Mongolia

The Preparatory Survey
on
The Ulaanbaatar 4th Thermal Power Plant
Rehabilitation Project
In Mongolia

Final Report

December 2012

Japan International Cooperation Agency

Electric Power Development Co., Ltd.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

Short Title		Official Term
ACS	:	Automatic Control System
ADB	:	Asia Development Bank
AVR	:	Automatic Voltage Regulator
B/C	:	Cost Benefit Ratio
CCR	:	Central Control Room
CES	:	Central Energy System
CHP	:	Combined Heat and Power Plant
CPU	:	Central Processing Unit
CRT	:	Cathode Ray Tube
CV	:	Control Valve
DCS	:	Distributed Control System
DSCR	:	Debt Service Coverage
ECV	:	Extraction Control Valve
EES	:	East Energy System
EH, E/H	:	Electric Hydraulic
EIA	:	Environment Impact Assessment
EIRR	:	Economic Internal Rate of Return
EMS	:	Emergency System
EPC	:	Engineering, Procurement, Construction
ERA (ERC)	:	Energy Regulatory Authority (Energy Regulatory Commission)
ESP	:	Electrostatic Precipitator
FIDIC	:	Fédération Internationale Des Ingénieurs-Conseils
FIRR	:	Financial Internal Rate of Return
HOB	:	Heat Only Boiler
HPH	:	High Pressure Heater
ICB	:	International Competitive Bidding
IEEE	:	Institute of Electrical and Electronics Engineers.
IMF	:	International Monetary Fund
I/O	:	Input/Output
IRR	:	Internal Rate of Return.
ISO	:	International Organization for Standardization
JBIC	:	Japan Bank for International Cooperation
JICA	:	Japan International Cooperation Agency
JICA-ST	:	JICA Survey Team
JIS	:	Japan Industrials Standard
L/A	:	Loan Agreement
LCB	:	Local Competitive Bidding
LLCR	:	Loan Life Coverage Ratio
LPH	:	Low Pressure Heater

Short Title		Official Term
MNET	:	Ministry of Nature, Environment and Tourism
MNS	:	Mongolian National Standard
MSV	:	Main Stop Valve
NDC	:	National Dispatching Center
NETGCO	:	National Electricity Transmission Grid Company
NOx	:	Nitrogen Oxides
NPV	:	Net Present Value
ODA	:	Official Development Assistance
OEM	:	Original Equipment Manufacturer
OPS	:	Operator work Station
PCB	:	Poly Chlorinated Biphenyl
PIU	:	Project Implementing Unit
PLC	:	Programmable Logic Controller
P/Q	:	Pre-Qualification
PSR	:	Project Status Report
RI/O	:	Remote Input Output
SOx	:	Sulphur Oxides
SPM	:	Suspended Particulate Matter
Tg.	:	Tugrug (Mongolian currency)
TPP	:	Thermal Power Plant
WB	:	World Bank
WES	:	West Energy System

Chapter 1

Introduction

TABLE OF CONTENTS

LIST OF TABLES

Chapter 1 Introduction

1.1 Background of Survey

Mongolia has very harsh climate in winter, especially in coldest season in December and January, ambient temperature sometimes goes down as low as minus 40 degree C, not only power but also heat supply is key role of power stations in Mongolia. Because of recent rapid economic growth and higher concentration of people to its capital Ulaanbaatar city (population 1.15 million), the power and heat demand supply balance is becoming very tight and construction of new power and heat generation facilities and renovation of existing facilities are considered to be urgently carried out. For that purpose, Mongolian government is planning to shut down existing inefficient Thermal power plant NO.2 and NO.3, and to continue power and heat supply in capital area by operation of Thermal power plant NO.4 and by construction of new Thermal power plant NO.5. Thermal power plant NO.4, constructed in 1983, is major power and heat supply source, which has a key role to supply approx. 70% of power demand of Central electricity system around Ulaanbaatar city, and approx. 65% of heat demand in Ulaanbaatar city. However, it has some problems for reliable operation because of deterioration of several equipments, for example, turbine trips more than once a month. Therefore, in order to continue to operate Thermal power plant NO.4 in future, as a major power and heat supply source, urgent replacement and rehabilitation is necessary.

According to National Development Strategy (2007–2021) of Mongolian government, it is planned to increase efficiency of energy sectors and to secure reliability of energy supply, and also in Government Action Plan (2008–2012), securing stable power and heat supply is set as political goal. Based on above circumstances, as a result of the discussion between the Government of Mongolia and JICA in November 2011, both parties reached to common recognition that preparatory survey for the formation of the rehabilitation project of Thermal power plant NO.4 by Japanese ODA loan should be carried out. Accordingly, JICA and the Government of Mongolia had further discussion, and agreed upon the contents of the preparatory study, and completed Minutes of Meeting about it.

Based on above background, the purposes of this preparatory survey are to review past report about power and heat supply sectors in Mongolia, to organize the current situation and future plan of existing power and heat supply sectors in Ulaanbaatar city by collecting information from Mongolian government authorities and other donors, to organize and evaluate necessary rehabilitation plan for Thermal power plant NO.4, and to contribute to formation of Japanese ODA loan project which has high development effect.

1.2 Purpose of Study

The purpose of this work is to carry out necessary investigation for evaluation about rehabilitation project of Thermal power plant NO.4 (TPP4), as for its necessity, purpose, project contents, cost, schedule, procurement and implementation method, implementation organization, operation and maintenance organization, environmental and social consideration, etc., in order to realize the project by Japanese ODA loan.

1.3 Survey Area

Ulaanbaatar city, Mongolia

1.4 Work Period

This work is carried out from the end of February, 2012 to the end of January, 2013.

1.5 Scope of Work

a) Collection and analysis of past study report
b) Preparation, explanation and discussion about Inception Report
c) Review of Power/Heat supply sector in Mongolia
d) Investigation of current situation of TPP4
e) Study of rehabilitation plans and selection of priority plans
f) Feasibility study for priority plans
g) Environment and social consideration
h) Preparation of Interim Report
i) Preparation, explanation and discussion about Draft Final Report
j) Preparation of Final Report

1.6 Counterpart

(1) Counterpart agencies

For the implementation of the survey, Survey team keeps contact with the following Counter part agencies.

a) Ministry of Mineral Resources and Energy
b) Thermal Power Plant No.4

(2) Counterpart members

The counterpart members were composed of persons who can respond to various requests by Survey team.

Research and Development Department of Thermal Power Plant No.4

Head	Mr. G. Galbadrakh
	Mr. Kh. Erdenebat
	Mr. Kh. Amgalanbaatar

(3) Survey team members

In consideration of the scope of works, the team was composed of the following 7 members:

Table 1.6-1 Member of JICA Survey Team

Name	Position
1. Nobuchika KOIZUMI	Team Leader / Overall plan, heat supply plan, turbine, environmental equipment
2. Masaru HASHIMOTO	Thermal Power A / Boiler, turbine, environmental equipment
3. Tsuyoshi TOMIYAMA	Thermal Power B / Control and instrument
4. Kiyomori GIMA	Procurement and construction plan
5. Tetsuro TANAKA	Organization system / economic and financial analysis
6. Akira TAKAO	Environment and social consideration
7. Koji YONESU	Dust measurement of ESP

1.7 Survey Schedule in Mongolia

(1) 1st work in Mongolia

Member : Koizumi, Hashimoto, Tomiyama, Tanaka, Takao, Yonesu

From March 12, 2012 to March 25, 2012

Date	Visited Authority / Action
March 12	Arrived at UB.
March 13	Japanese embassy Ministry of Mineral Resources and Energy JICA Mongolia
March 14	Energy Authority TPP 4
March 15	TPP 4
March 16	TPP 4 (President) Ministry of Environment
March 17	Holiday
March 18	Holiday
March 19	TPP 4 Energy Authority Energy Regulatory Authority National Dispatching Center
March 20	TPP 4 UB Distribution Network Co Central Regional Electricity Transmission Grid State Owned Stock Co. ESP dust measurement
March 21	TPP 4 Ministry of Environment ESP dust measurement
March 22	TPP 4 Ministry of Environment ESP dust measurement
March 23	TPP 4 Ministry of Finance JICA Mongolia ESP dust measurement
March 24	ESP dust measurement Return to Japan
March 25	Arrived at Japan

(2) 2nd work in Mongolia

Member : Koizumi, Hashimoto, Tomiyama, Gima

From April 22, 2012 to May 1, 2012

Date	Visited Authority / Action
April 22	Arrived at UB.
April 23	JICA Mongolia TPP 4
April 24	TPP 4 ESP dust measurement
April 25	TPP 4 National Dispatching Center ESP dust measurement
April 26	TPP 4 ESP dust measurement
April 27	TPP 4 Japanese embassy JICA Mongolia
April 28	Holiday
April 29	Holiday
April 30	TPP 4
May. 1	Arrived at Japan

