No.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
MONGOLIA
MINISTRY OF INFRASTRUCTURE (MOI)
THE 4TH THERMAL POWER PLANT (TES4)
PROJECT IMPLEMENTING UNIT (PIU)

JICA DEVELOPMENT STUDY SUPPORTING THE REHABILITATION PROJECT OF THE 4TH THERMAL POWER PLANT IN ULAANBAATAR MONGOLIA

FINAL REPORT

SEPTEMBER 2002

ELECTRIC POWER DEVELOPMENT CO., LTD.

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PREFACE

In response to a request from the Government of the Mongolia, the Government of Japan decided to conduct the Development Study the Rehabilitation Project of the 4th Thermal Power Plant in Ulaanbaatar, Mongolia and entrusted the study to Japan International Cooperation Agency (JICA).

JICA sent a study team, led by Mr. Yasuhiro Kato of Electric Power Development Co., Ltd. (EPDC) to Mongolia five times from June 2001 to July 2002.

The team held discussion with the officials concerned of the Government of the Mongolia, and conducted related field surveys. After returning to Japan, the team conducted further studies and compiled the final results in this report.

I hope this report will contribute to the promotion of the plan and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Mongolia for their close cooperation throughout the study.

September 2002

川上隆朗

Takao KAWAKAMI
President
Japan International Cooperation Agency
Tokyo, Japan

Mr. Takao KAWAKAMI
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Mr. T.KAWAKAMI,

Letter of Transmittal

We are pleased to submit you with the final report of JICA Development Study for the Rehabilitation Project of the 4th Thermal Power Plant in Ulaanbaataar, Mongolia, of which study has been finished recently.

This study was conducted on the purpose of submission of the Bidding Documents for the Rehabilitation Project of the 4th Thermal Power Plant (Phase-II) as a part of the JBIC Loan Aid Project, submission of Maintenance and Rehabilitation Plans for the existing whole plant which was planed, and the Technology Transfer to the counterpart through the study.

In addition to the above, the Bidding Document of the Phase-II Project, which was taken into account of such contents for the project as the amount of the loan, and the observance of the project schedule based on the agreement between Mongolia and JBIC, was officially submitted to Mongolia by the end of September 2001 which was instructed by JICA.

As for the maintenance and rehabilitation plans for the said power plant, the final report (main report) was composed on basis of the information and the data which were collected until September 2001, and examined the maintenance and rehabilitation plan and the plant operation and management plan (including organization, administration of the plant equipment, environmental protection, personnel training, and financial management).

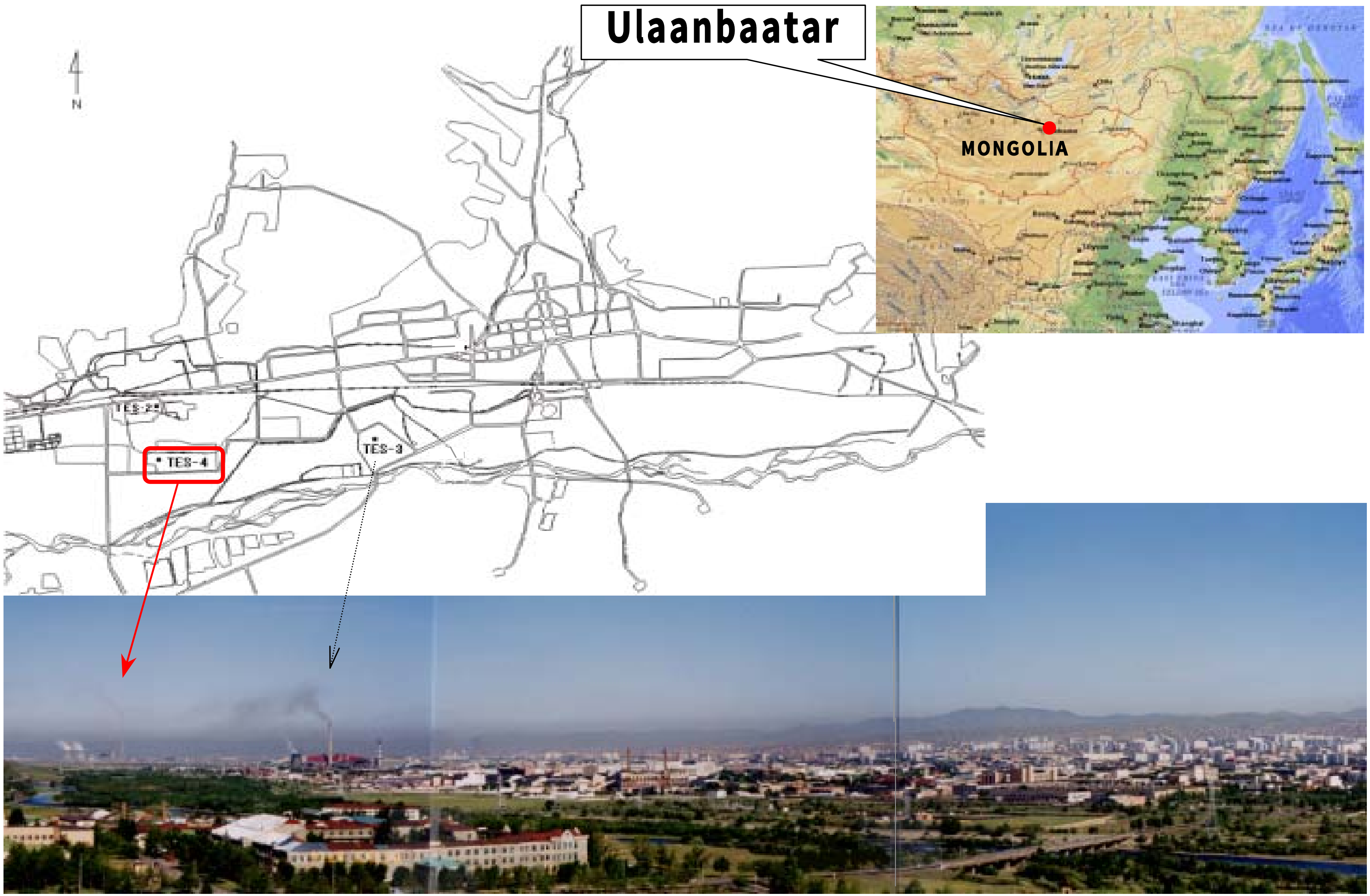
By implementing strictly the recommendations mentioned in this report, the said power plant will be able to keep its financial base and administration of the plant management, and to contribute for the long-term supply of stable power and heat to withstand the increment of the power and heat demand forecasted.

We wish taking this opportunity to express our sincere gratitude to JICA, the Ministry of Foreign Affairs, and the Ministry of Economy Trade and Industry. We also wish to express our deep gratitude to the Ministry of Infrastructure of Mongolia, and other authorities concerned of the Government of Mongolia, Embassy of Japan in Mongolia and JICA Ulaanbaatar office for the intimate cooperation and assistance extended to us during our investigation period.

Very truly yours,

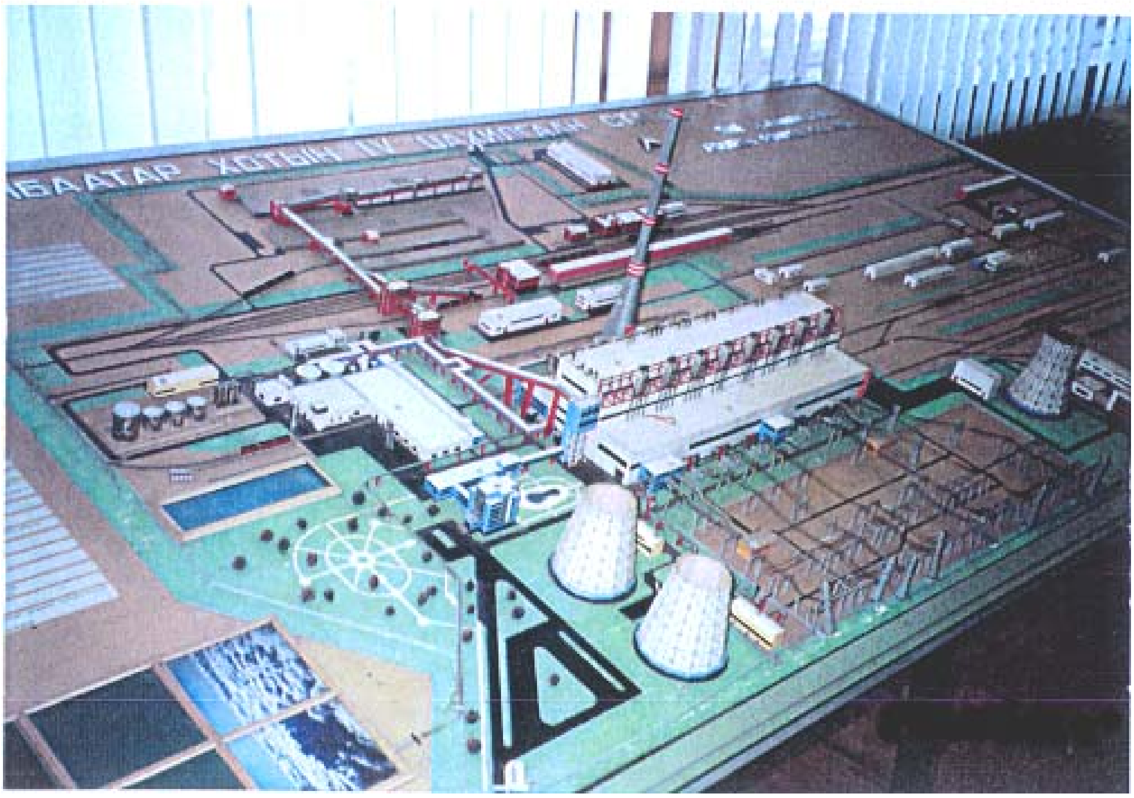
September 2002

Yasuhiro KATO
Team Leader
JICA Development Study of the Rehabilitation Project
of the 4th Thermal Power Plant in Ulaanbaatar Mongolia

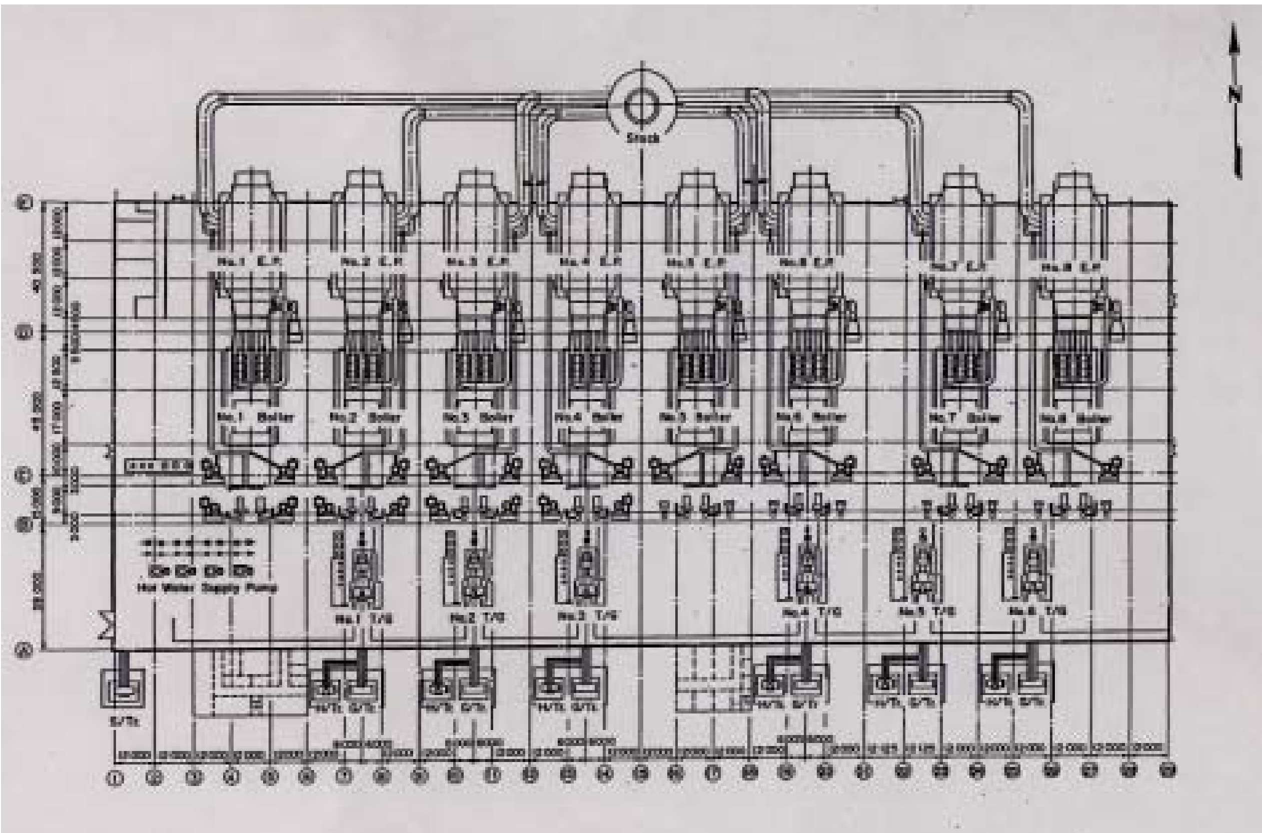


LOCATION MAP

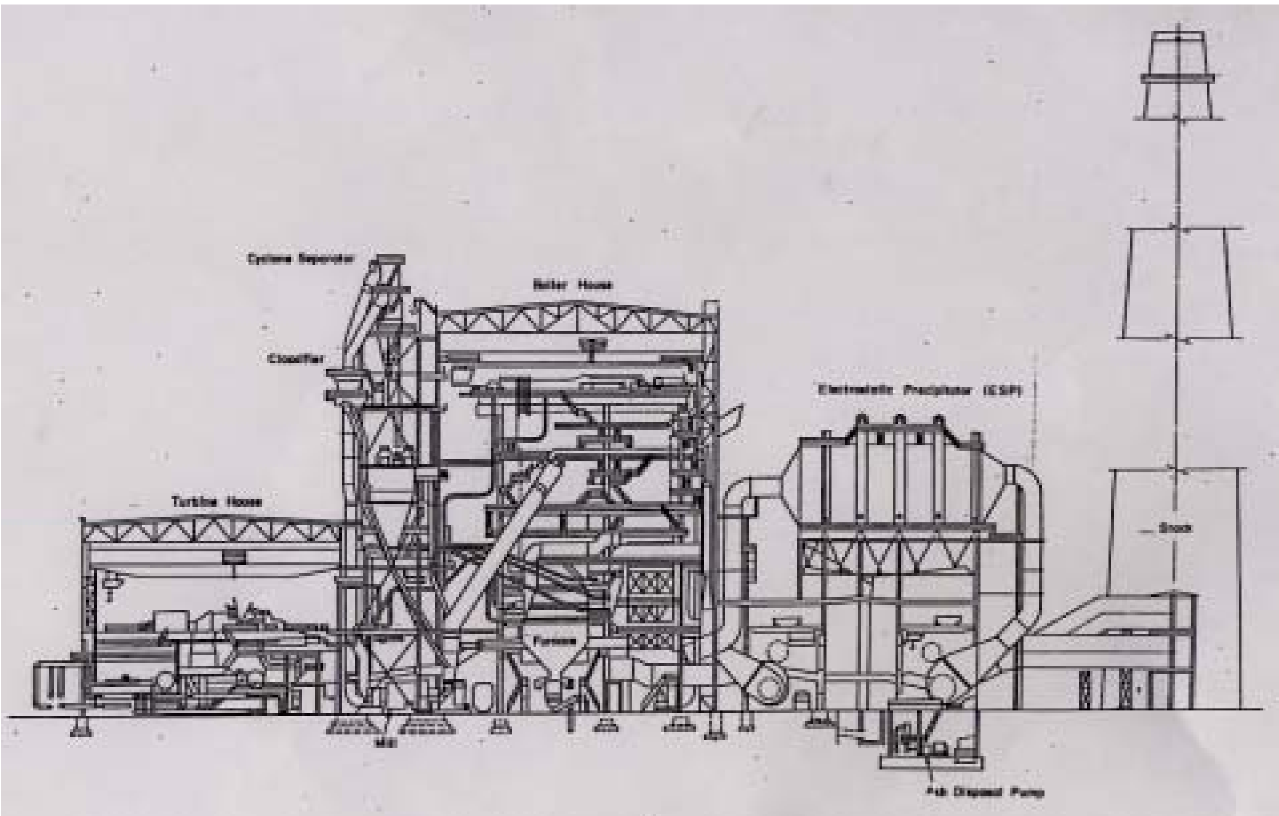
Power Plant General View



Power Plant Model



Plane View



Section View

Coal Carrier

Coal Storage Yard

Boiler Building

Electro Static Precipitator (ESP)

