.1-1 MV and LV cable length categorized by the number of year in use (as of 1995)

Age		Within 4	5~14	15~24	25~34	35~44	45~54	55~64	65~74	75~84	More than 85	Total
6 kV, 10 kV	(km)	133.0	471.0	587.0	162.0	130.0	48.5	11.5	8.0	2.5	1.5	1,555.0
U/G	(%)	8.6	30.3	37.7	10.4	8.4	3.1	0.7	0.5	0.2	0.1	100.0
0.4 kV U/G	(km)	64.0	271.0	517.0	61.0	32.7	8.3	5.8	3.8	0.2	0.1	964.0
	(%)	6.6	28.1	53.6	6.3	3.4	0.9	0.6	0.4	0.0	0.0	100.0

(Source: BEN)

(2) Overhead Line

The length of MV and LV overhead line categorized by the number of years in use is shown in Table I.6.1-2. As of 1995, about 36% (250 km) of MV and about 35% (750 km) of the LV lines has been used more than 30 years. Since there is no detailed fault records on overhead lines, the study team could not grasp the number of faults due to deterioration of the facilities. BEN, however, intends to replace the facilities used more than 30 years immediately.

Table I.6.1-2 MV and LV overhead line categorized by the number of year in use (As of 1995)

Usage year		within 4	5～14	15～24	25～34	35～44	45～54	55～64	More than 65	Total
6 kV, 10 kV	(km)	89.0	94.0	170.0	188.0	96.0	37.0	21.0	0.0	695.0
O/H line	(%)	12.8	13.5	24.5	27.1	13.8	5.3	3.0	0.0	100.0
0.4 kV	(km)	52.0	687.0	347.0	618.0	277.0	68.0	78.0	0.0	2,127.0
O/H line	(%)	2.4	32.3	16.3	29.1	13.0	3.2	3.7	0.0	100.0

(Source: BEN)

(3) Transformer Station

Table I.6.1-3 shows the number of the 10 kV and 6 kV transformers categorized by the number of years in use managed by BEN in whole Baku. As seen from the table, about 1,000 units (34 %) of the transformers out of 2,961 units have been used more than 25 years as of 1995.

According to the transformer repair shop records, 51 % of the transformers brought into repair shop had troubles in winding. Deterioration or over-loaded operation of the transformers is considered to be as the cause of troubles. It is also considered that troubles of the transformers are caused by penetration of water into the transformers due to the deterioration of the waterproof gaskets. Leakage of oil from transformers is often observed.

There are 2,077 transformer stations managed by BEN in whole Baku as of 1995. The transformer stations categorized by the number of years in use are shown in Table I.6.1-3. The study team observed more than 20 transformer stations on site. It was found that doors of some transformer stations could not smoothly be opened and closed and temporary holes on the transformer station are still opened. It is necessary to repair them urgently from the viewpoint of safety.

The minimum-oil or bulk-oil circuit breakers are installed in each transformer station and there is no maintenance-free circuit breaker such as vacuum type and SF6 type. The minimum-oil circuit breaker, although it has a good performance, is hardly used contemporarily, because the inspection of the insulating oil are necessary after the cut large current off several times and it must pay attention to fire even though there is little quantity of combustible oil. Though there is no detailed data on the number of years in use of circuit breakers, deteriorated minimum-oil circuit breakers often cause leakage of oil after a few switching operations and result in malfunction of switching.

Table I.6.1-3 Transformers and transformer stations categorized by the number of year in use (as of 1995)

		within 4	5～14	15～24	25～34	35～44	45～54	55～64	65～74	75～84	More than 85	Total
Transformer	(Qty)	193	968	850	530	320	100	0	0	0	0	2,961
	(%)	6.5	32.7	28.7	17.9	10.8	3.4	0.0	0.0	0.0	0.0	100.0
Transformer	(Qty)	159	550	423	516	243	108	55	21	1	1	2,077
Station	(%)	7.66	26.48	20.37	24.84	11.70	5.20	2.65	1.01	0.05	0.05	100.0

(Source: BEN)

6.2 Lack of Important Facilities

Through site investigations and data collection, the study team identified the present problems of the power distribution system, especially the lack of important facilities are as follows:

(1) Shortage of Switchgears

Due to the shortage of switchgears, it was observed that two circuits of MV feeders were connected to one switchgear at some transformer stations. When a fault occurs at one feeder of this system configuration, the fault spread to the other feeder and an expansion of out-of-service area results. It was often observed that more than two circuits of LV feeders were connected to one switchgear at LV panels.