(3) 3nd work in Mongolia (explanation of Draft Final Report)

Member : Koizumi, Hashimoto, Tanaka, Tomiyama, Takao, Gima

From June 11, 2012 to June 21, 2012

Date	Visited Authority / Action
June 11	Arrived at UB.
June 12	JICA Mongolia TPP 4
June 13	Ministry of Mineral Resources and Energy
June 14	Energy Authority
June 15	Japanese embassy JICA Mongolia
June 16	Holiday
June 17	Holiday
June 18	TPP 4
June 19	TPP 4
June 20	Ministry of Finance
June 21	Arrived at Japan

(4) 4nd work in Mongolia (investigation of the locomotive)

Member : Koizumi

From October 14, 2012 to October 20, 2012

Date	Visited Authority / Action
October 14	Arrived at UB.
October 15	JICA Mongolia TPP 4
October 16	TPP 4
October 17	TPP 4
October 18	TPP 4 JICA Mongolia
October 19	TPP 4
October 20	Arrived at Japan

Chapter 2

Economic Situation of Mongolia

TABLE OF CONTENTS

LIST OF TABLES

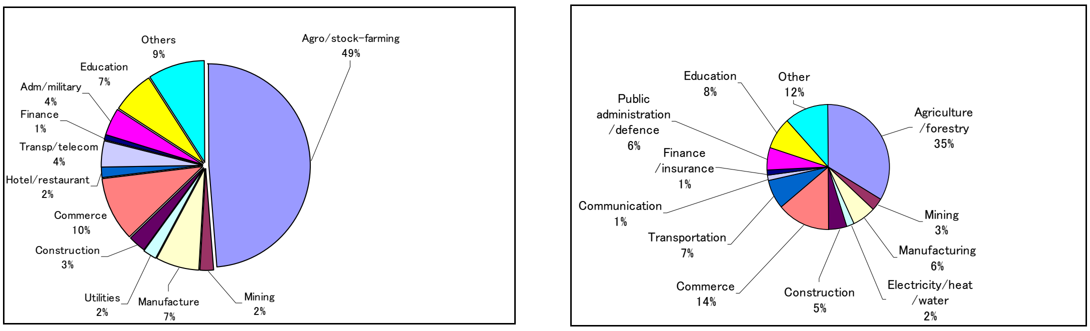
LIST OF FIGURES

Chapter 2 Economic Situation of Mongolia

2.1 Basic Structure of Economy

The area of Mongolia is 1,564 km^2 and its population is 2,781 thousand as of the end of 2010 growing by 1.6% from the previous year. The urban population is 1,760 thousand and the rural 1,020 thousand. Ulaanbaatar, capital city of the country, has a population of 1,152 thousand, accounting for about 40% of the total population, which is overconcentration in the capital.

The economically-active population is 1,147.1 thousand as of 2010, out of which the employed population is 1,033.7 thousand, with an unemployment rate of 9.9%, improving from 11.6% in 2009. As seen in Fig. 2.1-1 the employment structure, about 35% is engaged in agriculture and stock-farming, the largest employer sector, while in 2000 about 50% was engaged in that sector, showing a declining trend.

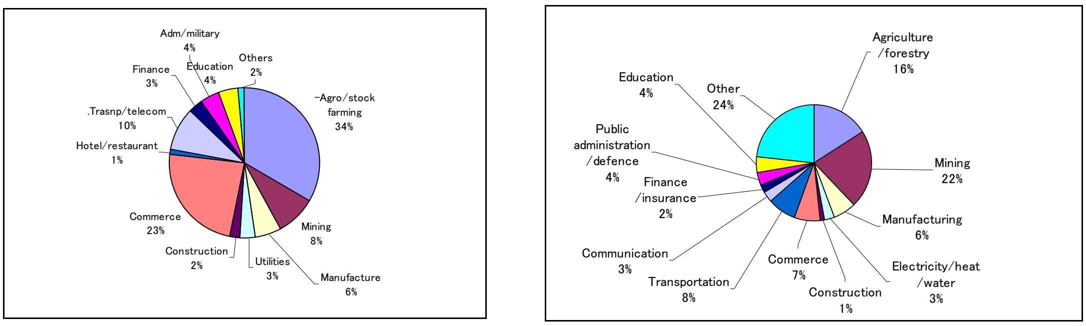


(1) as of 2000 (2) as of 2010

(Source: Mongolian Statistical Yearbook, 2000 & 2010)

Fig.2.1-1 Employment Structure

The industry structure seen from GDP, as shown in Fig.2.1-2, the mining sector accounts for 22%, the largest industry of the country. Considering the time of 2000 when the agriculture and stock farming was 34% and the mining only 8%, the past 10 years has seen a rapid growth of the mining sector and a drastic decline of the traditional agriculture and stock farming.

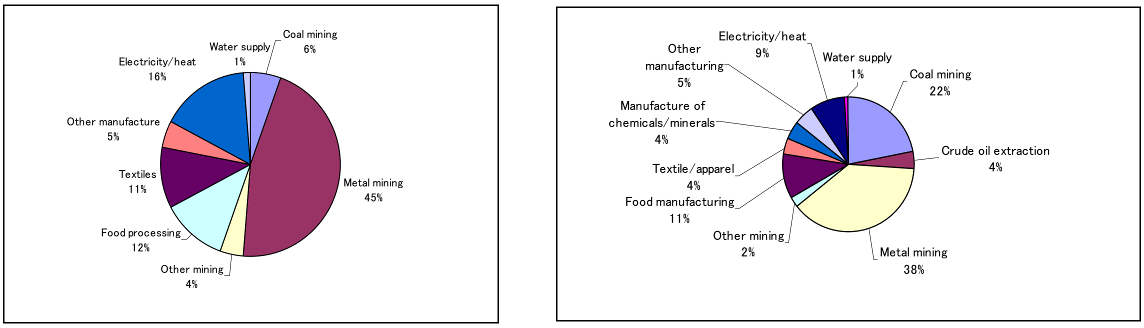


(1) as of 2000 (2) as of 2010

(Source: Mongolian Statistical Yearbook, 2000 & 2010)

Fig.2.1-2 GDP Structure by Industry

Out of the mining and manufacturing output including electricity, heat and water supply, as seen in Fig.2.1-3, 38% was metal mining, followed by coal mining of 22%. In the manufacturing sector, textile and apparel processing the products from the agriculture and stock farming sector was 4% and food manufacturing 11%. As of 2000, the textile and apparel accounted for 11%, dropping significantly. Meanwhile, crude oil extraction, which was not seen in 2000, accounted for 4%. The energy sector of power and heat was 9%.

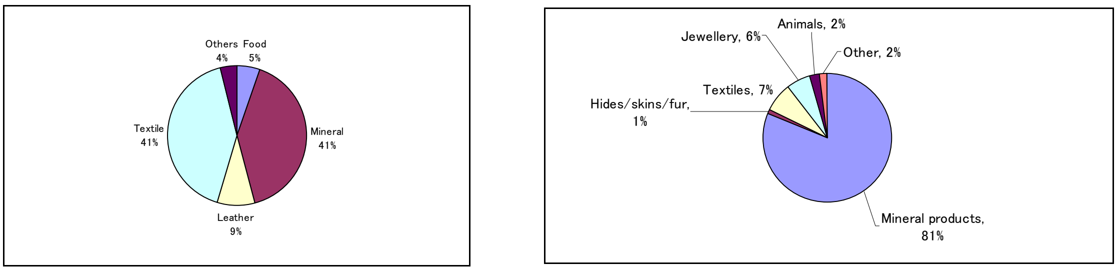


(1) as of 2000 (2) as of 2010

(Source: Mongolian Statistical Yearbook, 2000 & 2010)

Fig.2.1-3 Mining and Manufacturing Output

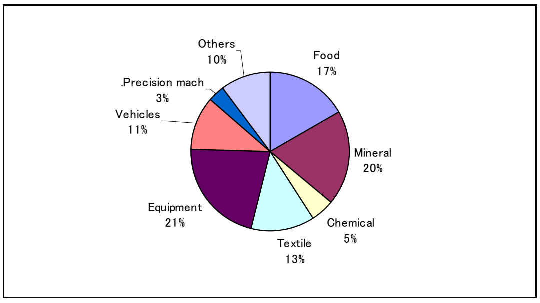
In the external trade, as seen in Fig.2.1-4, mineral products are prominent in exports. In 2000, mineral and textile products were both about 40%. Obviously, the export structure has been undergoing a large change. At the same time, as seen in Fig.2.1-5, the mineral products were 25% of the imports partly because oil products were included. Then comes machinery and electric appliances accounting for 21%. The import structure has not changed much compared with 2000.