Transformer

Switch Yard

Boiler Control Panel (Rehabilitated)

Boiler Control Panel (Existing)

Mill (Rehabilitated)

Generator & Exciter (Existing)

No.3 Ash Pond (Existing)

No.4 Ash Pond (Under Construction)

CONTENTS

ABBREVIATION

ACGHI	:	American Conference of Governmental Industrial Hygienists
ADB	:	the Asian Development Bank
B/C	:	Benefit par cost
CCR	:	Center control room
CES	:	Central Energy System
COMECON	:	Council for Mutual Economic Assistance
CRT	:	Character display
D/D	:	Detail Design
EA	:	Energy Authority
ECCR	:	Electric center control room
EDO	:	Electric Distribution Office
EES	:	East Energy System
EIA	:	Environmental impact assessment
EIRR	:	Economic Internal Rate of Return
ERA	:	Energy Regulatory Authority
ESP	:	Electrostatic Precipitator
ETC	:	Energy Training Center
FBC	:	Fluidized-Bed Combustion
FC	:	Foreign Currency
FDF	:	Forced Draft Fan
FIRR	:	Financial Internal Rate of Return
FL	:	Floor Level
FRP	:	Fiber Reinforced Plastic
GCB	:	Gas circuit breaker
GDP	:	Gross Domestic Product
GNP	:	Gross National Product
GTZ	:	German Technical Cooperation
HDO	:	Heat Distribution Office
HOB	:	Heat only boiler
IARC	:	International Agency for Research on Cancer
IAS	:	International Accounting Standards
IDF	:	Induced Draft Fan
IEE	:	Initial Environmental Impact Evaluation
IMF	:	International Monetary Fund
IRR	:	Internal Rate of Return

JBIC	:	Japan Bank for International Cooperation
JICA	:	Japan International Cooperation Agency
JISHA	:	Japan Institution of Safety and Health Association
J-Power	:	Electric Power Development Co., Ltd.
LAN	:	Local Area Network
LC	:	Local Currency
MBB	:	Make before break
MEGM	:	Ministry of Energy Geology and Minerals
M/M	:	Minutes of meeting
MOID	:	Ministry of infrastructure Development
NDF	:	Nordic Development Fund
NEDO	:	New Energy and Industrial Technology Development Organization
NOx	:	Nitrogen Oxides
PGF	:	Primary Gas Fan
O&M	:	Operation and maintenance
OCB	:	Oil circuit breaker
OCR	:	Over-current relay
OECF	:	Overseas Economic Cooperation Fund
PDCA	:	Plan-Do-Check-Action
PIU	:	Project Implementing Unit
QC	:	Quality Control
ROE	:	Return on equity
ROA	:	Return on assets
SAPROF	:	Special Assistance for Project Formation
SATU	:	Name of Environmental Assessment & consulting company
SIDA	:	Swedish International Development Cooperation Agency
SOE	:	State Owned Enterprise
SOx	:	Sulfur Oxides
SPM	:	Suspended Particulate Matter
S/W	:	Scope of Works
TES2	:	Ulaanbaatar Thermal Power Plant No.2
TES3	:	Ulaanbaatar Thermal Power Plant No.3
TES4	:	Ulaanbaatar Thermal Power Plant No.4
TV	:	Television
VCB	:	Vacuum circuit breaker
WES	:	West Energy System
ZD	:	Zero Defect

UNITS

Prefixes

μ	:	Micro- = 10^{-6}
m	:	Milli- = 10^{-3}
c	:	Centi- = 10^{-2}
d	:	Deci- = 10^{-1}
da	:	Deca- = 10
h	:	Hecto- = 10^{2}
k	:	Kilo- = 10^{3}
M	:	Mega- = 10^{6}
G	:	Giga- = 10^{9}
T	:	Tera- = 10^{12}

Unit of Length

mm	:	Millimeter
cm	:	Centimeter
m	:	Meter

Units of Area

cm^2	:	Square centimeter
m^2	:	Square meter
km^2	:	Square kilometer

Units of Volume

m^3	:	Cubic meter
l	:	Liter
kl	:	Kiloliter

Units of Mass

g	:	Gram
kg	:	Kilogram
t	:	Ton (metric)

Units of Density

kg/m^3	:	Kilogram per cubic meter
mg/kg	:	Milligram per kilogram
ppm	:	Parts per million
mg/m^3N	:	Milligram per normal cubic meter
$\mu g/m^3N$	:	Microgram per normal cubic meter
$\mu g/m^3$	:	Microgram per cubic meter
mg/l	:	Milligram per liter

Units of Pressure

t/m^2	:	Ton per square meter
kg/cm^2	:	Kilogram per square centimeter (gauge)
mmHg	:	Millimeter of mercury
mmAq	:	Millimeter of aqueous
hPa	:	Hecto Pascal

Units of Energy

kcal	:	Kilocalories
kWh	:	Kilowatt-hour
MWh	:	Megawatt-hour
GWh	:	Gigawatt-hour
kW/ m^2	:	Kilowatt per square meter

Units of Heating Value

cal/kg	:	Calories per kilogram
kcal/kg	:	Kilocalorie per kilogram
kJ/kg	:	Kilojule per kilogram

Units of Temperature

°C	:	Degree Celsius or Centigrade
°K	:	Degree Kelvin

Units of Electricity

W	:	Watt
MW	:	Megawatt
A	:	Ampere
kA	:	Kiloampere
V	:	Volt
kV	:	Kilovolt
kVA	:	Kilovolt ampere
MVA	:	Megavolt ampere
MVar	:	Megavar (mega volt-ampere-reactive)
kHz	:	Kilohertz

Units of Time

s	:	Second
min	:	Minute
h	:	Hour
d	:	Day
w	:	Week
y	:	Year

Units of Flow Rate

t/h	:	Ton per hour
t/d	:	Ton per day
t/y	:	Ton per year
m^3/s	:	Cubic meter per second
m^3/min	:	Cubic meter per minute
m^3/h	:	Cubic meter per hour
m^3/d	:	Cubic meter per day
m^3N/s	:	Cubic meter per second at normal condition
m^3N/h	:	Cubic meter per hour at normal condition

Units of Conductivity

μS/cm	:	MiscroSiemens per centimeter

Units of Sound Power Level

dB(A)	:	Deci-bell (A-weighted)

Units of Currency

US$	:	US Dollar
Yen	:	Japanese Yen
Tug	:	Mongolian tugrug (9.07Tug＝1Yen：2001/10)
MTug	:	Million tugrug
GTug	:	Billion tugrug

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OVERALL EVALUATION AND RECOMMENDATIONS

OVERALL EVALUATION AND RECOMMENDATIONS

I. General

This study was conducted based on site surveys and data collected on Ulaanbaatar Thermal Power Plant No.4 (TES4), and a maintenance and rehabilitation plan was prepared from an overall perspective of power plant management considering not only rehabilitation plans for equipment and facilities, but also plans for personnel training and financial management to assure financial discipline.

By implementing the recommendations in this plan, TES4 will be able to strengthen its financial base and administration of plant management, thus contributing to the long-term stable supply of good quality power and heat to combat the forecasted increase in power and heat demand.

From the above perspective, it will be necessary to consider the following during the implementation of the recommendations:

- It will be indispensable to obtain the understanding of the Mongolian government and to promote the reform of the energy sector, as well as to obtain the understanding of the heads and staff of each section of TES4, and to properly implement the recommendations in order for TES4 to positively materialize the recommendations mentioned in this report.

- Once corporatized, TES4 must procure funds on its own; however, the provision of financial aid from Japan and other foreign countries will be necessary to secure the foreign currency needed for equipment and other procurement considering the current severe situation of the international balance of payments of Mongolia, while TES4 retains funds of local currency adequately.

- With respect to organizational reform and personnel training, the provision of software support such as technical and intellectual support will be indispensable because the improvement of operation and management skills will contribute to raising the efficiency not only for TES4, but also for all plants in Mongolia.

Based on the above considerations, an overall evaluation and recommendations are described in the following.

II. Evaluation and Recommendations

(1) Maintenance and Rehabilitation Plans

Selection of the equipment requiring rehabilitation was made and an execution plan was prepared together with cost estimate and annual fund requirements. The effects of the rehabilitation were determined and an economic and financial evaluation was made. As a result, it was concluded that the rehabilitation plan was worthy of implementation. The result of the evaluation and the recommendations are shown below:

1) Selection of Rehabilitation Equipment

The selection of equipment to be rehabilitated was made by the importance and degree of degradation of the equipment and was ranked in 3 categories (A: Rehabilitation from which a large effect is expected, B: Rehabilitation for decrepit equipment, C: Repair works considered by TES4). Particular attention was paid to the point that, on account of the 40-year service life of TES4 up to 2025, ash ponds No. 5 and 6 with a capacity of 10 years each will be necessary, and that it will be necessary to rehabilitate 80 MW turbines, which fail frequently, in order to respond to the future increase in demand. It will also be necessary to conduct environmental measures to meet the environmental regulations and other life extension measures.

2) The Rehabilitation Improvement Effect

The expected effects of the above rehabilitations are shown in the table below. This table reveals that positive implementation of each item will have significant effects, leading to a strengthened financial base of TES4.

The Rehabilitation Improvement Effect for the Equipment (Rank A)

Rehabilitation Improvement Item	*Rehabilitation Improvement Effect (MTug/year)*
(1) Reduction of Auxiliary Power Ratio	693.6
(2) Recovery of Condenser Vacuum	170.3
(3) Saving Heavy Oil Consumption	164.3
(4) Increase in Power Availability	10,749.4
Total	11,777.6

3) Future Maintenance and Rehabilitation Plan

The future maintenance and rehabilitation plan is shown below.

Large-scale Rehabilitation works (FC)	Phase-Ⅱ (7,000 MYen)	Rank A (9,000 MYen)	Rank B (4,700 MYen)	Remodeling for prolongation of the life of equipment
Routine repair (LC) (including Rank C)	In 2000: 7% (2,800MTug) (including No.4 ash pond)	In 2006: 8% Preventive maintenance organization is fixed gradually.	In 2011: 10%	In 2016: 12%
Extraordinary rehabilitation works (FC+LC)	80 MW Turbine F.S. No.5 ash pond (10,000MTug)	80 MW Turbine Modification	No.6 ash pond (10,000MTug)	Environmental measures

4) Economic and Financial Evaluation

An economic and financial evaluation was made on the A-ranked rehabilitation plan based on the rehabilitation improvement effect and the future maintenance and rehabilitation plan. The result is shown below:

- The economic evaluation resulted in B/C=3.21, showing viability of the rehabilitation plan, although EIRR could not be calculated.
- The financial evaluation resulted in FIRR=3.83% and B/C=0.69, revealing that the plan was not favorable from the standpoint of corporate profitability, but this conclusion was due to TES4's low level of tariff, so that a raise in tariff would be necessary.

5) Funding Plan

As for the funding plan, the following 7 cases were established with different loans and other conditions.

Case 1: With the same conditions as Phase-II Yen credit

Case 2: No borrowing except for the arranged Phase-II Yen credit (It should be noted that this case is not realistic as the foreign currency portion must be borrowed from abroad because of Mongolia's shortage of foreign reserves)

Case 3: Interest rate for foreign currency is 30% (average rate for short-term lending in 2000 according to the statistics of the Bank of Mongolia) and the remaining conditions are unchanged from Case 1.

Case 4: Modifying Case 3 by changing the foreign interest rate to 10%, an allowable rate to make the cash flow for each year positive.

Case 5: More realistic loan conditions for foreign currency with a 5-year repayment period and (grace for construction time) and 30% interest rate.

Case 6: Modifying Case 5 by changing the foreign interest rate to 5.5%, an allowable rate to make the cash flow for each year positive.

Case 7: Modifying Case 5 by changing the sales prices to: power 33.35/kWh and heat 6,900/Gcal, the minimum level to make the cash flow for each year positive and to avoid capital deficiency.

Cases 1, 3 and 4 assume a 20-year repayment period, but are not possible without soft conditions such as those provided by yen credit with an interest rate as low as 1%. Case 2 is a case where all the funding requirements can be met by its own fund, but in reality, foreign currency is necessary, so that this case is not possible either.

Of the above 7 cases, Case 5 is the case the most likely to be faced by a corporation that may possibly be privatized in future. As seen in Case 6, even if an unrealistically low interest rate is applied, capital deficiency occurs and the case becomes impossible, which leads to the belief that a price hike is necessary as in Case 7.

To that effect, the first thing to do is to make accounting treatment appropriate, implement asset revaluation and normalize the depreciation period in order to prepare financial statements more properly reflecting the actual financial situation. The next thing concerns loan conditions; as there has been no long-term lending in the financial market in Mongolia and loan conditions are unclear, improvement of the financial market is essential, while TES4 must make borrowing conditions clear through negotiations for each loan and prepare funding plans considering the size and timing of the price hike and whether to procure local fund requirements by its own fund.