(2) Measuring Facilities

To measure the energy purchased from Azenerji and sales energy to private customers, watt-hour meters are installed on those feeders in the transformer station of BEN. However, any meter, which records various load characteristics like the maximum load, watt-hour, and power-factor, etc. is not installed on the other feeders or transformer circuit. Ammeters are necessary and important to grasp a status of the load currents on the feeders, however, most of existing ammeters are damaged and not in a working order. Therefore, it is difficult to grasp the actual condition of distribution system and also difficult to take appropriate countermeasures to meet the increasing demand. This is also one factor of overload operation of transformers and damage for underground cables as a result.

(3) Protection of Cables

The rising portions of underground cable to the supports are hardly protected with steel pipe. They have been likely damaged by vehicles or construction works.

6.3 Shortage of Materials for Maintenance and Spare Parts

(1) Medium Voltage Protection Device

Power fuses for the primary side of transformers are important protection devices against over-current of the system. It was observed in many transformer stations that wires instead of fuses are used due to shortage of spare parts. This sort of abnormal use of wires instead of fuses causes damages to transformers by overloading. Actually, burnout of transformers took place as a result of this malpractice.

(2) Low Voltage Protection Device

Low voltage fuses are normally provided in LV distribution panels. Our site survey revealed that in almost all LV distribution panels of survey sites, wires were used in parallel with fuses or instead of fuses. This arrangement does not protect low voltage distribution lines from over-current and results in cable damages and/or overloading of transformers.

6.4 Improper Installation and Maintenance Works

The following improper work for installation and maintenance are observed in the facility maintenance of BEN's system. This is considered related to the shortage in the number of maintenance staff in comparison with the number of faults and troubles.

(a) Connection works of MV and LV lines are manually conducted instead of using cable connection materials.

(b) It was often observed that unused cables and wastes of wires were left in transformer stations.

(c) It was often observed that insulation tapes peeled off and live conductors were exposed. This might cause injuries on maintenance staff.

(d) Doors of transformer stations could not smoothly be opened and closed. In some case, a door of the transformer room could not be tightly closed.

(e) It was often observed that temporary holes of the transformer station for introducing cables were left without closing.

(f) Because of incomplete cleaning, dust remained on live parts of transformer stations and rubbish was left without cleaning.

6.5 Energy Losses

One of important issues of the distribution network of BEN is the high level of losses. Although technical losses, which caused by shortage of current capacity in distribution lines, improper distribution of loads and improper cable connection, account for a part of high level of losses, it is considered that the substantial amount of the losses is non-technical losses. The let-alone policy of the non-technical losses not only leads to financial deterioration of the enterprise, but also is a kind of discrimination to people who pay bills as required and helps developing injustice. This also should be rectified as soon as possible to promote market economy.

Since the technical losses are a matter of hardware, reduction of the technical losses requires large amount of investments. In view of the present reality that the existing facilities are old and deteriorated, repair and renovation of the existing facilities should have higher priority. Through the modification of system configuration to double circuit lines and the selection of appropriate cable size, reduction of the technical losses should be done gradually.

On the other hand, non-technical losses are matters of administrative losses including poor metering, inadequate billing system, poor management of collection of payment. The reduction of the non-technical losses is possible by small amount of investments. Consequently, the improvement should be launched on urgently.

(1) Monthly Record of Losses

The monthly record of losses in 1997-1999 is shown in Table I.6.5-1.

Table I.6.5-1 Monthly sales amount and losses

Month	1997		1998		1999	
	Sales Amount (GWh)	Losses (%)	Sales Amount (GWh)	Losses (%)	Sales Amount (GWh)	Losses (%)
1	233.0	32.1	279.3	29.9	322.8	23.9
2	224.2	32.5	284.4	26.3	305.1	20.0
3	220.2	33.6	280.8	23.0	303.0	22.2
4	200.2	16.8	228.0	9.5	242.7	16.0
5	168.3	8.9	188.9	7.8	214.5	11.4
6	161.5	4.7	184.7	8.3	190.9	6.5
7	148.6	17.9	190.8	10.4	195.1	11.8
8	158.3	12.3	204.7	6.7	209.4	11.2
9	155.0	13.3	190.7	5.5	196.4	7.1
10	159.9	17.6	207.2	10.3	213.1	12.2
11	207.7	22.3	246.1	15.4	276.8	19.5
12	247.9	28.1	316.9	21.3	331.9	23.3
Total	2,284.8	22.5	2,802.5	16.7	3,001.7	17.0