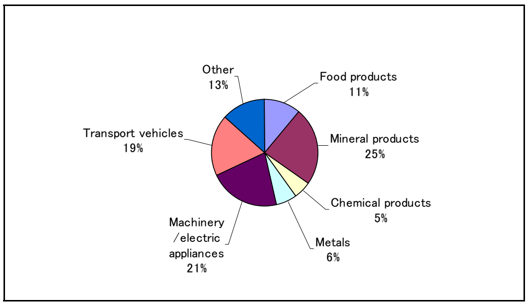
(1) as of 2000 (2) as of 2010

(Source: Mongolian Statistical Yearbook, 2000 & 2010)

Fig.2.1-4 Composition of Exports



(1) as of 2000



(2) as of 2010

(Source: Mongolian Statistical Yearbook, 2010)

Fig.2.1-5 Composition of Imports

2.2 Macro-economic Situation

Mongolian economy recorded a growth rate of 10.6% in 2004, the first-ever double-digit year-on-year growth since the start of market-oriented economic reform in 1990. Then, the economy grew at a pace of 7.3% in 2005, 8.6% in 2006, 10.2% in 2007. For the 3 years from 2004 to 2007, GDP per capita almost doubled. However, the global financial crisis and the sharp fall in copper price brought about a serious economic crisis to the country. The real growth rate in 2009 dropped to 1.3% from 8.9% in 2008. Thereafter into 2010, Mongolian economy grew by 6.1% showing a steady recovery thanks to brisk recovery of international prices of minerals boosting domestic demand.

The global financial and economic crisis in 2008 affected Mongolian economy in other factors than its growth rate from 2008 to 2010. The inflation rate reached 28% in 2008 and the government finance recorded a large deficit in the above 2 years. In the balance of international payments, there was a large deficit in the current account of 2008 with the foreign exchange reserves dropping to 2 months of import. Thereafter, however, the country saw the key economic indicators improving, illustrating a recovery of its economy.

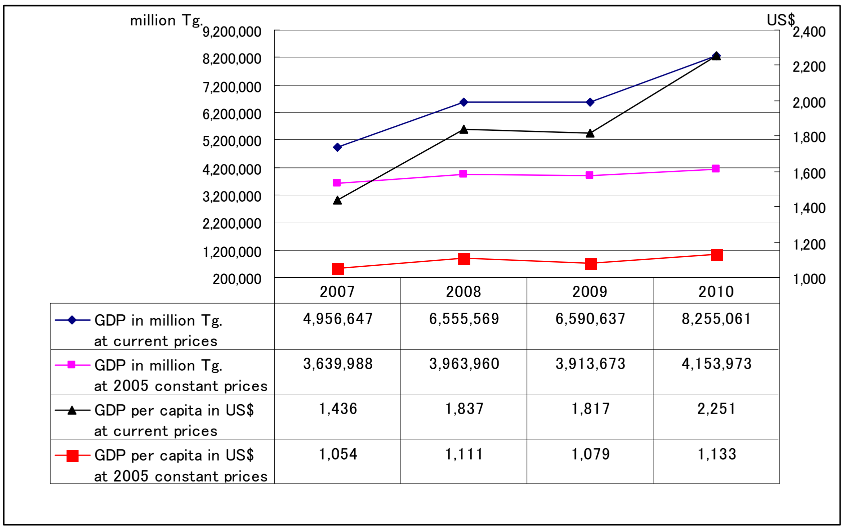
Table 2.2-1 shows the historical key economic indicators of Mongolia during the recent years.

Table 2.2-1 Historical Key Economic Indicators

	2007	2008	2009	2010	Average
GDP growth rate (%)	10.2%	8.9%	-1.3%	6.1%	6.0%
Inflation rate (%)	9.6%	28.0%	8.0%	10.1%	13.9%
Fiscal balance (of GDP:%)	2.69%	-4.52%	-5.20%	0.03%	-1.8%
Fiscal balance excluding grants (of GDP: %)	2.24%	-4.77%	-5.49%	-0.39%	-2.1%
Current account balance of payments (of GDP: %)	6.80%	-4.50%	12.16%	13.80%	7.1%
Current account balance of payments excluding grants (of GDP: %)	4.24%	-5.13%	10.86%	13.04%	5.8%
Foreign exchange reserves (months of import amount)	4.6	2.0	5.6	6.1	4.6
Debt service ratio (%)	2.1%	2.7%	4.7%	5%	3.6%

(Source: Mongolian Statistical Yearbook, 2010 and Bank of Mongolia & World Bank database)

Fig.2.2-1 shows GDP and GDP per capita. GDP in 2010 is translated[1] in about 521.5 billion yen. GDP at current prices increased by 1.7 times compared to 2007 and GDP per capita by 1.6 times.

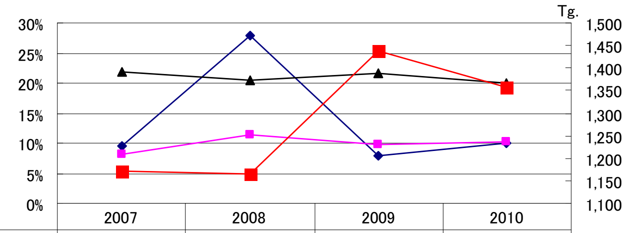


(Source: Mongolian Statistical Yearbook, 2010)

Fig.2.2-1 GDP and GDP per capita

Fig.2.2-2 shows inflation rate, interest rate (central bank bills and commercial bank loan) and exchange rate. Inflation rate rose to 28% in 2008 but later recovered quickly. The Mongolian currency, Tugrik, lost its value by about 15% against US$ compared to 2007. The interest rate of commercial bank loans remained very high because of not only inflation worries but low level of confidence in domestic industries.

[1] The exchange rate as of March 19, 2012: $1=1,320Tg. = ¥83.38

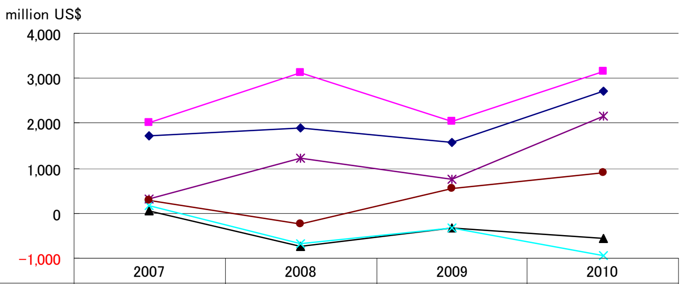


	2007	2008	2009	2010
Inflation rate, annual average	9.6%	28%	8%	10.1%
Interest rate (Central bank's bills Interbank market)	8.11%	11.30%	9.87%	10.32%
Lending rate	21.83%	20.58%	21.67%	20.07%
Exchange rate against US$	1,169.85	1,166.06	1,437.91	1,355.93

(Source: Mongolian Statistical Yearbook, 2010 & Bank of Mongolia)

Fig.2.2-2 Inflation Rate, Interest Rate and Exchange Rate

Fig.2.2-3 shows the balance of international payments: trade account, current account, capital and financial account and overall account. The current deficit is covered by the capital and financial surplus. The direct investment accounts for 73% of the capital and financial account (US$ 1,573.6 million) in 2010. Table 2.2-2 shows the foreign exchange reserves, maintaining a good level of 4 months or more of import except 2008.



	2007	2008	2009	2010
Export (general merchandise)	1,715.80	1,908.70	1,572.40	2,720.20
Import (general merchandise)	2,003.10	3,121.90	2,044.20	3,148.40
Trade account balance	57	−738	−332	−557
Current account balance	171.8	−690.1	−341.8	−931.5
Capital and financial account balance	328.7	1,232.1	768.8	2,148.8
Overall balance	288	−232.6	555.5	906.4

(Source: Mongolian Statistical Yearbook, 2010)

Fig.2.2-3 Balance of International Payments

Table 2.2-2 Foreign Exchange Reserves

	2007	2008	2009	2010
Forex reserves: US$ million	972.4	637.2	1,145.3	2,091.2

(Source: Mongolian Statistical Yearbook, 2010)

Chapter 3

Review of Energy Sector

TABLE OF CONTENTS

Chapter 3 Review of Energy Sector

LIST OF TABLES

LIST OF FIGURES

Chapter 3 Review of Energy Sector

3.1 Institutional Framework of Energy Sector

Since incorporation into socialistic regime of Soviet Federation in 1921, Mongolia had formed a monocultural economy as a member of COMECON. In energy sector as well, vertically-integrated energy supply used to be made by the state under a socialistic regime for a long time. On the part of the people receiving such energy, they were very likely to consider energy supply to be provided by the state so that the energy prices were maintained at nominal low levels.