(2) Organizational Reform

TES4 was corporatized in September 2001, and managing the plant as an independent profit-making enterprise and strengthening management bases and vitality are required, so TES4 should reconsider its organization with particular attention paid to its autonomy. It will be necessary to streamline the organization and to delegate the powers to lower levels, discontinuing the system of decision-making only by the top level so as to create a change of mind-set in the lower organizations. Moreover, it will be necessary to create new departments for safety and health and for quality control to strengthen the awareness of accident prevention and the stable supply of power and heat.

With regards to plant maintenance, it will be necessary to concentrate repair functions in the Repair Department by transferring repair functions scattered in different sections of the operation to that department, thus making clear the Repair Department's responsibility for equipment failure and promoting quality improvement of maintenance work. The main recommendations are shown below:

- Streamline and make clear the line and staff organization and the chain of command
- Delegate powers to lower levels and share the information within each section (make different departments and sections thoroughly relate to each other)
- Create a Safety and Health Department and Quality Control Department

(3) Administration of the Plant Equipment

1) Administration of the Operation

Trips and failure of equipment due to wrong operation by the operators in TES4 have occurred frequently – out of 202 shutdowns in 2000, some 24% of the shutdowns was due to wrong operation by the operators. Hence, countermeasures will be essential and the points to be improved are shown below:

- Understanding of plant observation items, alarm values and limiting values, and preparation of the relevant measuring instruments
- Strict implementation of inspection patrol and understanding of check points of equipment
- Preparation of operation manual and schematic diagrams of the plant
- Improvement of the method for taking over the next shift and means of in-house communication
- Improvement in keeping the operation logs: log sheet, chart, long-term deterioration record and monthly efficiency report
- Supervising states of switchgear strictly for maintenance and improvement of coping with accidents; utilization of training simulator and preparation of operation procedure in case of accidents.

2) Administration of the Maintenance

Given that the repair groups have been repeating similar failures, which leads to a decrease in confiability and an increase in maintenance cost, it will be necessary to take the following countermeasures as shown below:

- Improvement in maintenance administration organization: daily repair work, major overhaul and middle overhaul
- Understanding of plant conditions: history record of maintenance, inspection results and analysis of causes of failure
- Preparation of a maintenance plan based on permanent countermeasures and remaining life assessment
- Preparation of repair manual and improvement in repair skills: preparation of a manual and feedback on repair works
- Preparation of replacement parts and materials and maintenance of repair and testing tools
- Improvement of workplace environment

3) Administration of the Engineering

Management items closely related to the power plant operation, as shown below, are scattered in different sections, which does not allow for efficient management. The administration of the engineering improves the plant efficiency, protects the environment and maintains the plant. Therefore, it will be necessary to review the current organization. Specifically, administration management should be concentrated in a department, absorbing the Engineering Department and Research Department, and particular emphasis should be placed on efficiency management. The relevant departments should cooperate to detect the causes for efficiency decreases and to conduct countermeasures. The items of centralized management are shown below:

- Plant efficiency control
- Coal quality control
- Plant water quality control
- Boiler combustion control
- Plant performance test

4) Administration of the Fuel

It is important to positively make purchase plans, inventory control and administration of receiving and dispatching facilities.

5) Administration of the Inventory

Inventory control is to quantitatively control purchases and stocks such as spare parts in order to assure the procurement of spare parts as planned in terms of quantity and quality, and to store them in such as way as not to deteriorate their functions. It is necessary to conduct control as planned and without waste in close coordination with the maintenance plans.

6) Administration of Safety and Health

A poor working environment will not only cause industrial accident and occupational disease but also adversely affect of repair work result. The table below shows that there were over 112 industrial accidents in 2000. It is necessary to improve the current working environment. To that effect, it will be necessary to create a department of safety and health control under direct control of the president and to implement the following items in order to improve occupational safety and health.

Number of Industrial Accidents and Return to Work in 2000

(Unit: Case)

Number of Industrial Accidents (number of medical certificates)	*Return to work*		*Situation of recipients of compensation*		
	Change of job	*Return to the original job*	*Continuing to work*	*Retired*	*Dismissed*
112	17	35	10	12	38

- Improvement of work place environmental administration organization
- Thorough instruction for improvement of the work place environment (illumination, dust and noise)
- Accident occurrence and measures for reducing industrial accidents to zero
- Patrol for safety and fire prevention and display of points of danger (hazard display)
- Safety instructions for repair work, display of work place, and proper arrangement and order of work place
- Safety education (participation in an external seminar and practice of safety education in-house)
- Workers' health check

(4) Environmental Conservation

The required items of environmental conservation for TES4 are, firstly, the addition of ash disposal ponds and, secondly, the installation of sirens for safety valves. Moreover, utilizing ash and reducing SO_X in flue gas is expected to be required in future, so it will be necessary to prepare for the necessary funds as planned. Shown below are the evaluations and recommendations regarding environmental conservation:

1) TES4 Flue Gas

Measurements made in 1998 show that the density of soot discharged from each unit (converted in 6% O_2) varies widely, ranging between 463 - 735 ppm for SO_2 and 142 - 475 ppm for NO_2.

The dust density (converted in 6% O_2) ranges from 190 to 942 mg/m^3N in 1998 - 2000.

2) Calculated diffusion of soot

Soot diffusion was calculated by a simple method, revealing that the landing point of maximum density reached a distance of more than 30 km both at an average wind speed of 1.9 m/s and at a maximum wind speed 9.0 m/s in the winter of 2000 (stability of atmosphere: more than 90%), which leads to the supposition that air pollutants had little influence on the city.

3) Noise

Under normal operation of the plant, the noise levels measured in the premises of the plant and the vicinity were below the standard value of 85 dB (A) with little influence on the surrounding environment. However, sometimes when the safety valves discharged steam, the level of acoustic pressure of the safety valves reached about 150 dB (A), exceeding the standard and also beyond the standard level of 85 dB (A) in the vicinity of the power plant. Therefore, it will be necessary to equip noise-eliminating measures such as a silencer.

4) Waste water treatment

All of the waste water of the power plant except domestic waste water is collected in a slurry pit to be utilized for the transport of ash to the ash disposal pond. The current system has no wastewater treatment but wastewater is not discharged out of the system, so it can be considered to have no influence on the surrounding environment.

5) Problems regarding operation of the ash pond

No.3 Ash Pond, which has been used since 1995, is almost full and it will be difficult to meet the demand from 2002. No.4 Ash Pond, which is now under construction, is of an emergent nature (at some 2 year's of capacity), so that it will be necessary to construct another ash disposal pond with a larger capacity for a stable power supply at the earliest time possible.

Relatively strong winds in spring may affect the surrounding environment with flying ash from No.3 Ash Pond. It will be necessary to conduct partial soil cover, periodic water spray and other measures.

(5) Personnel Training

Even if an excellent organization and management system is established, no growth of an enterprise can be expected without the right human resources. Personnel training within a company is to provide the necessary expertise and personnel training based on the corporate philosophy, business goals and business strategy. It will be necessary to make clear the purpose of a particular personnel training, how the personnel training will be reflected in daily work and to establish a training curriculum with understanding and awareness at organizational and individual levels.

A performance appraisal system including management by objective and a suggestion encouragement system should be periodically reviewed to avoid the mannerism and demerit system. It is vital for each member of staff to conduct a circle of plan, do, check and action consciously. Shown below are the items to be improved:

- Promotion of on-the-job training
- Personnel training of operation and maintenance as well as efficiency management
- Establishment of corporate philosophy
- Elicitation of common problems
- Thorough implementation of management by objective and review of the performance appraisal system
- Promotion of the suggestion encouragement system

(6) Financial Management

It will be necessary to change management policy from production-first to profit attaining principles as planned with more profit awareness. The responsibilities for budget making and execution should be made clear in each department and it will be necessary to establish such a system so as to be able to respond flexibly to factors of budgetary change and review cost, the distinction between direct and indirect sections and the production cost calculation for power and heat in order to determine a more accurate production cost.

Fund management will be one of the most important issues of management. Although it is not clear how the issue of receivables and payables will be solved, it will be necessary to prepare funding plans for working funds and capital funds for the future self-management of funds and to establish a system of fund management as a corporation able to conduct fund monitoring and timely measures in order not to fall short of funds.

CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 Background of Study

Mongolia, with an area of approximately 1.56 million km^2 (about 4 times the area of Japan) is located in the eastern part of Central Asia. The country is a landlocked country surrounded by the Russian border in the north and Chinese border in the south. It has a continental climate, with an annual average temperature of 1°C below zero. During the coldest season (from December to January), the outdoor temperature often drops down to 40°C below zero. The annual rainfall is about 300 mm and the rainy season is from June to September.

The population of Mongolia is about 2.4 million. And 0.8 million people live in Ulaanbaatar (about 30% of all population), which is the capital city of Mongolia.

The total capacity of all the power generating facilities in Mongolia is about 830 MW. The electric power supply in this country is fed by three major electrical power systems, namely the Central Energy System (CES), the Eastern Energy System (EES) and the Western Energy System (WES).The power generation capacity of the CES, which has the largest consumption area (Ulaanbaatar City), is currently about 790 MW. TES4 in this study belongs to CES and supplies about 63% of the electrical power demand in CES and about 64% of the total thermal energy demand in Ulaanbaatar City.

However, this power plant was made in former Soviet Union and designed to operate by the indirect combustion system. Because of the frequent occurrence of accidents, the availability of this power plant has been very inferior and this has resulted in frequent electrical power failures as well as the low temperature of hot water for room heating purposes.

In addition to the above project, the counter measure for ashes processing system blockage, the countermeasure for wear-proof coal pulverizer system, and rehabilitation of the hot water supply system has been implemented through two grant aid programs started from 1992.

To cope with this situation and upon the request of the Government of Mongolia, the Japanese Government has started the Phase-I project (for a combustion system conversion of boiler No.1 in 4 out of a total of 8 boilers, improvement-renewal of the control equipment and the supply of boiler tubes) in TES4 under a loan assistance program, which began in 1996.

In May 1998, the Mongolian Government requested loans from the former OECF (the current Japan Bank for International Cooperation, or JBIC) for the conversion of the combustion method of the boilers (No.5 to No.8 boiler), rehabilitation of the control units (No.5 to No.8 boiler), replacement of the generator excitation systems (No.1 to No.4 Generator), replacement of boiler tubes, etc. as Phase-II of the Rehabilitation Project of the power plant.

This study based on above-mentioned request was implemented, and the M/M signed on July 2 1999, and the S/W signed on September 6 1999.

1.2 Purpose of Study

This study aimed at the implementation of the following works for Phase-II of the Rehabilitation Project of the 4th Thermal Power Plant in Ulaanbaatar, Mongolia. By the study implemented from last year, the purpose of the study has been completed as scheduled.

- Collection, sorting and review of the available material information, and literature
- Plant survey of the existing facilities
- Determination and verification of the specifications of the equipment to be rehabilitated in Phase-II and cost estimation to be incurred on the project
- Preparation of the bidding documents
- Preparation of maintenance and rehabilitation plans for the existing whole plant

In accordance with the Agreement confirmed between Mongolia and JBIC, technical specification of the equipment to be rehabilitated in Phase-II and cost estimation were studied. The bidding documents and cost estimation report were duly completed and submitted to Mongolia in September 2001. Accordingly, this report has been made with the focus on maintenance and rehabilitation plans for the whole power plant.

To achieve successful implementation of the rehabilitation project of the existing thermal power plant and to promote the superior results of the Project, establishment of the maintenance and rehabilitation system is necessary not only for the equipment referred to in the loan assistance, but also for the equipment not referred to in the loan assistance. For this reason, the plan for maintenance and rehabilitation referred to all equipment of the existing thermal power plant.

For the management of the electrical thermal power plant including the promotion plan for employees and the economic and financial evaluation, this maintenance and rehabilitation plan was studied from the global perspective. In addition to this, the plan was studied to take into account environmental protection.

1.3 Area of Study

The area to be studied was the 4th Thermal Power Plant and its surroundings (within the city of Ulaanbaatar) in Mongolia.

1.4 Scope of Study

This study was implemented in accordance with the Scope of Work (S/W), which was signed on September 6, 1999 and the scope of the study was as follows. Please note that the data used in this report are those collected until October 2001.

(1) Preparation of maintenance and rehabilitation plan

For the preparation of the plan, not only existing data, information, literatures and documents, but also outline of the design, drawings, supervision planning, construction schedule and executing organization etc. for all facilities and equipment to be rehabilitated were reviewed, examined and investigated.

The plan consisted of the planning of personnel education, training and also financial aspects, in addition to the planning of the facilities to be rehabilitated.

In addition to the above, the plan was designed to cover environmental protection such as air pollution, waste water penetration, ash disposal ponds and so forth.

(2) Cost estimation

The cost estimation for the plan including foreign and local currencies was studied and the annual planning of funds for the plan was examined.

(3) Economic and financial analysis

In relation to the maintenance and rehabilitation plan, the economic internal rate of return (EIRR), financial internal rate of return (FIRR) and sensible analysis were conducted. Based on the above analysis, future financial aspects (profit and loss, asset and balance sheet) were proceeded by consideration of the operation and maintenance.

(4) Assessment for the plan and recommendation

By assessing the plan and extracting problems, recommendations need to be made for the issues to be improved in the future such as the pollution caused by dust (especially), protection against pollution and utilizing waste water etc.

(5) Seminar of technology transfer

A seminar based on the plan needs to be held in Mongolia and the technology transfer to the counterpart should be strictly executed.

CHAPER 2

ECONOMIC SITUATION OF MONGOLIA

CHAPTER 2 ECONOMIC SITUATION OF MONGOLIA

2.1 Political and Economic Background

After the collapse of the Soviet Union and COMECON in 1990, Mongolia transformed from single-party dominance to multi-party democratic government and is on its way to a market economy from a centrally-planned economy. To that effect, liberalization policies have been pushed forward such as the liberalization of prices, international trade and foreign exchange rates, and the privatization and reform of economic sectors.

The disruption of economic infrastructure due to the withdrawal of the Soviet Union has inflicted a serious blow on Mongolia, which has depended mainly on the Soviet Union politically and economically.

Since 1921, The country had been assigned the role of raw material supplier to COMECON, so that monocultural economic development was conducted with copper mines as the main point of development and traditional stock farm products such as wool, leather and cashmere were exported to the Soviet Union. Most industrial products were imported from the Soviet Union on a barter basis. This basic structure of the economy has remained unchanged to date, although trading partners have changed.

Mongolia depended on the Soviet Union not only for international trade but also for technology, management, education and military back-up, which hampered the development of self-reliance and is currently forcing the change to a market economy.

Moreover, since the collapse of the Soviet Union, the country has not received support from the Soviet Union and Soviet technical staff and military troops have withdrawn. This situation has led to a drop in GDP of over 20% and economic dislocation due to a serious shortage of supply and foreign exchange.

Western countries, in response to the democratization of Mongolia in 1992, and as if to fill the void left by Soviet withdrawal, have been extending assistance to the country through aid organizations such as IMF, the World Bank, the Asian Development Bank and bilateral channels.