(Source: BEN/ESE)

The above table shows that more distribution loss takes place in winter season when electrical demand rapidly increases. In an ideal electrical circuit, when the load increases to twice, energy loss increases to four times and the loss ratio increases to twice. In actual distribution network, however, since the extent of demand increase is not uniform, the loss rapidly increases partially, the increment of loss ratio becomes higher than the whole demand increase ratio as a result. Since this indicates that the technical loss ratio, which occupies to the total loss in Baku, is considered to be fairly high, the improvement effectiveness can be expected with taking the countermeasures mentioned before.

On the other hand, in case system configuration and level of demand in a distribution network are same, the technical losses are in a similar level, even if there are some differences at the time of metering. However, in Table I.6.5-1, demand of 207.7 GWh and losses of 22.3% in November 1997, demand of 204.7 GWh and losses of 6.7% in August 1998 and demand of 207.2 GWh and losses of 10.3% in October 1998 are recorded. In view of the fact that these three demands are same level with similar demand patterns in similar season, if losses are composed only by the technical losses, such big variation in losses can not have taken place. This indicates that the non-technical losses, which are irrelevant to demand structure and demand level, are also not negligible.

(2) Consideration to reduce the non-technical losses

We explained in Section 5.3.4 that the loss ratio in Sabunchi area raises the loss ratio of whole Baku. However, in the information about data of demand and sales amount of each area, which are obtained from ESE, the area with the highest loss level is Mashtaga Village. As indicated in Table I.6.5-2, the loss ratio in Mashtage is abnormally high. It is no exaggeration to say that the losses of Mashtaga raise losses not only in Sabunchi area, but also in the overall region of Baku City. Namely, the high level of the losses of 46.1% in Mashtaga raises the loss level (11.0%) of Sabunchi area to 28.9% and raises the loss level of overall Baku City to 16.8%.

If metering, billing and collection system of Mashtaga are improved and the loss ratio of Mashtaga is reduced to the level of the loss ratio in Sabunchi area (11.0% with the exception of Mashtaga) and also to the level of the average loss ratio in Baku (16.8%), the resultant saving in purchase amount from Azenerji and the loss ratio of Baku after improvement is given in Table I.6.5-2.

Table I.6.5-2 Impact of improved loss rate in Mashtaga on power loss in Baku

Item	1993	1994	1995	1996	1997	1998
Loss in Sabunchi excluding Mashtaga (%)	26.2	22.9	19.3	17.6	16.3	11.0
Loss in Mashtaga (%)	58.7	67.5	68.8	72.4	75.0	46.1
Assuming Mashtaga's loss same as Sabunchi (11%)						
Power to be saved (GWh)	51.3	78.1	79.6	105.0	133.4	90.2
Improved loss rate of Baku (%)	25.9	20.8	23.1	21.0	18.8	14.5
Assuming Mashtaga's loss same as Baku (16.8%)						
Power to be saved (GWh)	50.7	77.9	77.0	102.2	130.4	84.2
Improved loss rate of Baku (%)	25.9	20.8	23.2	21.0	18.9	14.6

The above table indicates that if the loss ratio of Mashtaga is improved to the average level of Baku City, the loss ratio of 16.8% in 1998 is reduced to 14.6%, the purchase amount of 84.2GWh (6.06 billion AZM) from Azenerji is saved. It should be noted that the improvement levels presented in Table I.6.5-2 above are achievable targets with some adjustments in energy meter reading system.

Non-Technical losses are mainly due to theft and administrative losses, such as the lack of meters, improper metering and billing and collection system. Table I.6.5-3 shows classification of losses.

Table I.6.5-3 Classification of losses

(1) Technical losses
(2) Non-technical losses
(2-1) Administrative Losses
(2-2) Losses Owing to Energy Theft
Administrative Losses include:
(2-1-1) Poor meter calibration
(2-1-2) Poor management of late payment
(2-1-3) Inadequate billing system
(2-1-4) Customers not in billing system or without meters
(2-1-5) Political reasons (e.g. Protection for refugees)

6.6 Electricity Charge Collection Performance

The amounts of account receivable against monthly sales amounts of BEN Network were reviewed. Table I.6.6-1 summarizes energy sales revenue and charge collection performance with some indicators during 1995-1999.