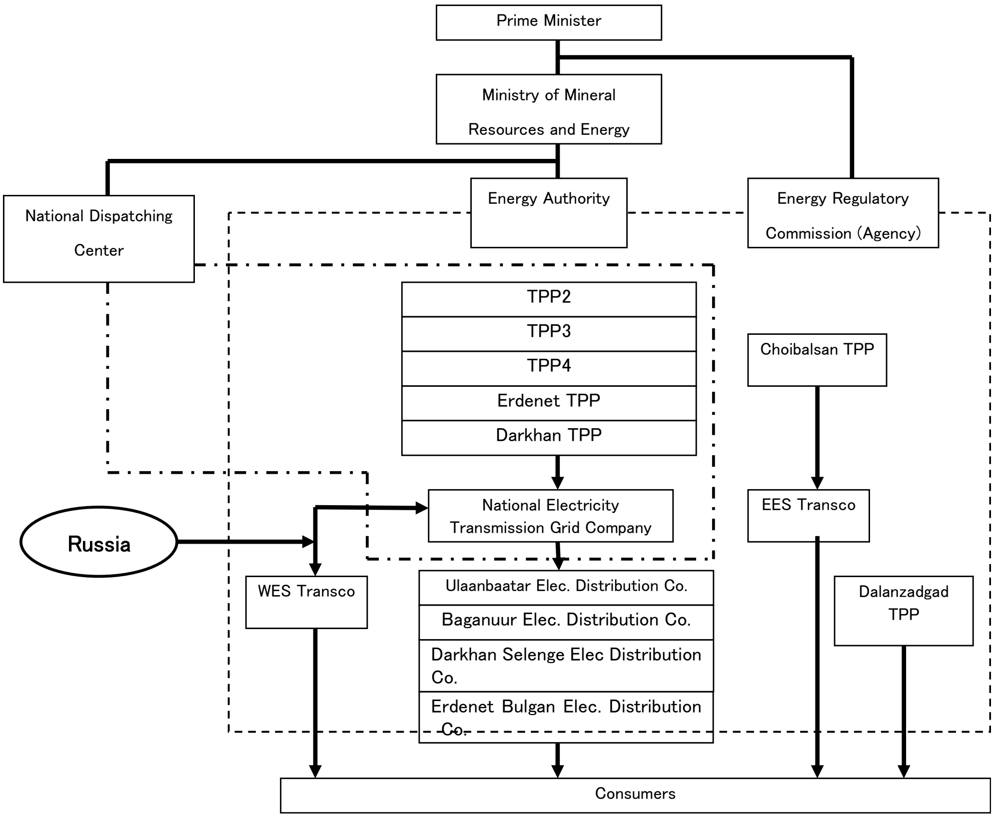
The collapse of the Soviet regime in 1990 forced Mongolia to liberalize itself. Since 1992 to date, as one of the movements for liberalization, the once-socialistic energy sector has been undergoing various reforms toward market-oriented economy with support from international aid organizations centered on the World Bank. Main issues were the following 3 points:

A. Sector reform toward market-oriented economy
B. Management issues of energy enterprises
   (Tariff reform, accumulated deficit of the enterprises, improvement of revenue collection, and chain debt and accumulated receivables and payables)
C. Increase in supply capacity and national energy security
   (Improvement of existing power plants, decrease in transmission and distribution losses,, new power developments and private sector participation)

This Chapter will review the energy sector and, at the same time, will see how the above 3 issues have been coped with. Firstly, Issue A of sector reform will be reviewed.

In April 2001, the New Energy Law was promulgated, unbundling the vertically-integrated regime of the state enterprise dedicated to energy supply from generation, transmission, distribution and supply and corporatize the newly-born enterprises. Those energy companies must obtain licenses from ERA (‘Energy Regulatory Authority’, now called ERC ‘Energy Regulatory Commission’), the entity created by the same law and had been obliged to conform to regulations by ERA. The 2008 administrative reform established MMRE (Ministry of Mineral Resources and Energy) and EA (Energy Agency), one of its agencies, has been in charge of overseeing 18 companies of the above energy companies except NDC (National Dispatching Center). EA is also in charge of new projects and if such new project does not belong to the existing energy companies, shall establish PIU (Project Implementation Unit) to implement such project.

The current power sector structure is shown in Fig.3.1-1.



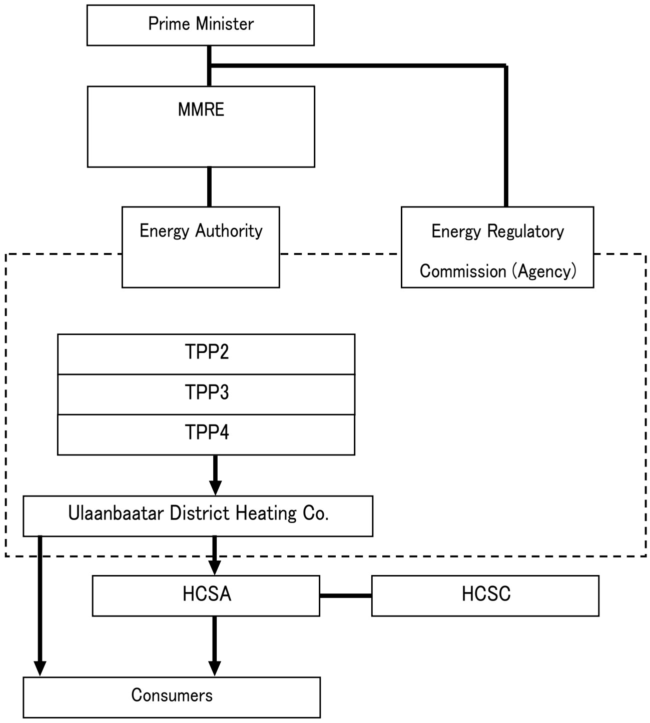
(Source: J-POWER Database)

Fig.3.1-1 Power Sector of Mongolia

The total power supply capacity of Mongolia is about 920 MW with 3 main power systems.: CES (Central Electrical System) including Ulaanbaatar, capital city of the country, Darkhan, city of metallurgical complex, Erdenet, city of copper mines and Baganuur, city of coal mines, EES (East Electrical System) centered in Choibalsan and WES (Western Electrical System) receiving power from Russia. In other areas not connected with the above systems, municipal diesel power plants provide power in Aimag or Soum centers.

In CES, NDC issues dispatching orders to 5 power plants to send generated power to NETGCO (National Electricity Transmission Grid Company), who sells power in bulk to 4 Disco's (distribution companies) to supply power to the consumers. NDC conducts operation and control of only CES including power import from Russia. In EES, Transmission company conducts distribution as well. In WES, Transmission companies supplies power imported from Russia to the consumers.

As for heat, hot water produced by 3 power plants is provided to the consumers through Ulaanbaatar District Heating Company and the HCSA, although some consumers are directly provided with heat. HCSA does not own facilities and is only in charge of management. Fig.3.1-2 shows the current heat sector structure of Ulaanbaatar.



(Source: J-POWER Database)

Fig.3.1-2 Heat Sector of Ulaanbaatar

As shown in Table 3.1-1 , there are 19 energy entities: 7 power generation companies, 2 heat production companies, 1 power dispatching organization, 3 transmission companies, 4 distribution companies and 2 heat supply companies, of which 18 companies had been corporatized except the dispatching organization. Originally, privatization was aimed in order to pave the way to competitive market-oriented environment. At the time of this Review, no progress was seen. Having been corporatized, the above energy companies are still state-owned but they have left 'state-run mind', developing mind change and doing self-efforts to improve performance.

Currently, the share ratio of the government organizations is all the same for each energy company as follows:

a) MMRE 49%
b) State Property Committee 31%
c) Ministry of Economy and Finance 20%

Table 3.1-1 Energy Companies Created by New Energy Law

Activity	Name of Company	No. of companies
Power generation	Ulaanbaatar Thermal Power Plant 2（TPP2） Ulaanbaatar Thermal Power Plant 3（TPP3） Ulaanbaatar Thermal Power Plant 4（TPP4） Erdenet Thermal Power Plant Darkhan Thermal Power Plant Choibalsan Thermal Power Plant Dalanzadgad Thermal Power Plant	7
Heat production	Baganuur District Heating Co. Nalaikha District Heating Co.	2
Power dispatch	National Dispatching Center	1
Power transmission	National Elec. Transmission Grid Co.(NETGCO) Eastern Regional Elec. Transmission Grid Co. Western Regional Elec. Transmission Grid Co.	3
Power distribution	Ulaanbaatar Elec. Distribution Network Co. Erdenet Bulgan Elec. Distribution Co. Darkhan Selenge Elec. Distribution Co. Baganuur East-southern Region Elec. Distribution Co.	4
Heat supply	Ulaanbaatar District Heating Co. Darkhan District Heating Co.	2
Total		19

(Source: Report on Mongolian Power Sector by Japan Electric Power Information Center Inc., 2010 Jan.)