That assistance helped bail the country out of the economic crisis at the beginning of the 1990s and the country is now attaining a certain level of macroeconomic stability; however, the country is still faced with a pile of problems as it tackles self-sustainable economic development through a market economy.

2.2 Economic Situation

2.2.1 Economic Structure

The area of Mongolia is 1,564,000 km^2 and the population is 2,408,000, as of the end of 2000 with a density of slightly over 1.5 person/ km^2. About 57% of the population, 1,377,000 people, live in urban areas and rural villages, and the remaining live a nomadic life. In Ulaanbaatar, the capital of the country, there are 787,000 people, more than 30% of the total population, which shows over-concentration in a particular city.

This situation has led to considerable economic problems in maintaining its function as the country's capital, building the infrastructure and sustaining modern life consumption. It is said that over 35% of the population are below the poverty line, which is another important problem.

The economically active population is 848,000 people as of the end of 2000, of which 809,000 are employed with an unemployment rate of 4.6%, improved from 6.3% as of 1992. The employment structure is shown in Fig. 2.2-1 and nearly 50% are engaged in agriculture and stock farming

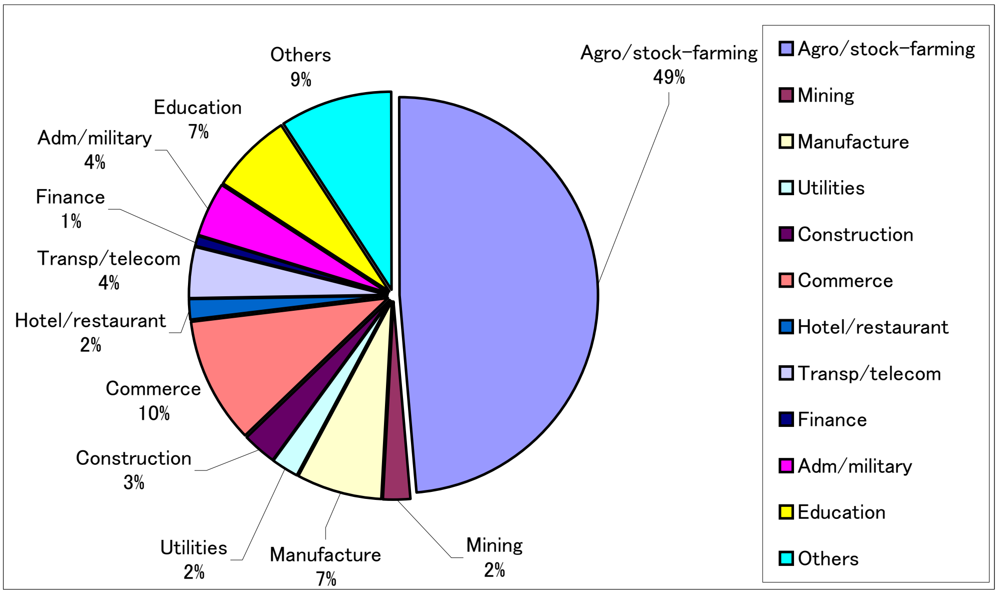


Fig. 2.2-1 Employment Structure

(Source： Mongolian Statistical Yearbook 2000)

Fig. 2.2-2 shows the industrial structure viewed from the GDP with 34% in agriculture and stock farming and 23% in commerce, which represent, combined together, nearly 60% compared to 14% in mining and manufacturing. In terms of mining and manufacturing output including power, heat and water, metal mining accounts for 45%, of which copper occupies the most. Coal accounts for 6%, supplying chiefly the power and heat sector and playing an important role. In manufacturing, textiles account for 11% and food processing for 12%, which represent, combined together, 23%, mainly processing produce from agriculture and stock farming. Electricity and heat account for 16%, showing its importance to the life and industrial infrastructure of the Mongolian economy.

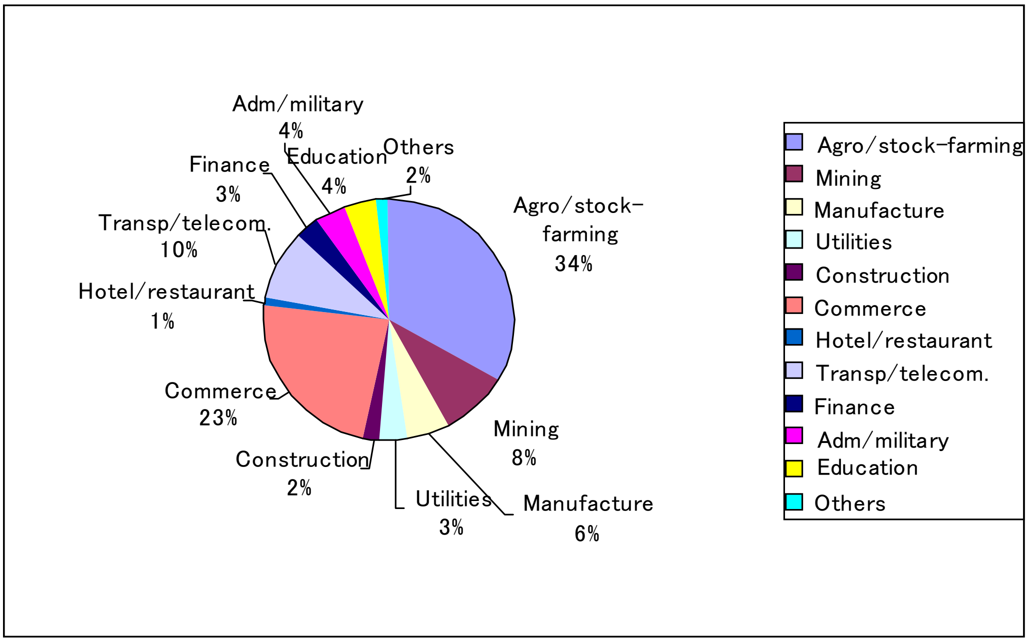


Fig. 2.2-2　Industrial Composition of GDP

（Source：Mongolian Statistical Yearbook 2000）

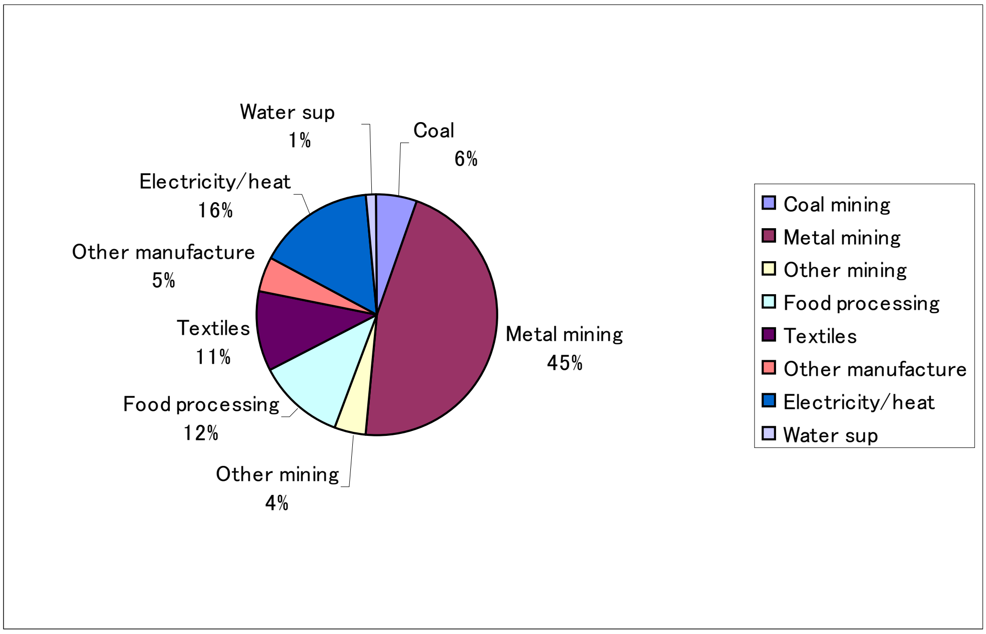


Fig. 2.2-3　Mining and Manufacturing Output

（Source：Mongolian Statistical Yearbook 2000）

In international trade, as seen in Fig. 2.2-4 and Fig. 2.2-5, mineral produce, mainly copper, and textile and leather goods are exported, while oil products and other minerals, clothing and manufactured products are imported.

Fluctuation in international prices of the country's main export items such as copper and cashmere and its main import items such as oil tends to exert a considerable influence not only on the balance of international payments but also on the whole economy, which means vulnerability inherent in the Mongolian economy to price fluctuations in the international market of the above items.

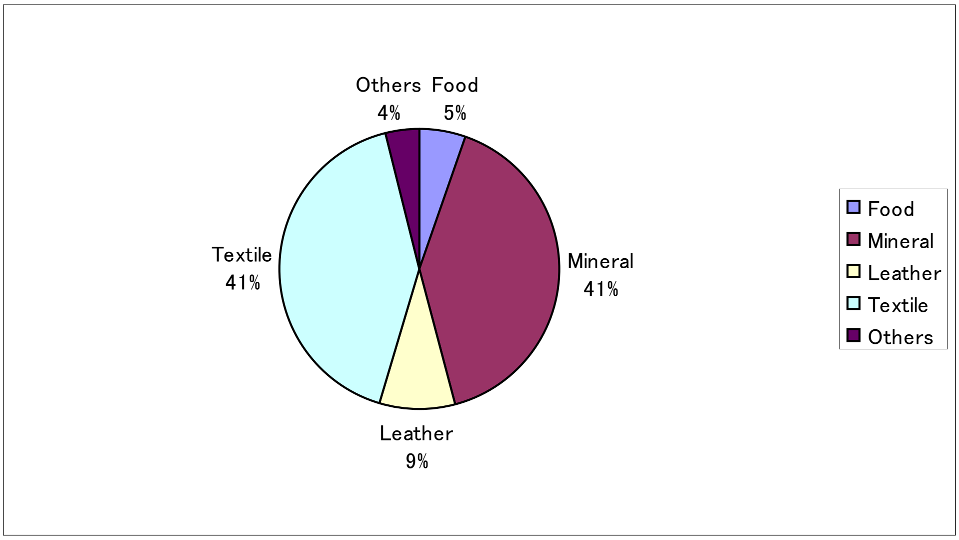


Fig. 2.2-4 Export Structure

（Source：Mongolian Statistical Yearbook 2000）

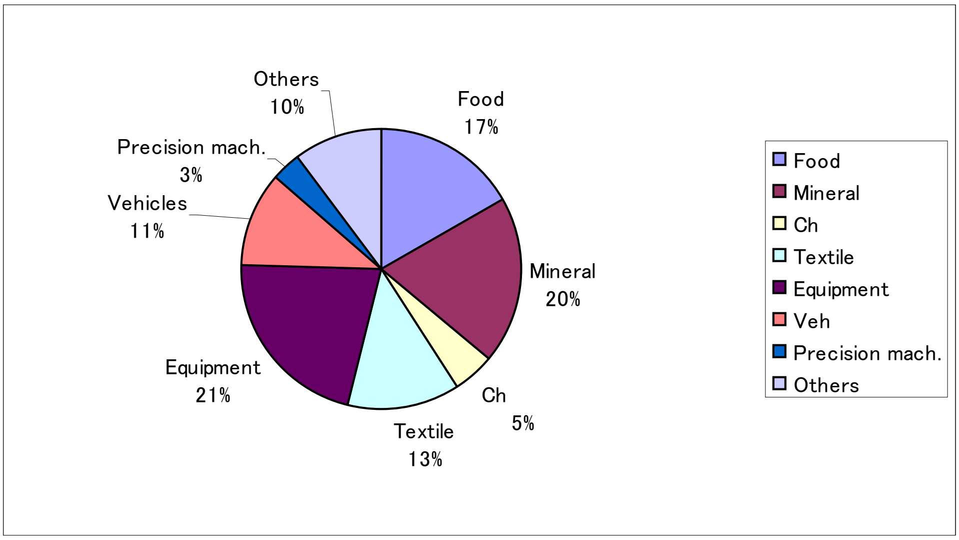


Fig. 2.2-5 Import Structure

（Source：Mongolian Statistical Yearbook 2000）

2.2.2 Transition of Economic Situation

The economic size of Mongolia is 1,045 billion Tug in terms of GDP as of the end of 2000 (preliminary estimate), equivalent to some 100 billion Yen. The magnitude of international trade is US$ 502 million in exports and US$ 632 million in imports, evidencing the country's heavy dependence on international trade.

Economic movement of Mongolia from 1990 through 2000 as shown in Fig. 2.2-6 by key economic indices reveals that GDP decreased considerably from 1990 through 1993, the period for the beginning of democratization.

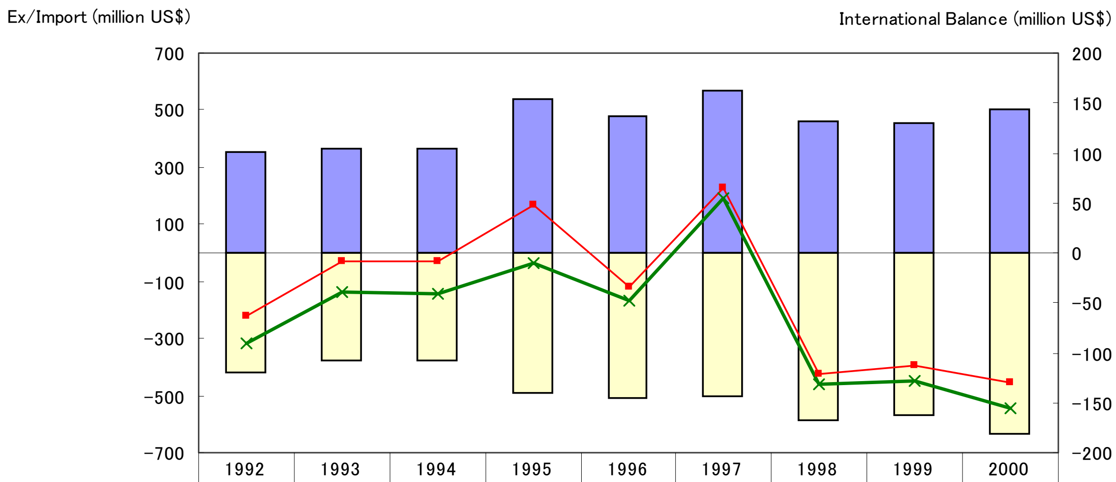
From 1994 saw a recovery, which has continued since then in both the sectors of industry, and agriculture and stock farming. It should be noted that the large decrease in agriculture and stock farming in 2000 was due to snow damage causing the death of as much as 3.5 million heads of livestock.