Table I.6.6-1 Electricity sales revenue and charge collection performance

Year	1995	1996	1997	1998	1999
Sold Energy (GWh)	1,704.9	2,008.2	2,284.9	2,802.5	3,001.7
Claimed Amount (in million AZM)	137,999.6	158,989.1	212,102.3	276,553.4	272,289.9
Paid Amount (in million AZM)	44,254.9	54,487.1	78,339.3	77,041.1	76,866.4
Balance (in million AZM)	93,744.7	104,502.0	133,763.0	199,512.3	195,423.5
Ratio of paid/claimed amount (%)	32.1	34.3	36.9	27.9	28.2
Account Receivable Equivalent to Monthly Sales (months)	8.2	7.9	7.6	8.7	8.6

(Source: BEN/ESE)

As seen above, collection performance by BEN during 1995-1999 has been considerably poor. Ratio of payment against claimed amount has been in the order of around 30% and annual account receivable amount has been on average equivalent to some 8 months of average monthly sales revenue. To improve such collection performance, the following measurements and actions need to be forwarded:

- To make a contract including penalty provision with each customer's signature
- To require customers to provide a certain amount of deposit

- To promote automatic withdrawal of the charge from bank account, and diversify the means of charge payment available to customers in view of lessening the load of charge collection staff
- To regularly inform the customers of accumulated arrears amount, and to urge them of early payment
- To disconnect supply service in case of payment delay or arrears exceeding the prescribed conditions
- To take legal action and make a legal settlement, unless service disconnection possible
- To enlighten the customers to be familiar with the concept "beneficiary to pay" against public utility service, and campaign for the awareness change

6.7 Issues in Financial Performance

As mentioned in Section 5.6, financial performance of BEN in 1995-1999 has worsened. The following issues are considered to be the major factors to account for its sluggish financial performance.

(1) Higher increase in distribution cost relative to average retail tariff

Though weighted average retail energy price has increased from 1995 to 1999 by 13.4 % (from AZM 80.0/kWh to 90.7), average cost of energy distribution has increased by 53.7 % (from AZM 63.9/kWh to 98.2) during the same period. Furthermore the average cost of energy distribution (including running and O&M expenses) exceeds the average retail price, meaning that the margin between wholesale tariff payable to Azenerji and weighted average retail price for customers does not cover running and O&M expenses.

Also having been responsible for energy supply to the group who is exempted from paying the charge, BEN has been forced to further bear the financial disadvantage and operate in accordance with the policy securing public benefit. It is also noted that even if the collection performance by BEN is improved, the operating profit and resultant capital accumulation would be hardly possible based on the current margin level.

(2) Extra losses by non-claimed electricity supply to the privileged

As mentioned, the non-claimed (non-revenue) supply to the refugee and other privileged has been increasingly made according to the policy concerned. Such supply leads to an extra loss to the one, which is normally recognized by the difference between the purchased and sold (consumed) energy. BEN incorporates such free supply volume of energy into sold volume, not but count it as revenue.

(3) Low level of charge collection rate

As the revenue source of BEN's power supply business is only from energy sales, low level of charge collection rate is very important issue. The ratio of collected revenue against claimed one (invoiced amount) has been around 35.2 % during the period from 1995 to 1999. Annual account receivable has been equivalent to around 8 month's amount of average monthly sales revenue.

It is noticed that the shortage in actually collected revenue (accumulating receivable) is somehow offset by deferring debts payment due (accumulating payable) to its creditor at least on the cash-flow basis. However, the financial situation faced by BEN has still made own financing of early rehabilitation and expansion of the distribution facilities hardly possible, and has been a major obstacle preventing energy distribution service from being financially independent.

To improve the financial situation of BEN, therefore, the following measurements will be desirable for consideration:

(a) To examine and revise the margin (between the wholesale tariff payable to Azenerji and weighted average retail price for customers) of BEN's revenue at least to cover its depreciation costs for fixed assets as well as running and O&M costs

(b) To improve the energy charge collection performance, and so on

6.8 Load Dispatching Equipment of BEN

As described in Section 5.2.5, the system control of the distribution network of BEN is carried out by the experience of the load-dispatcher through the telephone and radio equipment. The present load dispatching system in not able to grasp the real-time condition of the distribution system such as the position of the switchgears and the load current on the distribution lines. When the fault occurs to the distribution network, it is one of the missions of the load-dispatch instruction to resume the electric power supply to the healthy section early. As the operators have to go to the fault point and operate switchgear manually, it spends long time to resume electric power supply to the healthy section. The distribution system operation plans are established efficiently using the important data such as power flows on the lines. The measurements of the lines, however, are being carried out only once a day at present.