With the above series of sector reform, the basic institutional reform is considered to have been completed. However, it is said that the power sector adopted the single-buyer model with NETGCO of CES as single buyer but NETGCO does not seem to be the entity finally responsible to power supply to final consumers by procuring less expensive power and sending it to distribution and supply companies. They only transport power produced or imported. In actual operation, NDC issues dispatching orders including power import from Russia. Such orders are not based on economic principles; TPP2 and TPP3, whose production costs are more expensive, are operated to meet the base load in order to give priority to heat production, while the least expensive TPP4 is dispatched in such a way as to meet the base load not covered by the above 2 power plants and the middle and peak loads. Such dispatching orders force the low load-responsive coal-fired thermal plant in an unreasonable way, causing advanced deterioration. TPP4 accounts for about 70% in power generation, holding scale-merit advantage over smaller-scale TPP2, TPP3 and other power plants. This fact cannot guarantee competition on an equal footing.

The above-mentioned situation leads to think that Mongolian power sector is still halfway toward market-oriented power sector under competitive environment. It is questionable whether the current unbundling is the optimum solution to such a small-scale power sector as CES with a supply capacity far below 1,000 MW and no participation has been seen from the private sector. Such situation can, however, be esteemed that breaking away from the ‘state-run mind’, each energy company has come to do efforts for improved management.

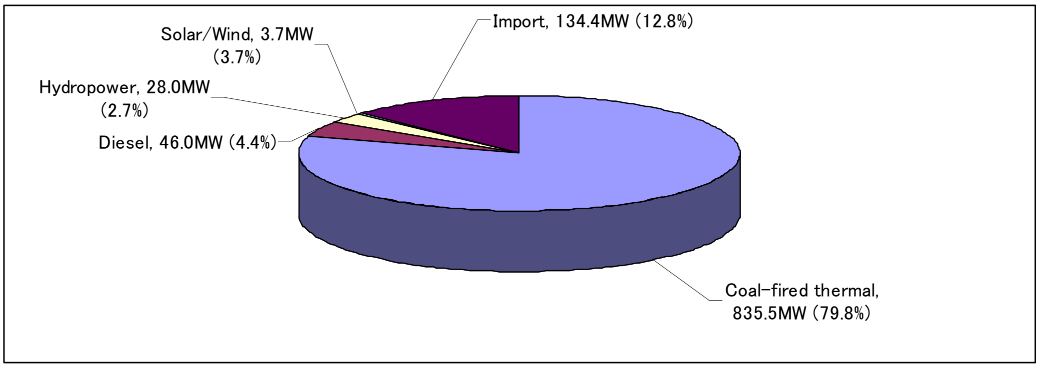
The government of Mongolia has been conducting energy sector reform aimed at market-oriented power sector step by step through: Unbundling→Corporatization→Commercialization→Privatization. The government has the intention to make 2013 the last year for political gradual tariff hike and subsidy to energy companies, while from 2014 energy tariff will be liberalized[1] in order to promote private sector participation in energy sector, into the stages of commercialization and privatization.

[1] ERC has an intention to introduce Price Indexation as a measure of price-cap regulation.

3.2 Performance of Energy Sector

3.2.1 Generation Mix and Power Supply Situation

The generation mix of Mongolia in MW basis is shown in Fig.3.2-1. This figure includes import from Russia. Coal-fired thermal power is about 80%, followed by diesel power accounting for about 4%. with Import from Russia is accounting for nearly 13%. This means that Mongolia is not self-sustained in power supply so that national energy security is not secured. Besides, power imported from Russia is performed in order to meet peak demand, playing an important role for power system stability. In this connection, domestic development of such load-responsive power sources as hydropower is necessary from a point of view of national energy security.



(Source: Presentation Material of EA General Director in May 2010)

Fig.3.2-1 Generation Mix of Mongolia

In 2011, domestic power supply capacity was 916MW with 93.5% (856 MW) by coal-fired thermal power, 3.0% (28 MW) by hydropower, 2.8% (26 MW) by diesel power and 0.6% (6 MW) by renewable energies. Coal-fired thermal power has outstanding presence in power supply of the country.

Table 3.2-1 shows the coal-fired thermal power plants in Mongolia. In CES, in power stations other than TPP4, power generation at rated capacity Is not possible because of deterioration.

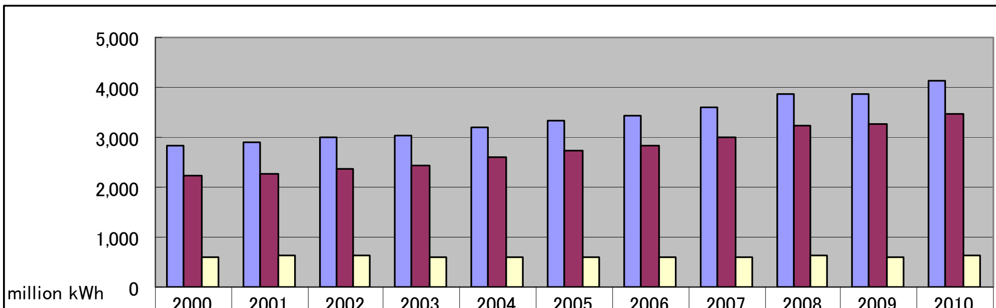
Table 3.2-1 Coal-fired Thermal Power Plants in Mongolia

System	Power & Heating Plant	Installed Capacity (MW)	Available Capacity (MW)	Start Year of Operation	Expected Years of Retirement
CES	Ulaanbaatar TPP2	21.5	18	1961 – 1969	2014
	Ulaanbaatar TPP 3	136.0	105	1968 – 1982	2015 – 2030
	Ulaanbaatar TPP4	580.0	580	1983 – 1991	After 2030
	Darkhan CHP	48.0	39	1966; 1986	After 2030
	Erdenet CHP	28.8	21	1987 1989	After 2030
	Subtotal CES	**814.3**	**763**		
EES	Choibalsan CHP	36.0	–	1969; 1979	–
	Dalanzadgad Plant	6.0	–	2001	–
	Total	**856.3**	–		

(Source: ADB TA NO.7502-MON 2011)

CES is supplied by 5 coal-fired thermal power plants: TPP2 (21.5 MW), TPP3 (136 MW) and TPP4 (580 MW), located in Ulaanbaatar, and Darkhan and Erdenet thermal power plants. Peaking power is imported from Russia.

Fig. 3.2-2 shows the history of generation, supply and station use of CES

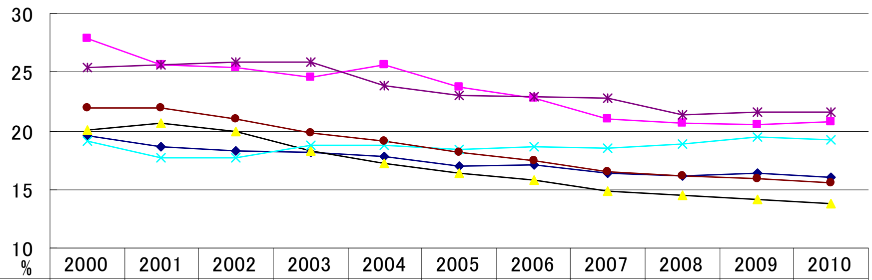


	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Generation	2,844	2,898	3,004	3,028	3,195	3,320	3,433	3,594	3,874	3,874	4,127
Supply	2,228	2,274	2,375	2,429	2,585	2,718	2,832	3,002	3,250	3,260	3,483
Station Use	616	624	629	599	610	602	601	592	624	615	645

(Source: ERA Statistics 2010)

Fig.3.2-2 History of Generation, Supply and Station Use of CES

Generation and supply is on rising trend due to increase of demand and improvement of availability. The more power is generated, the more station use increases in proportion with it, but station use remain flat. Station use ratio, which is obtained by dividing station-used power by generated power, is shown in Fig. 3.2-3 by the 5 thermal power plants of CES. That figures shows that the decrease in station use of TPP3 and TPP4, recipient of much assistance from international aid organizations, is notable.