Year	1990	1991	1992	1994	1995	1996	1997	1999	2000
GDP growth (%)	-2.5	-9.2	-9.5	2.3	6.3	2.4	4.0	3.2	1.1
Industry	0.3	-12.5	-9.7	1.7	17.4	-2.0	4.4	1.7	7.3
Agro/stock-farming	-1.3	-4.4	-2.1	2.7		4.7	4.8	4.2	-21.4

Fig. 2.2-6 Real GDP Growth Rate

(Source：Ministry of Finance and Economy)

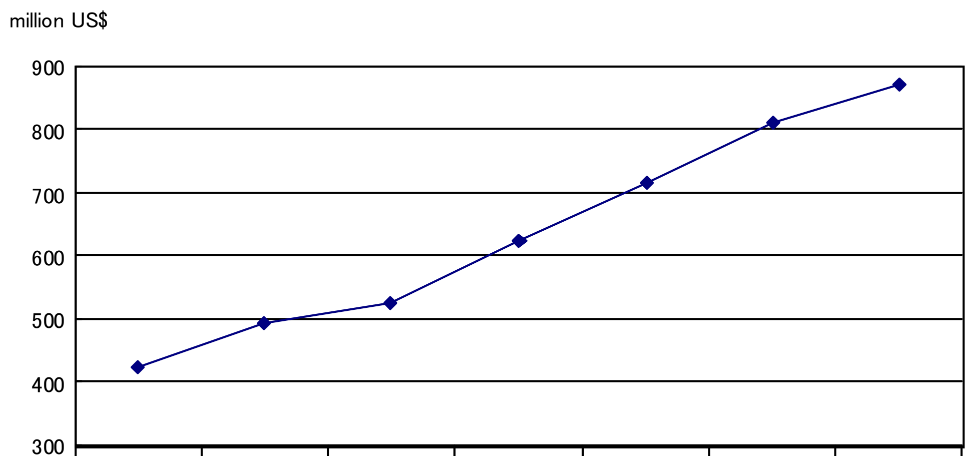
Fig. 2.2-7 shows the balance of international payments, illustrating a chronic deficit in trade and current balances (excluding the official transfer balance). Equilibrium on the balance of payments is attained by influx from financial assistance and overseas borrowing through international aid organizations and donor countries. That situation has increased the external debt burden year by year as shown in Fig. 2.2-8.



	1992	1993	1994	1995	1996	1997	1998	1999	2000
Export	355.8	365.8	367.0	537.4	475.8	568.5	462.4	454.1	502.0
Import	−418.4	−374.5	−374.9	−488.9	−510.8	−503.4	−584.5	−567.0	−631.6
Trade balance	−62.6	−8.7	−7.9	48.5	−35.0	65.1	−122.1	−112.9	−129.6
Current balance	−90.7	−39.9	−40.3	−11.0	−48.1	55.2	−131.3	−127.9	−156.0

Fig. 2.2-7 Balance of International Payments **(excl. official transfer balance)**

(Source : Ministry of Finance and Economy)

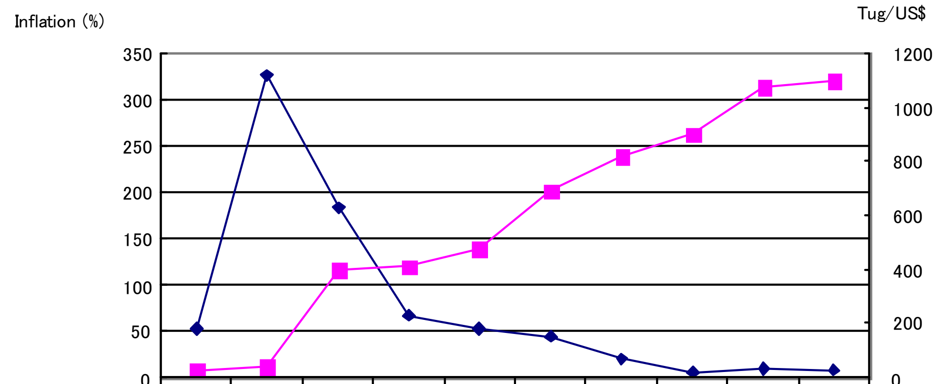


Year	1994	1995	1996	1997	1998	1999	2000
External debt	423.5	493.7	525.4	622.5	717.7	809.3	871.1

Fig. 2.2-8 External Debt Burden

(Source : Ministry of Finance and Economy)

Regarding inflation as seen in Fig. 2.2-9 with the consumers' price index, the first half of the 1990s saw three-digit hyperinflation and inflation calmed down to below 10% from 1998 onward. Meanwhile, the Tug was devalued by over 60% in 2000 with respect to 1993.



Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Consumer price index change(%)	52.7	325.5	183.0	66.2	53.3	44.6	20.5	6.0	10.0	8.1
Exchange rate (against dollar)	25.9	40.0	396.5	414.1	473.6	693.5	813.2	902.0	1,072.0	1,097.0

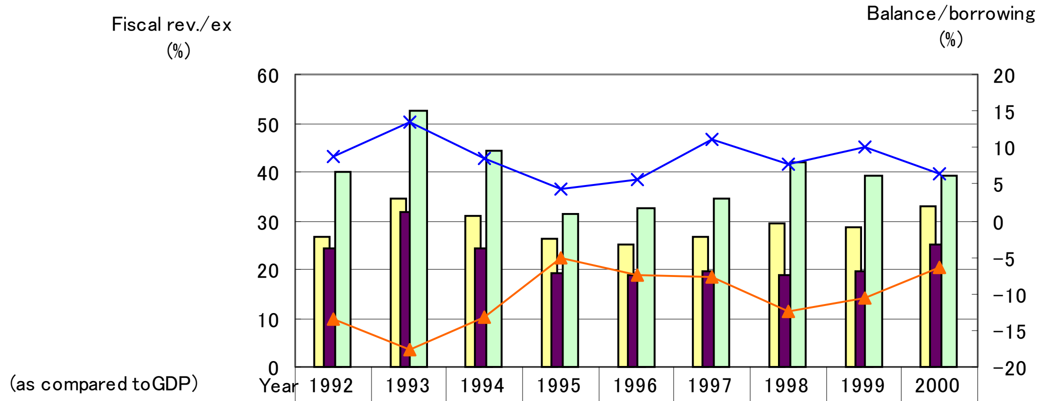
Fig. 2.2-9 Inflation and Exchange Rate

(Source : Ministry of Finance and Economy)

The economic overview from 1990 as shown above has revealed that the country's economy has stabilized in terms of GDP and inflation, while the country's trade structure with chronic deficit and vulnerability to international prices of prime trade items remain large destabilizing factors. Recent macroeconomic stability has been attained mainly by support from the international community and a pile of problems still remains on the road to self-supporting development.

Fiscal conditions of the Mongolian government, as shown in Fig. 2.2-10, reveal that government spending accounts for about 40% of GDP as of the end of 2000, having a considerable weight with the country's economy. Government spending has been curbed but tax revenues have not been able to cover the spending so the fiscal deficit has been made up mainly with government borrowing from abroad.

One of key targets in economic management by the government has been to curb inflation and stabilize the exchange rate of the Tug, so that a policy of money and fiscal restraint has been adopted. This tightening policy took effect by holding down inflation but caused the issue of arrears in government organizations with business enterprises, which has led to a debt cycle among business enterprises.



Year	1992	1993	1994	1995	1996	1997	1998	1999	2000
Fiscal revenue	26.6	34.7	31.0	26.3	25.2	26.7	29.4	28.8	32.9
Tax revenue	24.3	31.7	24.4	19.2	18.7	19.7	18.8	19.6	25.2
Fiscal expenditure	40.1	52.5	44.2	31.5	32.7	34.5	41.9	39.4	39.3
Fiscal balance	−13.4	−17.7	−13.3	−5.2	−7.5	−7.8	−12.5	−10.6	−6.4
Official borrowing (external)	8.7	13.4	8.5	4.3	5.5	11.1	7.7	10.1	6.4

Fig. 2.2-10　Fiscal Situation

(Source：Ministry of Finance and Economy)

The government of Mongolia has set targets such as GDP growth at 6%, inflation at 5% and deficit of the balance of international payments at 13% of the GDP (at the current balance excluding the official transfer balance) in its mid-term targets for the next 3 years announced in 2001's, "The Government's Medium Term Strategy and Policies to Deepen Economic Reform and Restructuring." The government also intends to hold its fiscal deficit below 6.5% by curbing its spending to 37% of GDP against its expected revenues of 31% of GDP.

CHAPTER 3

SITUATION OF POWER AND HEAT SECTOR OF MONGOLIA

CHAPTER 3 SITUATION OF POWER AND HEAT SECTOR OF MONGOLIA

3.1 Sector Structure and Reform

3.1.1 Sector Structure

The power and heat sector of Mongolia is currently (at the time of survey, October 2000) operated by state-owned enterprises under the supervision of the Ministry of Infrastructure. There are three main power grids: the CES linking Ulaanbaatar, the capital of Mongolia, Darkhan, an iron-making city, Erdenet, a copper-mining city and Baganuur, a coal-mining city; the EES centered in Choibalsan; and the WES with constant supply from Russia. In all of these systems, state-owned enterprises are engaged in the power and heat supply business.

Rural areas, which are not connected to these systems, have publicly-operated diesel power stations in Aimags and Soums. The three power grids mentioned above are not interconnected.

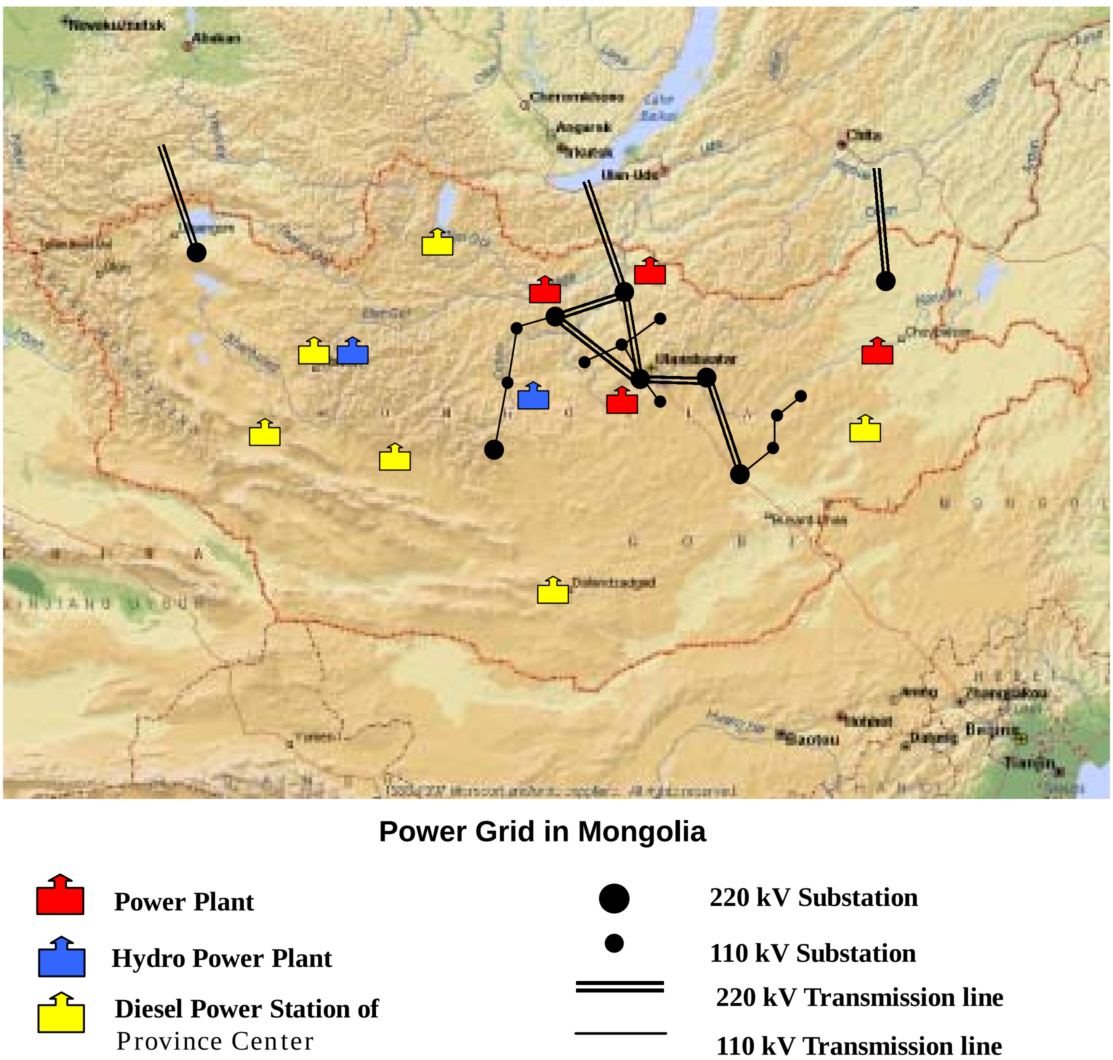


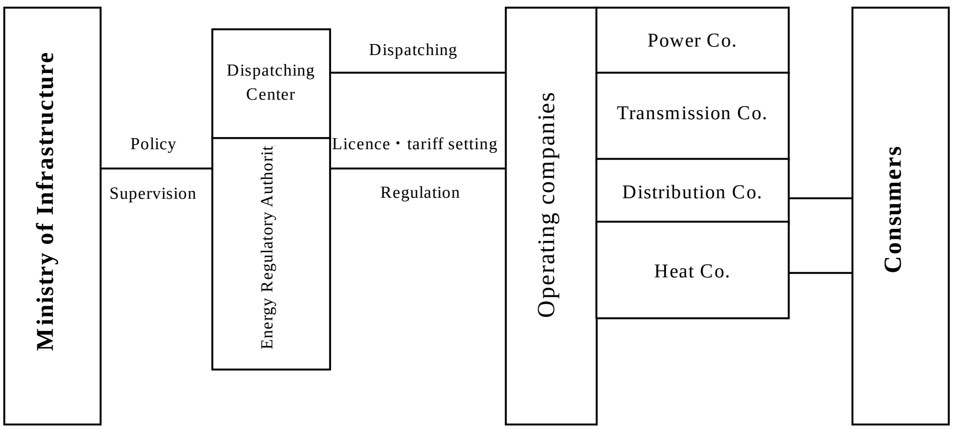
Fig. 3.1-1 Power Grid in Mongolia

In the CES, the largest power grid, there are Thermal Power Plant No.2 (21.5 MW), Thermal Power Plant No.3 (148 MW) and Thermal Power Plant No.4 (540 MW) in Ulaanbaatar, supplying power and heat. There is the Darkhan Power Plant (48 MW) in Darkhan, and the Erdenet Power Plant (28.8 MW) in Erdenet. The total installed capacity of the CES is 786.3 MW.

The EES has the Choibalsan Power Plant (36 MW), while the WES is supplied with electricity from Russia, keeping diesel power on standby for emergency. The total installed capacity of Mongolia is 828.3 MW including the Dalandzadgad Power Plant (6 MW) commissioned in 2000 in the southern Gobi region.