To solve the problems mentioned above from the viewpoint of load dispatching equipment, the following equipment is necessary.

- Information transfer path or communication equipment between the load dispatching center and equipment such as the circuit breakers and disconnectors in the distribution network
- Equipment to control the circuit breakers remotely from the load dispatching center
- Equipment to measure the load current remotely from the load dispatching center
- Equipment to store the operation record or measured data automatically

The contract boundary points between BEN and Azenerji in the distribution network are not unified and decided at every substation of Azenerji. For example, BEN operates the circuit breakers for out-going feeders in one substation of Azenerji and Azenerji operates them in another substation. Through the means that the contract boundary points of each substation are different at present, the problem has not occurred in particular. However, when the automatic control of the distribution facilities is introduced and upgraded from now on, it is expected that the problems on the maintenance of automatic control equipment occur because the specification and operation method of the automatic control system is not unified. Therefore, it will be necessary to clear the demarcation between the two sides, for example, Azenerji holds responsibility for the circuit breaker operation of the substations and BEN holds responsibility for the circuit breaker operation in the distribution network.

All the distribution system of BEN is displayed on the two pairs of graphic panel in the Load Dispatching Center. There is a limit in those graphic panels to the expansion of the distribution system to meet the growth of the electric power demand and it is impossible to indicate the operation data such as power flow on the lines on those panels. In the case that larger distribution system is displayed than now, it would seem difficult for the load-dispatchers to judge instantaneously from the view point of human engineering and the issue of the system control command delays as a result. It is, therefore, necessary to reduce the load to the load-dispatchers dividing the distribution system to the plural sections and displaying the circuit breakers and the single line diagram of each section simply on the graphic panel. The computer system will be used to report the detailed information to the load-dispatchers in that case. The reliability of electric power supply will improve by introducing the automatic control system of the distribution network and more improvements to the supply reliability could be expected by reducing the load to the load-dispatchers.

Presently, the load-dispatch instructions are almost trusting on the experience of the load-dispatchers. Most of the load-dispatchers are, however, turning the advanced age. It is expected that the exact control of the distribution network becomes difficult in the future if some countermeasures are not taken from now on. Although even the employment of young engineers is important, it's urgently necessary to leave the technical knowledge e.g. making the manuals or database system of the know-how of the load-dispatchers.

6.9 Division of Areas for Operation and Maintenance of the Distribution Facilities

As mentioned in Section 5.1, in order to manage the operation and maintenance of the distribution facilities of Baku City efficiently, Baku City is divided into central and suburb areas and furthermore they are divided into 20 network areas in total. BEN is an electric utility, which has an objective to supply stable and highly reliable electric power to customers. It is considered to be reasonable to divide its administrative region into network areas each having certain extents, and to establish a system, which can quickly respond to contingencies like system faults.

The question here is that it seems that the present divided areas are decided irrelevantly from administrative areas, although how and on what grounds the present divisions of network areas were decided, is not clear. The maintenance system of the facilities should be designed properly to meet the needs of consumers. For this, a power demand forecast is important. Investigations are necessary to grasp population statistics, the status of maintenance of public infrastructures, regional economic activities, and furthermore, regional development programs and the current status of supply of electricity through public questionnaires. However, it is common that those fundamental informations are provided by other enterprises corresponding to administrative areas. To realize relationship between the actual needs for electricity and the present status of maintenance of the electricity supply facilities, it is more useful that various information about electricity supply is available, together with other fundamental information and planning programs for each administrative area. The more accurate and realistic policies will be expected.

As a matter of fact, although the study team inquired persons concerned with BEN to grasp the status and information of network areas, maps showing identification of administrative areas were not available and they could not explain accurately borders of areas. Naturally, various record books for maintenance of the distribution facilities and faults records are arranged for each network area. We needed, in the course of collection of information, great efforts to identify the distribution facilities in the study area and to arrange and analyze fault records, etc. However, since billing and collection system were arranged on the basis of divisions of administrative areas, it was easy to grasp demand for each divisional area.