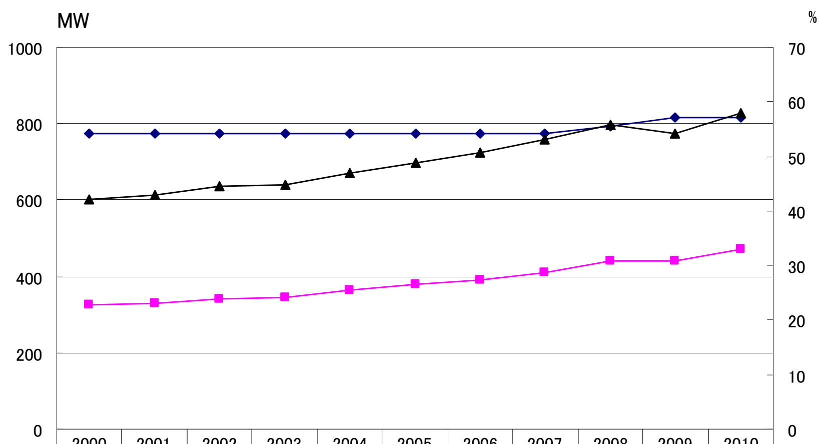
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
TPP2	19.56	18.68	18.34	18.22	17.76	17.01	17.15	16.4	16.21	16.35	16.07
TPP3	27.83	25.6	25.4	24.6	25.57	23.74	22.75	21.03	20.68	20.54	20.76
TPP4	20.11	20.71	19.89	18.27	17.17	16.4	15.78	14.8	14.44	14.09	13.84
Darhan TPP	19.06	17.67	17.75	18.78	18.79	18.39	18.65	18.5	18.89	19.47	19.18
Erdenet TPP	25.38	25.62	25.84	25.86	23.82	22.98	22.93	22.8	21.37	21.59	21.57
CES Total	22	22	21	19.78	19.08	18.13	17.5	16.47	16.11	15.87	15.62

(Source: ERA Statistics 2010)

Fig.3.2-3 History of Station Use of 5 TPPs of CES

The above 2 figures show that efforts have been made to decrease station use in each of the power plants.

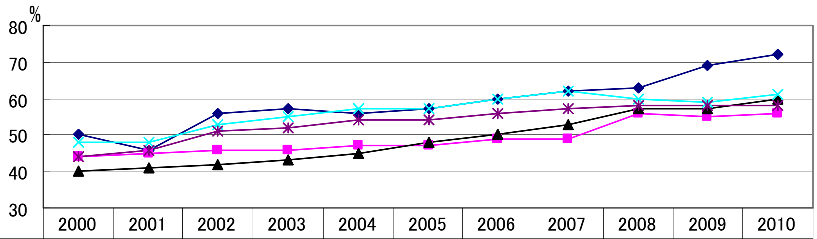
Meanwhile, plant utilization factor tends to increase as shown in Fig..2-4 but remains still at a low level such as less than 60% of the installed capacity as of 2010 partly due to lowered output by aging and shutdowns by failure but as for TPP4 mostly due to periodical inspection and standby. Utilization of TPP4 will be detailed in Chapter 4. Fig.3.2-5 shows, however, increasing trend in utilization of each power plants, which means the power plants have been made efforts in that point.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Installed Capacity	774.3	774.3	774.3	774.3	774.3	774.3	774.3	774.3	794.3	814.3	814.3
Utilized Capacity	325	330.7	342.5	346.5	363.7	379	391.9	410.3	442.2	442.3	471.1
% of Utilization	42.2	42.9	44.4	44.9	46.9	48.9	50.6	53	55.7	54.3	57.9

(Source: ERA Statistics 2010)

Fig.3.2-4 Utilization of Installed Capacity of CES

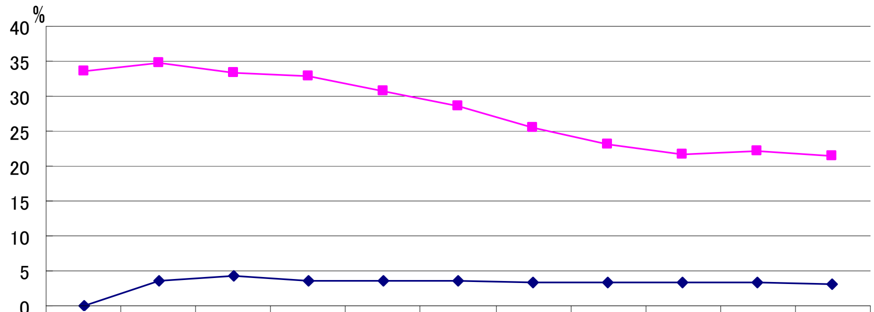


	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
TPP2	50	46	56	57	56	57	60	62	63	69	72
TPP3	44	45	46	46	47	47	49	49	56	55	56
TPP4	40	41	42	43	45	48	50	53	57	57	60
Darhan TPP	48	48	53	55	57	57	60	62	60	59	61
Erdenet TPP	44	46	51	52	54	54	56	57	58	58	58

(Source: ERA Statistics 2010)

Fig.3.2-5 Utilization of Installed Capacity of Thermal Power Plants

In the following, transmission and distribution loss will be discussed.



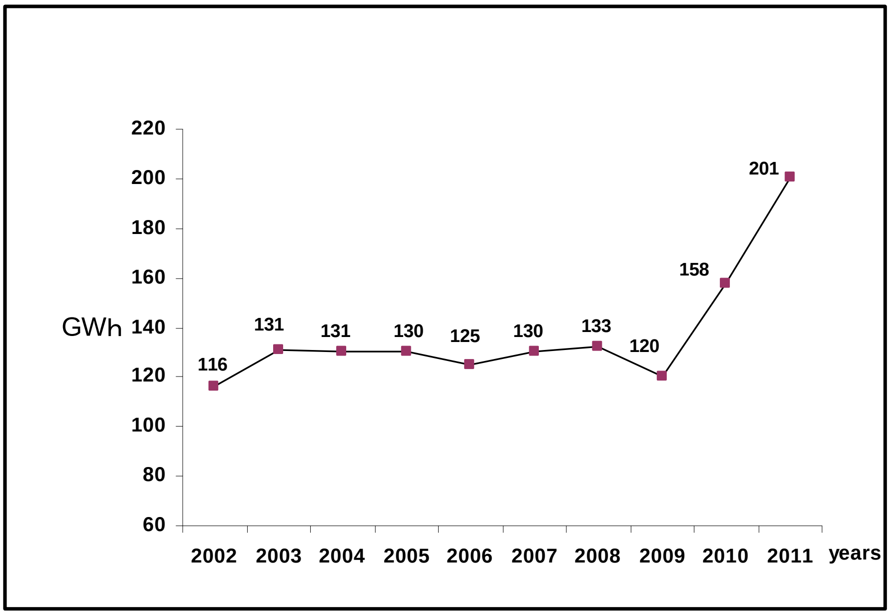
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
NETGCO	0	3.53	4.25	3.65	3.57	3.47	3.44	3.34	3.3	3.31	3.18
UB Disco	33.6	34.7	33.3	32.9	30.67	28.69	25.39	23.07	21.67	22.1	21.4

(Source: ERA Statistics 2010)

Fig.3.2-6 Transmission and Distribution Loss

No transmission loss is shown of NETGCO in the above figure because in that year NETGCO had not been established. Distribution loss of Ulaanbaatar distribution company was recorded yet high even in 2010 including power theft and there is plenty of room to improve. Their efforts should, however, be appreciated for having decreased the loss recorded at over 30% 10 years ago, with assistance from international aid organizations.

In the meantime, annual power import from Russia has been growing in terms of MWh since 2009 but not in terms of MW as seen in Fig.3.2-7 and Table 3.2-2. Russia and CES are interconnected by 2-circuit 220 kV transmission lines. According to NETGCO, The transmitting capacity is 300 MW but the practical limit is 250 MW considering possible failure propagation to CES in the case of failure of one of the circuit.