All of the power plants in the three main power grids are coal-fired using domestic coal. Heavy oil used for the startup of power plants and diesel oil used for diesel power plants come entirely from Russia. As coal-fired power plants have a limited ability to follow load, the CES imports electricity from Russia to meet peak demand.

Power produced by the above plants is supplied to each Energy Distribution Office (EDO) through a Transmission Company and heat to Heat Distribution Office (HDO). The Energy Regulatory Authority (ERA), in line with policies established by its supervisor, the Ministry of Infrastructure (renamed the Ministry of Infrastructure Development) supervises and regulates the sector by granting business licenses and approving tariffs.



3.1.2 Sector Reform

The government of Mongolia has been engaged in power sector reform for many years as part of market-oriented economic reform. Some structural reforms have so far been made and the New Energy Law enacted in April 2001 makes clear the unbundling of generation, transmission, distribution, dispatch and supply, and makes the acquisition of a license compulsory for each specified business.

The Law also created the Energy Regulatory Authority (ERA), actually established in June of the same year, replacing the Energy Authority (EA) to take charge of the supervision and regulation of the power and heat sector. In addition, the Law has made independent state-owned enterprises of generation and distribution, which had been administered by the EA, and established dispatch and transmission business concerns as the National Dispatching Center and the Transmission Company.

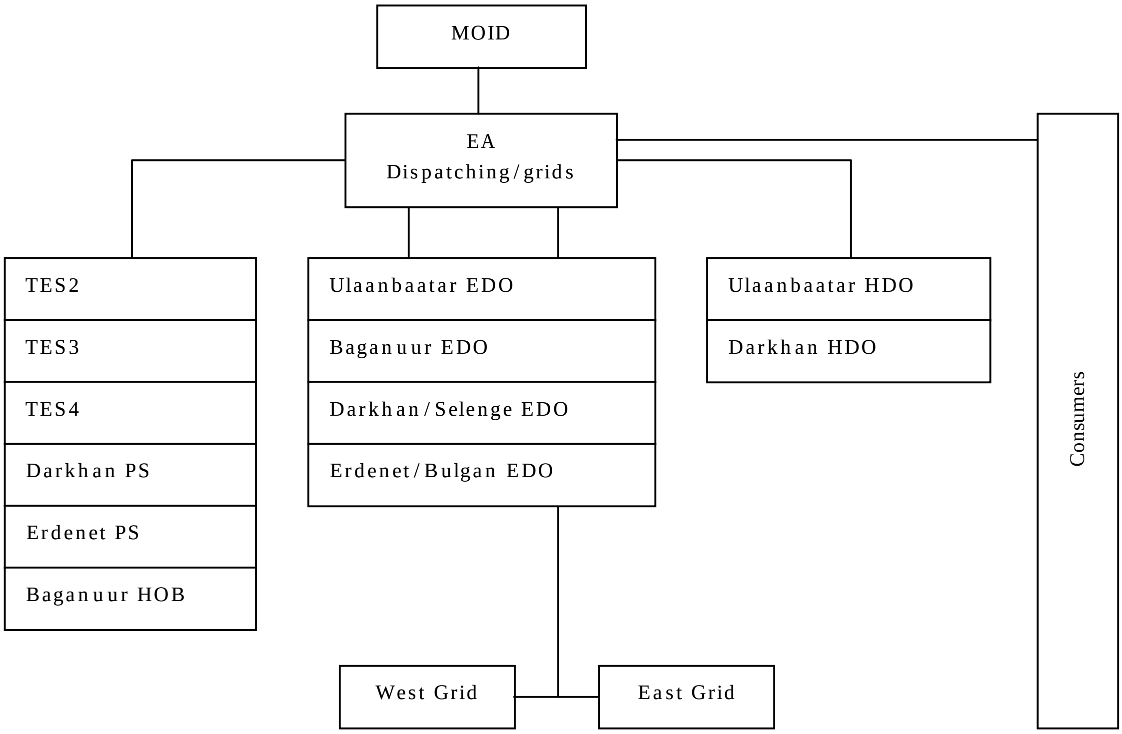
In August 2001, a decree was issued to corporatize 18 state-owned enterprises in the energy sector. Thus, it can be said that prima facie, legal and structural grounds have been established with a view to market-oriented reform. At the same time, the government owns all the shares of those corporations so a major issue remains concerning how much management independence the new corporations can acquire on account of their being government-owned joint stock companies.

The power sector reform movement to date will be described below.

Until 1996, state enterprises for each power grid such as the CES operated vertically integrated power business from generation to distribution under the supervision of the then Ministry of Energy, Geology and Minerals (MEGM).

The Energy Law enacted in 1996 created the EA to replace CES and other state enterprises. The EA successfully acquired the power and heat supply facilities of those state enterprises to manage all three power grids. In terms of organization, the EA became the parent company of each operating company, the latter of which became its subsidiary, to set out financially independent state-owned enterprises covering the supply cost.

This reform gave the EA 6 major thermal power plants, 4 power distribution offices and 2 heat distribution offices under its ownership and supervision. At the same time, power grids and dispatching were directly operated by the EA. The MEGM was also reorganized to become the Ministry of Infrastructure Development (MOID) to supervise the EA.



Along with that reform, in order to enable market-oriented business operation, EA opted to introduce an accounting system to conform to the International Accounting Standards (IAS) instead of the Soviet accounting system.

At the same time, in order to make the tariff level sufficiently reflect the practical production cost, asset revaluation was conducted based on the factors approved by the Ministry of Finance. Tariff was revised several times to improve the financial situation of the EA: a 60% raise for power and heat in September 1996, 28% for power and 13% for heat in January 1997 and 15% for power and 80% for heat between May and July of the same year, striving for sufficient revenue recovery to cover the supply cost and rational profit.

Furthermore, in order to maintain a practical level of tariff, the automatic tariff adjustment mechanism was introduced from September 1997 and the tariff was raised by over 20% in 1998 reflecting devaluation of the Tug. Since then, no raise had been made on account of political considerations until the tariff was raised by 14% for power and by 35% for heat in December 2000. Nevertheless, the heat sector remained in deficit against the power sector in surplus and such a situation could not improve the EA’s chronic deficit as a whole.

In spite of the supposedly financial independence of each state-owned enterprise, they were forced to follow the intentions of the EA and the government with respect to the production plan, tariff, budget, sales recovery, personnel assignment and other important issues of management and could not have autonomy.

In April 2001, the government of Mongolia enacted the New Energy Law in order to realize a radical reform based on market-economy principles. Thus, the EA was disbanded and the foundation for energy sector reform was laid based on a market economy. Nevertheless, the EA would remain in existence with a limited function and would take charge of the recovery of accumulated receivables and payables of energy sales according to the "Privatization Guidelines for 2001-2004."

The above Privatization Guidelines are intended to conduct the sector reform in two stages: the first stage will reform the sector in such a fashion as to commercialize the current system of management and production in line with market principles. To that effect, the following measures are to be taken:

1) Separate the regulatory function from the EA and delegate it to an independent regulatory organization according to the New Energy Law;
2) Reform the business units of energy production and distribution into commercial corporations;
3) Separate and privatize the repair and maintenance sections from the generation and transmission corporations; and,
4) Reorganize the EA into an organization in charge of the recovery of receivables and payables.

In August 2001, the following state-owned enterprises were corporatized by a decree according to the above guidelines. As of the time of survey, however, those corporations remained wholly owned by the government.

- Generation: TES2, TES3, TES4, Erdenet Power Plant, Darkhan Power Plant, Dalandzadgad Power Plant
- Heat Production: Baganuur HOB (heat only boiler) Nalaikha HOB
- Transmission: Central Transmission Co., Eastern Transmission Co. and Western Transmission Co.
- Distribution: Ulaanbaatar EDO, Erdenet/Bulgan EDO, Darkhan/Selenge EDO, Baganuur/ Southeastern EDO
- Heat supply: Ulaanbaatar HDO and Darkhan HDO
- Dispatch: National Dispatching Center

The above first stage has almost been completed to date in legal and organizational terms. In the meantime, the management of each corporation and business relations between them are a major issue with a view to reform based on a market economy and commercialization. At the same time, a huge pile of accumulated receivables and payables between the corporations, government organizations and coal companies remains a serious issue for their management.

The second stage of the sector reform is going to implement phased privatization of the above corporatized power and distribution entities owned by the state, and is going to sell them to strategic investors by tender. The transmission companies and dispatching center are supposed to remain state-owned.

At the time of survey, the following corporations had been listed for privatization:

- TES2
- TES3
- Darkhan Power Plant
- Erdenet Power Plant
- Baganuur HOB
- Darkhan EDO
- Erdenet/Bulgan EDO

In future, foreign capital is expected to participate in the energy sector, while there are plans for the transit of pipelines for oil and gas as well as electricity between Russia and China. Development of those plans may considerably affect the country’s energy sector. At the same time, oil exploitation, now at the exploratory stage, is expected to bring about a considerable influence if its output is found to be large.

3.2 Power Supply and Demand

Table 3.2-1 shows the historical change of power supply and demand of the Central Grid which TES4 supplies.

Table 3.2-1 Historical Change of Supply and Demand of Central Grid (Unit：GWh)

	1990	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*
Power production (generation end)	3,348	2,722	2,612	2,481	2,523	2,628	2,614	2,720	2,574	2,740	2,871
Auxiliary power	534	626	525	552	562	598	579	608	532	628	640
Auxiliary power ratio (%)	16%	23%	20%	22%	22%	23%	22%	22%	21%	23%	22%
Power production (sending end)	2,841	2,096	2,087	1,929	1,961	2,030	2,035	2,112	2,042	2,112	2,231
Power import	228	84	99	198	215	381	383	376	356	195	184
Power export	76	33	68	53	60	28	69	42	60	59	25
Power supply (sending end)	2,966	2,147	2,118	2,074	2,116	2,383	2,349	2,446	2,337	2,248	2,390
Transmission loss	323	340	287	289	262	598	413	507	823	549	
Transmission loss (%)	11%	16%	14%	14%	12%	25%	18%	21%	35%	24%	
Power sales	2,643	1,807	1,831	1,785	1,854	1,785	1,936	1,939	1,514	1,699	
Power sales (growth rate)		-31.6%	1.3%	-2.5%	3.9%	-3.7%	8.5%	0.2%	-21.9%	12.2%	
Maximum demand	530	524	481	468	464	477	488	506	512	499	526
Maximum demand (growth rate)	-10.2%	-1.1%	-8.2%	-2.7%	-0.9%	2.8%	2.3%	3.7%	1.2%	-2.5%	5.4%

（Source：MOI ‘Capacity Building in Energy Planning’）

In 2000, power generation (at the sending end) amounted to 2,231 GWh against 2.841 GWh in 1990, when market-oriented economic reform began, showing a recovery of only 80%. This well illustrates that the economic collapse due to the loss of Soviet support and the withdrawal of Soviet troops, who used to be large consumers of energy in socialist times, had a huge impact on the energy sector.

Station loss and transmission/distribution loss continued to be large, which is considered to be due to aging of the facilities and other technical causes, and partly due to insufficient billing and theft, particularly with respect to transmission/distribution loss.

Fig. 3.2-1 shows the power supply composition on a kWh basis. TES4 meets 63% of the total demand as of 2000, evidencing its importance. Import from Russia accounts for 8%.

Fig. 3.2-2 shows the power demand composition on a kWh basis. Erdenet copper mines account for more than 30%. This leads us to believe that the operating situation of Erdenet copper mines and their payment of electricity bills affect the management of power utilities.

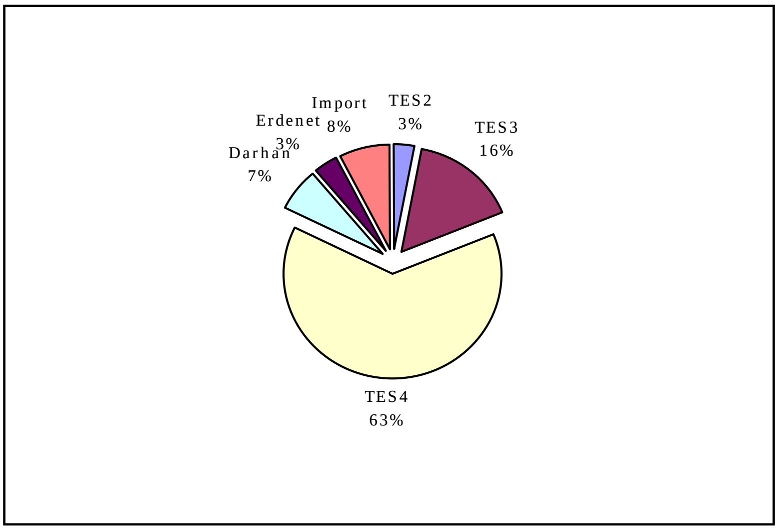


Fig. 3.2-1 Power Supply Composition of CES（as of 2000）

(Source: TES4)

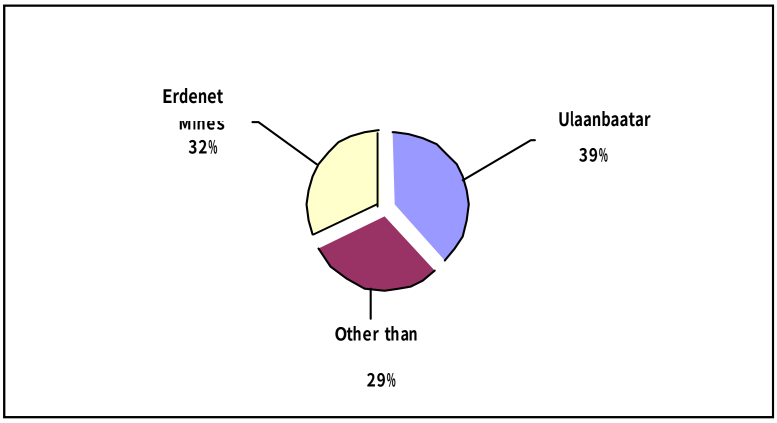


Fig. 3.2-2 Power Demand Composition（as of 2000）

(Source: MOI 'Capacity Building in Energy Planning'）

A power dispatcher operates the power system in such a way that part of the base load is allocated to other power plants rather than TES4, and the remaining part of the base load not covered by those power plants and the peak load are met by TES4. And the part of the peak load, which cannot be met by TES4, is covered by import from Russia.

Table 3.2-2 shows the power supply and demand forecast. This table is a forecast mainly based on a power system master plan prepared under technical assistance by ADB, showing a growth rate as high as 2.3% (average).

This forecast, which incorporates the effects of the rehabilitation of TES4 (expected maximum supply of 2,270 GWh), reveals that it will be necessary to continue power import from Russia and to plan new power plants in order to make up for the retirement of TES2 and TES3.

Table 3.2-2 (1) Power Supply and Demand Forecast

FORECAST ON POWER DEMAND(POWER & ENERGY) AND SUPPLY UP TO THE YEAR 2020

case-1: without phase-II, III project

			1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Supply	The 2nd Thermal Power Plant	MW		18	15	18	18	18	18	18	18	18	10	5	0
		GWh		78	63	78	78	76	76	76	76	76	42	21	0
	The 3rd Thermal Power Plant	MW		35	58	41	67	67	67	70	70	70	60	55	40
		GWh		200	331	234	371	382	382	399	399	399	342	314	228
	The 4th Thermal Power Plant	MW		270	315	315	320	330	340	350	360	380	380	390	400
		GWh	1,315	1,411	1,385	1,387	1,470	1,526	1,572	1,592	1,640	1,689	1,643	1,692	1,692
	Darkhan Thermal Power Plant	MW		29	22	32	32	32	32	32	32	30	28	25	24
		GWh		147	111	162	162	162	162	162	162	152	142	126	121
	Erdenet Thermal Power Plant	MW		16	16	22	22	22	22	22	22	22	22	22	22
		GWh		60	60	83	83	83	83	83	83	83	83	83	83
	New Power Plant	MW													30
		GWh													150
	Total	MW		368	426	428	459	469	479	492	502	520	500	497	516
		GWh		1,895	1,950	1,944	2,163	2,228	2,275	2,312	2,360	2,399	2,252	2,236	2,274
Demand	Maximum power demand	MW		488	506	512	521	531	540	550	560	570	580	593	601
	Energy demand	GWh		2,271	2,291	2,284	2,358	2,412	2,467	2,524	2,582	2,641	2,702	2,764	2,828
	Import Electric Power	MW		120	80	84	62	62	61	58	58	50	80	96	85
		GWh		376	341	340	195	184	192	212	222	243	450	528	553

			2008	2,009	2,010	2,011	2,012	2,013	2,014	2,015	2,016	2,017	2,018	2,019	2,020
Supply	The 2nd Thermal Power Plant	MW	0	0	0	0	0	0	0	0	0	0	0	0	0
		GWh	0	0	0	0	0	0	0	0	0	0	0	0	0
	The 3rd Thermal Power Plant	MW	40	35	35	35	35	35	35	35	32	20	18	0	0
		GWh	228	200	200	200	200	200	200	200	183	114	103	0	0
	The 4th Thermal Power Plant	MW	400	400	400	400	400	400	400	400	300	320	340	360	380
		GWh	1,692	1,692	1,692	1,692	1,692	1,692	1,692	1,692	1,692	1,692	1,692	1,692	1,692
	Darkhan Thermal Power Plant	MW	20	15	5	0	0	0	0	0	0	0	0	0	0
		GWh	101	76	25	0	0	0	0	0	0	0	0	0	0
	Erdenet Thermal Power Plant	MW	22	22	22	22	22	22	22	22	22	22	22	22	22
		GWh	83	83	83	83	83	83	83	83	83	83	83	83	83
	New Power Plant	MW	40	50	60	70	90	110	130	150	170	190	210	230	250
		GWh	200	250	300	350	450	550	650	750	850	950	1,050	1,150	1,250
	Total	MW	522	522	522	527	547	567	587	607	524	552	590	612	652
		GWh	2,304	2,301	2,300	2,325	2,425	2,525	2,625	2,725	2,808	2,839	2,928	2,925	3,025
Demand	Maximum power demand	MW	612	623	634	646	657	669	681	693	706	719	732	745	758
	Energy demand Ave. annual increase 2000 - 2020 2.3%/year	GWh	2,893	2,959	3,027	3,097	3,168	3,241	3,316	3,392	3,470	3,550	3,631	3,715	3,800
	Import Electric Power	MW	90	101	112	119	110	102	94	86	182	167	142	133	106
		GWh	589	659	727	772	743	716	691	667	662	711	704	790	775

Note) Phase III is the rehabilitation plant which ranked A, B and C to Chapter 5

Table 3.2-2 (2) Power Supply and Demand Forecast

FORECAST ON POWER DEMAND(POWER & ENERGY) AND SUPPLY UP TO THE YEAR 2020

case-2: with phase-II, III project

			1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Supply	The 2nd Thermal Power Plant	MW		18	15	18	18	18	18	18	18	18	10	5	0
		GWh		78	63	78	78	76	76	76	76	76	42	21	0
	The 3rd Thermal Power Plant	MW		35	58	41	67	67	67	70	70	70	60	55	40
		GWh		200	331	234	371	382	382	399	399	399	342	314	228
	The 4th Thermal Power Plant	MW		270	315	315	320	330	340	350	360	380	380	390	400
		GWh	1,315	1,411	1,385	1,387	1,470	1,526	1,572	1,592	1,673	1,723	1,676	1,726	1,726
	Darkhan Thermal Power Plant	MW		29	22	32	32	32	32	32	32	30	28	25	24
		GWh		147	111	162	162	162	162	162	162	152	142	126	121
	Erdenet Thermal Power Plant	MW		16	16	22	22	22	22	22	22	22	22	22	22
		GWh		60	60	83	83	83	83	83	83	83	83	83	83
	New Power Plant	MW													30
		GWh													150
	Total	MW		368	426	428	459	469	479	492	502	520	500	497	516
		GWh		1,895	1,950	1,944	2,163	2,228	2,275	2,312	2,393	2,433	2,285	2,271	2,309
Demand	Maximum power demand	MW		488	506	512	521	531	540	550	560	570	580	593	601
	Energy demand Ave. annual increase 2000 - 2020 2.3%/year	GWh		2,271	2,291	2,284	2,358	2,412	2,467	2,524	2,582	2,641	2,702	2,764	2,828
	Import Electric Power	MW		120	80	84	62	62	61	58	58	50	80	96	85
		GWh		376	341	340	195	184	192	212	189	208	417	494	519

			2008	2,009	2,010	2,011	2,012	2,013	2,014	2,015	2,016	2,017	2,018	2,019	2,020
Supply	The 2nd Thermal Power Plant	MW	0	0	0	0	0	0	0	0	0	0	0	0	0
		GWh	0	0	0	0	0	0	0	0	0	0	0	0	0
	The 3rd Thermal Power Plant	MW	40	35	35	35	35	35	35	35	32	20	18	0	0
		GWh	228	200	200	200	200	200	200	200	183	114	103	0	0
	The 4th Thermal Power Plant	MW	400	400	400	400	400	400	400	400	300	320	340	360	380
		GWh	1,862	1,998	2,134	2,270	2,270	2,270	2,270	2,270	2,270	2,270	2,270	2,270	2,270
	Darkhan Thermal Power Plant	MW	20	15	5	0	0	0	0	0	0	0	0	0	0
		GWh	101	76	25	0	0	0	0	0	0	0	0	0	0
	Erdenet Thermal Power Plant	MW	22	22	22	22	22	22	22	22	22	22	22	22	22
		GWh	83	83	83	83	83	83	83	83	83	83	83	83	83
	New Power Plant	MW	40	50	60	70	90	110	130	150	170	190	210	230	250
		GWh	200	250	300	350	450	550	650	750	850	950	1,050	1,150	1,250
	Total	MW	522	522	522	527	547	567	587	607	524	552	590	612	652
		GWh	2,474	2,607	2,742	2,903	3,003	3,103	3,203	3,303	3,386	3,417	3,506	3,503	3,603
Demand	Maximum power demand	MW	612	623	634	646	657	669	681	693	706	719	732	745	758
	Energy demand Ave. annual increase 2000 - 2020 2.3%/year	GWh	2,893	2,959	3,027	3,097	3,168	3,241	3,316	3,392	3,470	3,550	3,631	3,715	3,800
	Import Electric Power	MW	90	101	112	119	110	102	94	86	182	167	142	133	106
		GWh	419	353	285	194	165	138	113	89	84	133	126	212	197

Note) Phase III is the rehabilitation plant which ranked A, B and C to Chapter 5

3.3 Heat Supply and Demand

In major cities, heat is supplied by power and heat cogeneration facilities, and heat only boilers. Ulaanbaatar is supplied by TES2, TES3 and TES4.

Fig. 3.3-1 shows the heat supply composition as of 2000 (hot water and heat combined); TES4 accounts for 64%, playing an important role in the heat sector as well.

Table 3.3-2 shows the heat supply and demand forecast. This table shows a growth rate as high as 2.3% (average), similar to the power demand forecast and reveals that it is possible to meet the demand growth with the effects of the rehabilitation of TES4 (expected maximum supply of 7,600T-cal) in terms of demand volume.

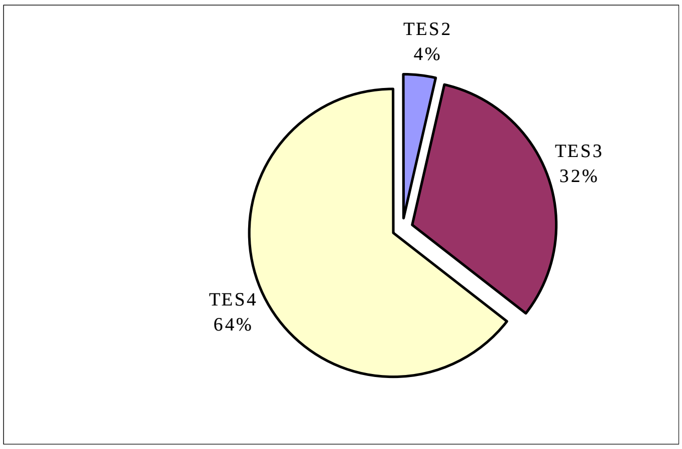


Fig. 3.3-1 Heat Supply Composition in Ulaanbaatar

(Source：TES4)

Table 3.3-1 (1) Heat Supply and Demand Forecast

FORECAST ON HEATING DEMAND AND SUPPLY UP TO THE YEAR 2020

case-1: without phase-II, III project

				1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Supply	The 2nd Thermal Power Plant	district heating	T-cal						120	120	120	120	120	120	120	120
		industrial steam	T-cal						25	25	25	25	25	25	25	25
	The 3rd Thermal Power Plant	district heating	T-cal						1,096	1,096	1,096	1,096	1,096	1,096	1,096	1,096
		industrial steam	T-cal						144	144	144	144	144	144	144	144
	The 4th Thermal Power Plant	district heating	T-cal	2,074	2,119	2,023	2,121	2,233	2,449	2,526	2,606	2,688	2,771	2,855	2,985	3,118
		industrial steam	T-cal	74	74	74	74	74	74	74	74	74	74	74	74	74
	ULAANBAATAR (Total)	district heating	T-cal	3,612	3,755	3,070	3,211		3,664	3,742	3,822	3,904	3,987	4,071	4,201	4,334
		industrial steam	T-cal	244	243	156	114		243	243	243	243	243	243	243	243
Demand	Energy demand 2000-2005 2.0%/year 2005- 2010 3.0%/year 2010-2015 2.4%/year 2015-2020 1.9%/year	gross distributed heat	T-cal	3,856	3,998	3,226	3,325		3,907	3,986	4,065	4,147	4,230	4,314	4,444	4,577
										0	0	0	0	0	0	0

				2008	2,009	2,010	2,011	2,012	2,013	2,014	2,015	2,016	2,017	2,018	2,019	2,020
Supply	The 2nd Thermal Power Plant	district heating	T-cal	0	0	0	0	0	0	0	0	0	0	0	0	0
		industrial steam	T-cal	0	0	0	0	0	0	0	0	0	0	0	0	0
	The 3rd Thermal Power Plant	district heating	T-cal	1,096	1,096	1,096	1,096	1,096	1,096	1,096	1,096	1,096	1,096	1,096	0	0
		industrial steam	T-cal	144	144	144	144	144	144	144	144	144	144	144	0	0
	The 4th Thermal Power Plant	district heating	T-cal	3,263	3,400	4,076	4,205	4,338	4,473	4,612	4,754	4,869	4,987	5,106	5,111	5,111
		industrial steam	T-cal	74	74	74	74	74	74	74	74	74	74	74	74	74
	ULAANBAATAR (Total)	district heating	T-cal	4,359	4,496	5,172	5,301	5,434	5,569	5,708	5,850	5,965	6,083	6,202	5,111	5,111
		industrial steam	T-cal	218	218	218	218	218	218	218	218	218	218	218	74	74
Demand	Energy demand 2000-2005 2.0%/year 2005- 2010 3.0%/year 2010-2015 2.4%/year 2015-2020 1.9%/year	gross distributed heat	T-cal	4,577	4,714	5,390	5,519	5,652	5,787	5,926	6,068	6,183	6,301	6,420	6,542	6,657

Note) Phase III is the rehabilitation plant which ranked A, B and C to Chapter 5

Table 3.3-1 (2) Heat Supply and Demand Forecast

FORECAST ON HEATING DEMAND AND SUPPLY UP TO THE YEAR 2020

case-2: with phase-II, III project

				1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Supply	The 2nd Thermal Power Plant	district heating	T-cal						120	120	120	120	120	120	120	120
		industrial steam	T-cal						25	25	25	25	25	25	25	25
	The 3rd Thermal Power Plant	district heating	T-cal						1,096	1,096	1,096	1,096	1,096	1,096	1,096	1,096
		industrial steam	T-cal						144	144	144	144	144	144	144	144
	The 4th Thermal Power Plant	district heating	T-cal	2,074	2,119	2,023	2,121	2,233	2,449	2,526	2,606	2,688	2,771	2,855	2,985	3,118
		industrial steam	T-cal	74	74	74	74	74	74	74	74	74	74	74	74	74
	ULAANBAATAR (Total)	district heating	T-cal	3,612	3,755	3,070	3,211		3,664	3,742	3,822	3,904	3,987	4,071	4,201	4,334
		industrial steam	T-cal	244	243	156	114		243	243	243	243	243	243	243	243
Demand	Energy demand 2000-2005 2.0%/year 2005- 2010 3.0%/year 2010-2015 2.4%/year 2015-2020 1.9%/year	gross distributed heat	T-cal	3,856	3,998	3,226	3,325		3,907	3,986	4,065	4,147	4,230	4,314	4,444	4,577
										0	0	0	0	0	0	0

				2008	2,009	2,010	2,011	2,012	2,013	2,014	2,015	2,016	2,017	2,018	2,019	2,020
Supply	The 2nd Thermal Power Plant	district heating	T-cal	0	0	0	0	0	0	0	0	0	0	0	0	0
		industrial steam	T-cal	0	0	0	0	0	0	0	0	0	0	0	0	0
	The 3rd Thermal Power Plant	district heating	T-cal	1,096	1,096	1,096	1,096	1,096	1,096	1,096	1,096	1,096	1,096	1,096	0	0
		industrial steam	T-cal	144	144	144	144	144	144	144	144	144	144	144	0	0
	The 4th Thermal Power Plant	district heating	T-cal	3,263	3,400	4,076	4,205	4,338	4,473	4,612	4,754	4,869	4,987	5,106	6,468	6,583
		industrial steam	T-cal	74	74	74	74	74	74	74	74	74	74	74	74	74
	ULAANBAATAR (Total)	district heating	T-cal	4,359	4,496	5,172	5,301	5,434	5,569	5,708	5,850	5,965	6,083	6,202	6,468	6,583
		industrial steam	T-cal	218	218	218	218	218	218	218	218	218	218	218	74	74
Demand	Energy demand 2000-2005 2.0%/year 2005- 2010 3.0%/year 2010-2015 2.4%/year 2015-2020 1.9%/year	gross distributed heat	T-cal	4,577	4,714	5,390	5,519	5,652	5,787	5,926	6,068	6,183	6,301	6,420	6,542	6,657

Note) Phase III is the rehabilitation plant which ranked A, B and C to Chapter 5

3.4 Power and Heat Tariff

3.4.1 Tariff Level Movement

For about 30 years, between 1960 and 1990, energy prices including heat were charged at nominal levels such as 0.35 Tug/kWh for residential use and 0.18 Tug/kWh for industrial use. Table 3.4-1 and Fig. 3.4-1 show the movement of energy prices from 1991 onward.