(Source: NDC Statistics)

Fig.3.2-7 Import from Russia

Table.3.2-2 Import Power Max

MW

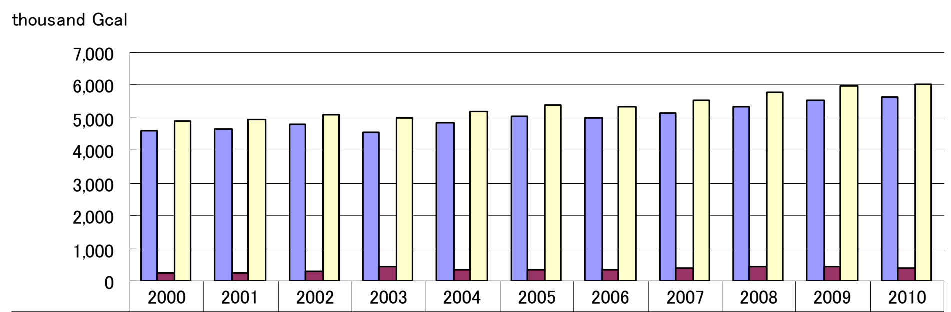
Years	2008	2009	2010	2011
TPP4 planned maintenance	202	175	175	175
Normal regime	104	112	147	120

(Source: NDC Statistics)

From the above, as for increase in power supply of Issue C, the existing power facilities have been improving with assistance from international aid organizations but cannot cope with anticipated power shortage in the near future. It is, therefore, necessary to develop large-scale power sources in the mid/long term. This point will be discussed later in Section 3.4.

3.2.2 Heat supply

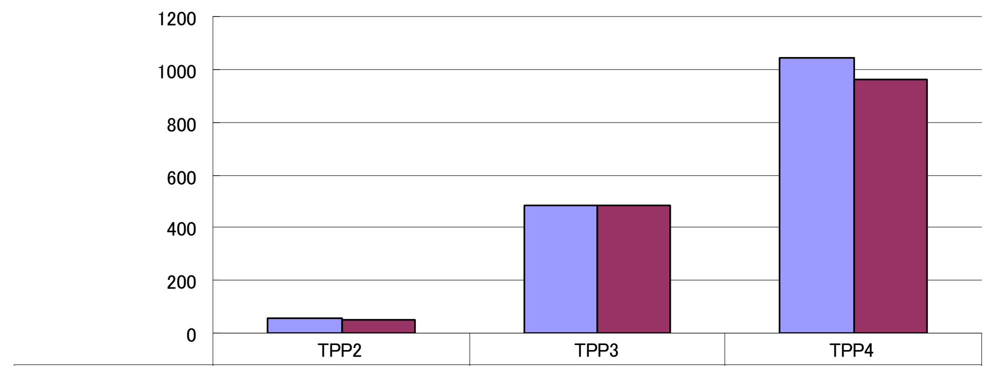
Fig.3.2-8 shows the history of heat supply and Fig.3.2-9 supply situation of the 3 power plants in Ulaanbaatar.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Water	4,623.1	4,663.0	4,787.5	4,548.3	4,839.2	5,046.1	4,986.5	5,121.4	5,359.1	5,537.0	5,620.7
Steam	261.2	264.9	312.2	444.4	336.9	347.7	358.2	411.4	422.0	420.7	397.5
Heat Total	4,884.3	4,927.9	5,099.7	4,992.7	5,176.1	5,393.8	5,344.7	5,532.8	5,781.1	5,957.7	6,018.2

(Source: ERA Statistics 2010)

Fig.3.2-8 History of Heat Supply of Central Region



	TPP2	TPP3	TPP4
Capacity Gcal/hour	55	485	1045
Usage Gcal/hour	50	485	960

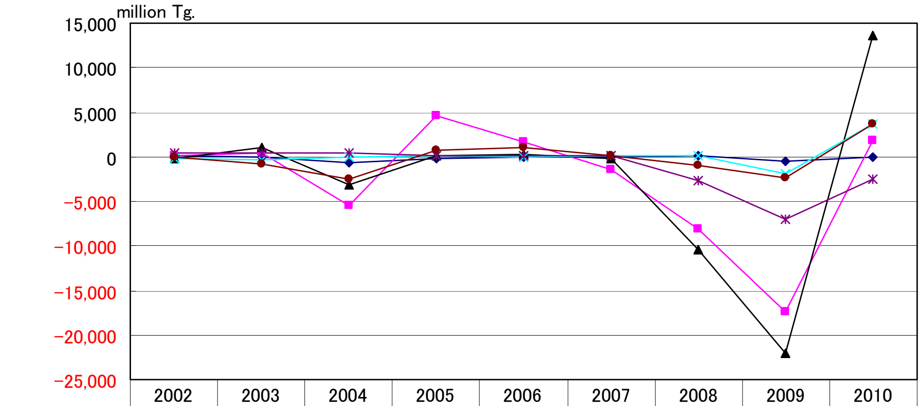
(Source: UB District Heating Co. 2011)

Fig.3.2-9 Heat Supply by 3 TPPs in Ulaanbaatar

For about 10 years between 2000 and 2010, heat supply increased by some 20%. Compared with power supply of the same period with an increase by 160%, heat has increased less, at some 2% annually. At the same time, in the areas centered in Ulaanbaatar, such urban developments are being continued as housing land and new buildings, so that heat demand is expected to increase. According to Ulaanbaatar Heat Company, they have not extended supply pipes to newly-completed buildings because there is no room for heat supply. In Fig.3.2-9, heat supply capacity of each power station and capacity of demand side to which hot water piping is connected. Seen from the heat supplier, TPP2 and TPP3 are reaching the limit of supply capacity, but as for TPP4, it has surplus capability, as shown in Chapter 4.

3.2.3 Management of Energy Companies

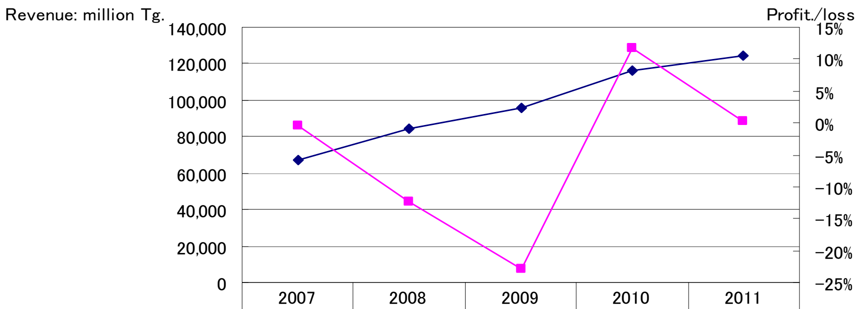
As above mentioned, energy enterprises were corporatized and expected to make efforts for management improvement. But most of the enterprises have been undergoing deficit for a long time. Fig.3.2-10 shows the history of performance of main companies of CES. In 2010, most of the companies turned around because of tariff hikes and government subsidies. TPP3 and TPP4 showed wild fluctuations in profit and loss because their revenue sizes are greater than the other companies so that their extents of profit and loss are accordingly large responding to tariff change. Recently, the tariff of power and heat for TPP4 has been on the increase but not at an enough level for heat to cover its production costs. Such years that the profit gained in power tariff could not make up for heat production costs showed a deficit. For reference, Fig. 3.2-11 shows revenues and profit/loss ratio to revenue of recent years.



	2002	2003	2004	2005	2006	2007	2008	2009	2010
TPP2	106	32	-651	-139	-17	2	90	-545	0
TPP3	67	458	-5,422	4,597	1,676	-1,430	-8,030	-17,369	1,754
TPP4	-145	1,057	-3,085	175	256	-234	-10,357	-22,024	13,594
UB Disco	-203	-344	22	87	16	167	156	-1,856	3,659
NETGCO	360	381	400	99	103	89	-2,610	-7,093	-2,508
UB Heat	-56	-791	-2,516	771	975	112	-1,007	-2,308	3,716

(Source: ERA Statistics 2010)

Fig.3.2-10 Profit and Loss of Main Energy Companies of CES

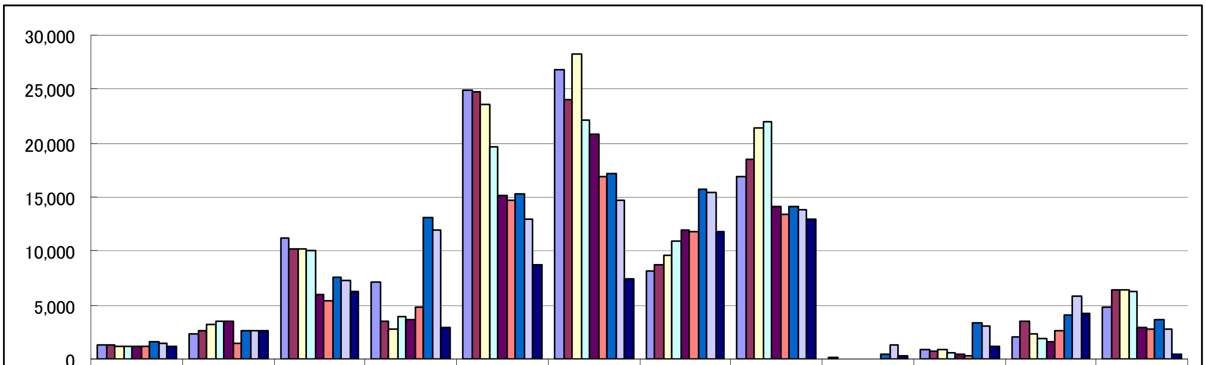


	2007	2008	2009	2010	2011
Revenue	67,414	84,400	96,102	115,892	124,168
% of profit/loss	-0.35%	-12.28%	-22.92%	11.73%	0.31%

(Source: JICA Survey Team)

Fig.3.2-11 Profit and Loss of TPP4

Shown in the following is the history of receivables and payables of the main energy companies. As shown in Fig.3.2-12, a general decreasing trend can be seen.