Table 3.4-1 Energy Price Movement（nominal term）

	unit	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*
Coal	Tug/ton	88	208	1,925	2,688	2,688	3,346	5,991	7,220	7,191	8,338
Oil	Tug/ton	1,260	6,560	47,240	58,459	67,500	77,876	94,796	98,000	111,575	123,000
Elec.	Tug/MWh	382	983	8,466	15,000	15,000	16,520	33.480	38,000	38,000	45,000
Heat	Tug/Gcal	87	175	577	1,232	1,232	1,475	2,739	2,880	2,880	5,000

(Source: ADB and ERA)

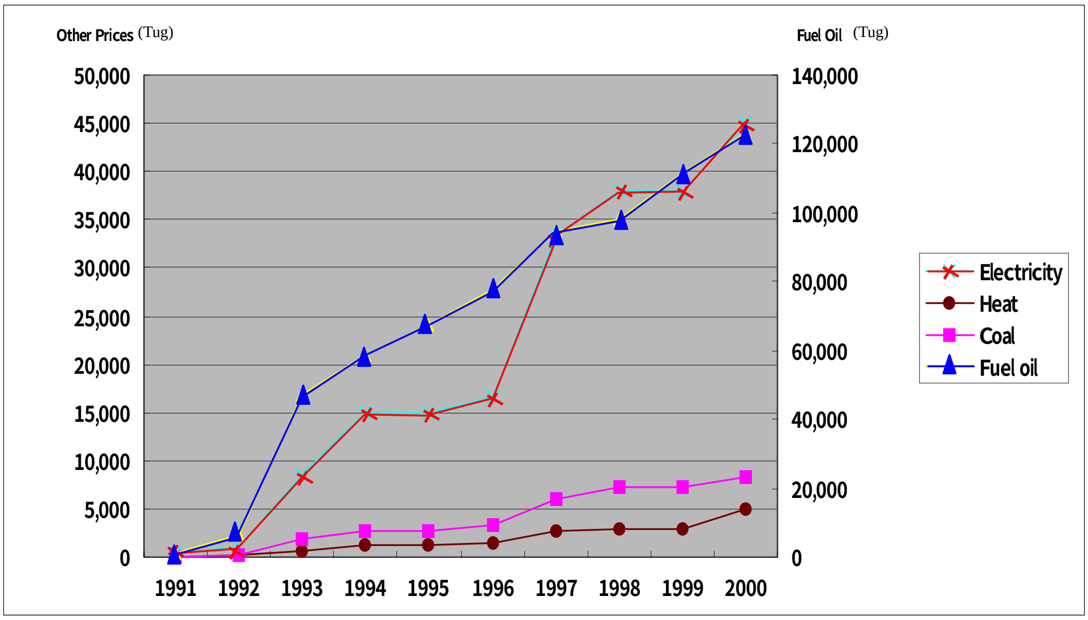


Fig. 3.4-1 Energy Price Movement（nominal term）

The above Fig.3.4-1 plots the prices in Table 3.4-1, while Table 3.4-2 translates the movement of nominal energy prices in Table 3.4-1 into real terms with 1991 as the base year, taking into account the inflation rate and the ratio of change of the energy prices. Fig. 3.4-2 indexes the price movement based on Table 3.4-2.

Table 3.4-2 Energy Price Movement（real term at 1991 level）

	unit	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*
Coal	Tug/ton	88	49	160	134	88	75	112	127	115	124
Oil	Tug/ton	1,260	1,542	3,923	2,921	2,200	1,755	1,773	1,729	1,790	1,825
Elec.	Tug/MWh	382	231	703	750	489	372	626	671	610	668
Heat	Tug/Gcal	87	41	48	62	40	33	51	51	46	74

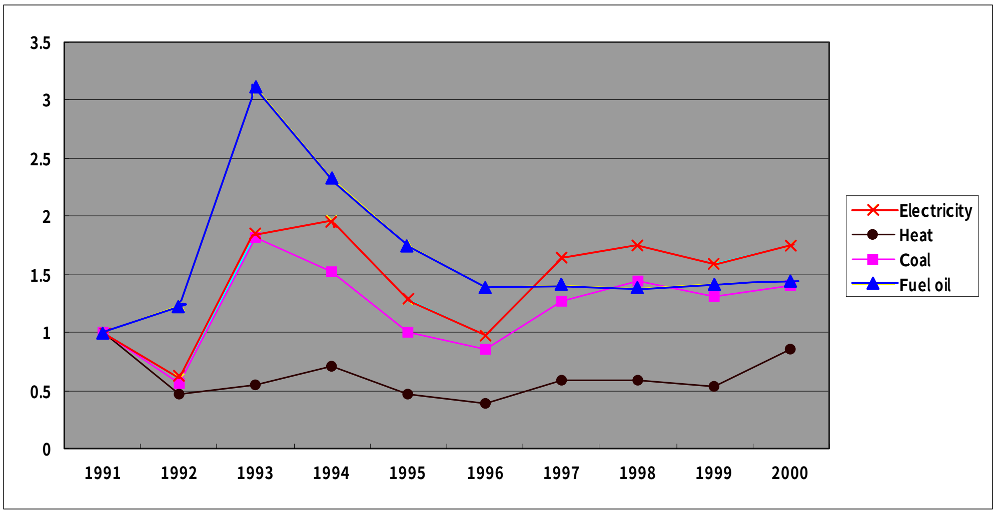


Fig. 3.4-2 Energy Price Movement（real term）

The movement of energy prices in real terms reveals that the prices of coal, heavy oil and power increased 2 to 3 times in 1993 with respect to 1991 levels, and those prices got close to 1991 levels and then remained stable from 1997 onward to reach nearly 1.5 times that of the 1991 levels as of 2000.

In the meantime, the heat price decreased by half of the 1991 level and then remained almost at the same level, and went up to a level slightly below the 1991 level in 2000. It has been revealed that the heat price was suppressed more than the other energy prices.

The same movement as translated into nominal dollar terms with respect to 1991, shown in Table 3.4-3 and Fig.3.4-3, shows that the coal price increased nearly 2 times in 1994 and then decreased to 1.4 times that of the 1991 level in 1996. In 1997 and thereafter, the coal price remained at over 2 times that of the 1991 level to become 2.2 times that in 2000. Heavy oil prices increased drastically by 3.4 times that of the 1991 level in 1992, and from 1996 onward ranged from 2.1 to 2.4 times.

Power prices increased to become 2.5 times that of the 1991 level in 1994 and then decreased to 1.6 times and increased again to become nearly 3 times that of the 1991 level in 1997 and 1998, and in 2000 reached 2.8 times that of the 1991 level. For the same period, the heat price decreased to 0.4 times that of the 1991 level in 1993 and returned close to the 1991 level in the succeeding two years, decreasing to 0.6 times that of the 1991 level in 1996 before later returning to the 1991 level and then increasing again to 1.4 times that of the 1991 level in 2000.

The movement translated into a dollar basis has also revealed that heat was cheaper than the other kinds of energy in that the prices of coal, heavy oil and power were more than two times that of the 1991 levels as of 2000, against a heat price at a level of 1.4 times. The power import price from Russia decreased year by year to reach some 60% of the 1996 level in 2000.

Table 3.4-3 Energy Price Movement（nominal dollar term）

	unit	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*
Coal	US $/ton	3.4	5.2	4.9	6.5	5.7	4.8	7.4	8.0	6.7	7.6
Oil	US $/ton	48.6	164.0	119.1	141.2	142.5	112.3	116.6	108.6	104.1	112.1
Elec.	US $/MWh	14.7	24.6	21.4	36.2	31.7	23.8	41.2	42.1	35.4	41.0
Import Russia	US $/MWh						41.0	36.0	36.0	33.0	25.0
Heat	US $/Gcal	3.4	4.4	1.5	3.0	2.6	2.1	3.4	3.2	2.7	4.6

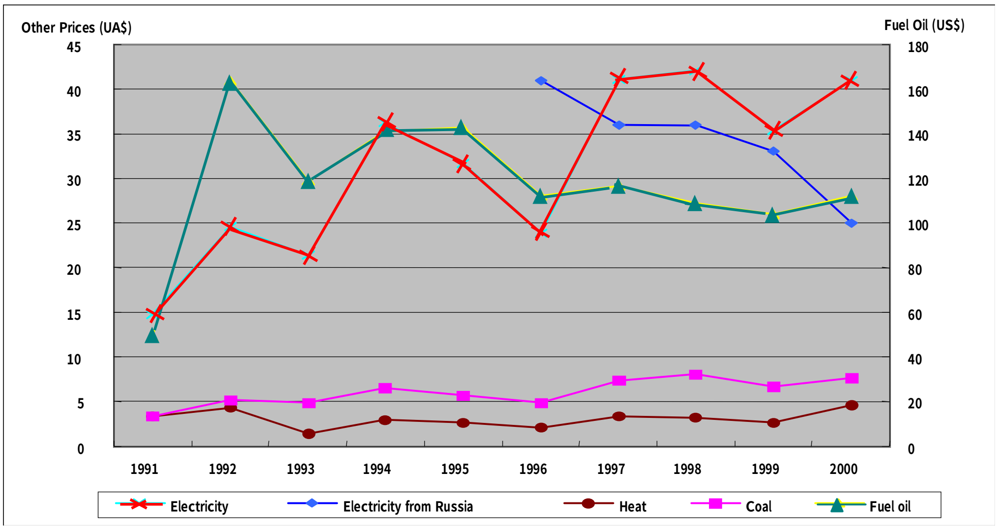


Fig. 3.4-3 Energy Price Movement（nominal dollar term）

3.4.2 Tariff Setting Mechanism

The power plants have so far been places of operation of the EA or its production units, so that the tariff for those power plants were prices for internal transaction rather than wholesale price and were determined as such taking into account consumer prices (retail prices), the production cost of the power plants and other expenses such as those for rural electrification.

That situation has not encouraged management efficiency of the power plants and did not allow the accumulation of retained earnings necessary for future maintenance and expansion of their facilities.

Table 3.4-4 shows the wholesale price and production cost of each power plant. The average retail price was 45 Tug/kWh for power and 5,000 Tug/Gcal.

Table 3.4-4 Wholesale Price and Production Cost of Power Plants

	Power (Tug/kWh)		*Heat (Tug/Gcal)*	
	Wholesale price	*Production cost*	*Wholesale price*	*Production cost*
TES2	28.40	22.98	2603.6	5936.7
TES3	31.76	25.36	3058.6	5065.0
TES4	19.76	16.02	2603.6	5041.6
Darkhan	28.05	20.01	1393.8	4073.3
Erdenet	38.62	31.80	3253.9	4461.2

(Source: TES4)

In September, 1997, an automatic tariff adjustment mechanism was introduced, in which the power plants were supposed to apply for tariff revision to the EA (currently the ERA) quarterly according to a decree issued by the Ministry of Infrastructure; however, tariff revision has seldom been made based on that mechanism. The price-setting formula of the adjustment mechanism considers factors such as increases in prices of coal and heavy oil, and changes of consumer prices and exchange rates of the Tug.

The ERA is currently studying a new tariff-setting method to apply from 2002 instead of the automatic tariff adjustment mechanism. This new method is named the "Interim Method" and is considered to be a step toward market mechanism with a view to a change from policy price to cost recovery.

By this method, cost recovery and fair return are expected to be achieved. The new method determines the production cost based on the past three-year records and adopts the rate-basis method for return, which determines the return by multiplying the value of employed assets by the average rate of interest (profit) according to the capital structure.

3.4.3 Sales Collection Mechanism

Until 1999, sales collection had been made in such a way that cash collected from consumers by each EDO/HDO was transferred to the EA, who then distributed cash to the power plants at the discretion of the EA. The distributed cash was, however, less than the amount of the actual sales, causing the problem of receivables. The EA was then responsible for the entire sector of power and heat in Mongolia so that the difference between the collected cash and the distributed cash was used to subsidize rural areas.

In 2000, such through-EA practice was abolished and a new settlement method was adopted in that each EDO/HDO would make direct payment of collected cash to the power plants. In reality, however, the whole amount of the sales was not paid and part of it was used for each EDO/HDO to manage their funds, which led to the further accumulation of receivables.

In October 2000, the above settlement method was modified, keeping the direct payment from EDO/HDO to the power plants, in such a way that the whole amount of the cash collected by EDO/HDO would go first to the power plants, which would then return to EDO/HDO their portion including expenses.

As for the Erdenet area, the through-EA method remained and, in addition to arrears by the Erdenet copper mines, the fact that the EA was paying sales tax on the energy sector from the collected amount left only a small amount being paid to TES4. No fundamental solution has so far been provided for the problems of receivables.

Another issue, that of debt cycle, as seen in the Baganuur area, was caused by nonpayment by the coal mines because of the nonpayment for coal purchases by TES4, which was being solved by set-off between coal sales and power sales. There were also arrears of power and heat sales in the government-related organizations including schools and hospitals and this problem was being dealt with by set-off with payable tax based on quarterly consultations between the sector’s companies, the Ministry of Finance and Economy and the tax authorities considering the government lack of funds.

The accumulated amount of receivables and payables is enormous and this debt cycle issue involves not only power and heat companies, but also the EA, government-related organizations, coal mines and copper mines and other nonpayment companies, prevailing in the economy of Mongolia. For this reason, it is not possible for the debt cycle issue to be solved by individual companies and it will take more time to solve. To address the debt cycle issue, in September 2001, discussions were made between the Ministries of Finance and Economy and of Infrastructure, the State Property Committee and 18 energy-related companies, but no conclusion was reached.

The frequently modified method of the collection of the sales amount is also deeply rooted in the debt cycle issue and it is necessary to establish a transparent method based on a market economy. Although no new collection method was made clear at the time of survey, a study was being conducted on a collection method in line with the sales transaction between the newly corporatized entities of the energy sector, where each power plant sells power to a transmission company, which in turn sells power to each EDO.