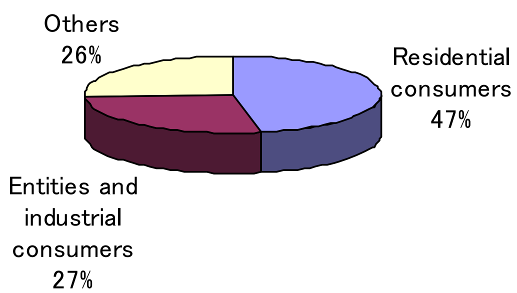
million Tg.	TPP2		TPP3		TPP4		UB Disco		NETGCO		UB Heat	
	Receivable	Payables	Receivable	Payables	Receivable	Payables	Receivable	Payables	Receivable	Payables	Receivable	Payables
2002	1,341.9	2,354.4	11,159.2	7,191.2	24,832.8	26,782.9	8,189.5	16,954.1	100.0	927.3	1,972.5	4,832.8
2003	1,246.4	2,666.4	10,143.5	3,547.0	24,746.2	24,077.8	8,720.7	18,433.3	8.7	769.7	3,422.8	6,427.4
2004	1,161.6	3,177.6	10,201.7	2,734.5	23,601.8	28,196.6	9,668.5	21,399.3	5.8	943.6	2,277.3	6,361.1
2005	1,126.5	3,466.6	10,014.5	3,910.8	19,652.6	22,180.1	10,856.9	21,951.8	19.4	628.2	1,884.2	6,287.5
2006	1,154.1	3,468.4	5,981.1	3,603.4	15,198.2	20,846.9	11,917.3	14,084.3	20.6	480.2	1,665.4	2,985.3
2007	1,162.9	1,412.4	5,378.1	4,778.6	14,742.6	16,939.5	11,761.9	13,446.3	17.4	269.5	2,615.8	2,779.1
2008	1,546.2	2,658.0	7,575.9	13,096.7	15,343.0	17,158.0	15,703.9	14,184.0	414.9	3,321.7	4,044.6	3,653.3
2009	1,521.2	2,667.6	7,294.3	11,905.9	12,920.4	14,653.0	15,393.9	13,776.9	1,253.6	3,062.2	5,869.2	2,801.6
2010	1,172.6	2,592.2	6,289.9	2,937.6	8,777.9	7,369.5	11,740.9	12,978.2	277.8	1,171.4	4,169.0	448.8

(Source: ERA Statistics 2010)

Fig.3.2-12 Receivables and Payables[2] of Main Energy Companies

Fig.3.2-13 and Fig.3.2-14 show the composition of receivables and payables, respectively.

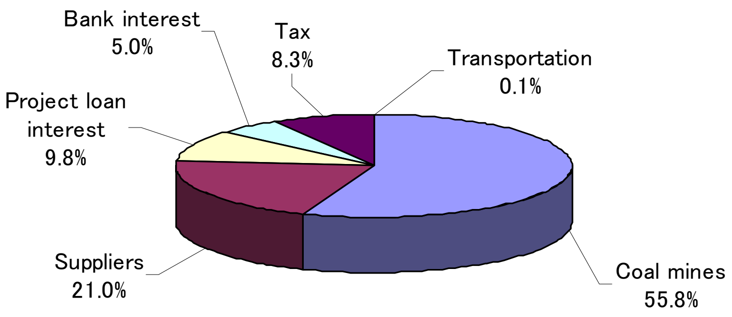
Fig.3.2-13 shows the accumulated amount of receivables so far. In the 1990s, the residential power demand was larger than that of the industrial demand and there were many households at low levels of ability to pay, so that outstanding amount of receivables from the residential consumers is larger than that from the industrial consumers.



(Source: ERA Statistics 2010)

Fig.3.2-13 Composition of Receivables of Energy Companies

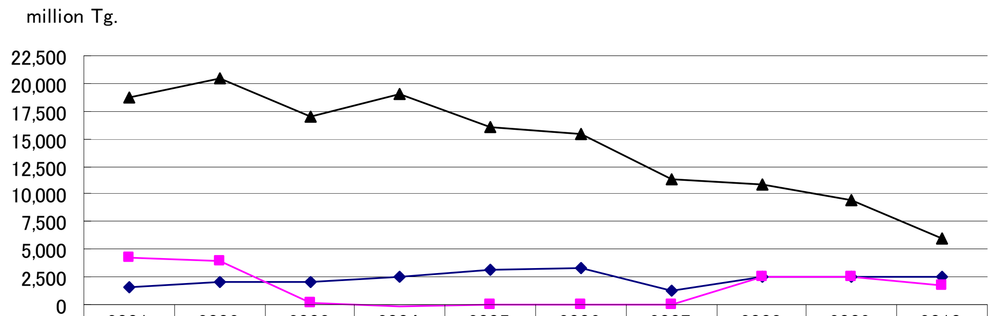
[2] Payables as used here include short-term loan interests and payable taxes



(Source: ERA Statistics 2010)

Fig.3.2-14 Composition of Payables of Energy Companies

The payables of energy companies were overwhelmingly large to coal mining companies for coal purchase. Fig.3.2-15 shows the history of payables to coal mining companies for coal purchase of the main power plants and Fig.3.2-16 shows that of receivables of the main coal mining companies to energy companies for coal sales.

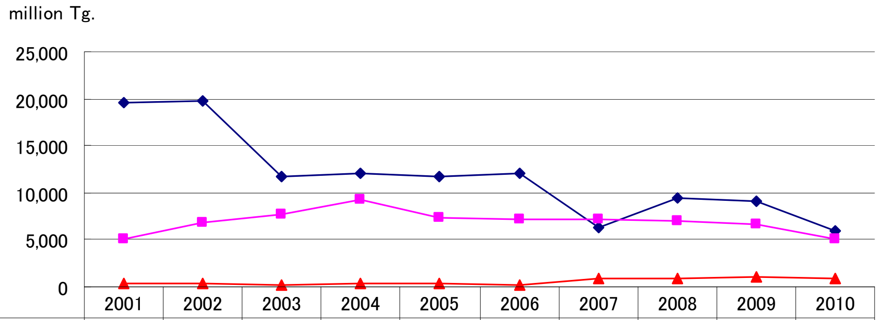


	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
TPP2	1,583.1	1,977.3	2,074.6	2,563.3	3,090.6	3,285.5	1,324.8	2,562.2	2,542.1	2,542.1
TPP3	4,311.9	3,940.6	223.3	−194.7	33.9	0.0	0.0	2,470.9	2,469.0	1,695.9
TPP4	18,715.9	20,531.7	17,014.1	19,052.1	16,000.5	15,414.6	11,381.6	10,821.4	9,480.7	5,962.3

(Source: ERA Statistics 2010)

Fig.3.2-15 Payables to Coal mines of Main Energy Companies

In 2001, the payables of TPP3 decreased to under 40% of that of 2001 and those of TPP4 to about 30%. The data obtained from TPP4 shows no payables to Baganuur coal mines in 2011. In the meantime, Fig.3.2-16 shows that the receivables of Baganuur decreased to about 30% of those of 2001.



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Baganuur	19,577.3	19,702.3	11,705.6	12,139.1	11,749.6	12,110.2	6,352.0	9,425.8	9,063.6	6,019.9
Shivee Ovoo	5,033.6	6,747.3	7,606.4	9,281.6	7,375.4	7,092.6	7,113.5	6,988.6	6,579.9	5,128.6
Shariin gol	396.5	327.1	233.4	279.6	323.6	154.8	906.5	789.8	1,006.6	877.0

(Source: ERA Statistics 2010)

Fig.3.2-16 Receivables from Main Energy Companies of Coal Mining Companies

As above stated, the issue of accumulated receivables and payables, so called ‘chain debt’, one of the management issues of Issue B, has been given efforts to resolve. At the same time, the issue of accumulated deficits is yet to be resolved. For purposes of reference, TPP4 recorded an accumulated deficit of 17 billion Tg. in 2011, although 2010 and 2011 saw single-year profit. Please refer to Table 4.1-4 in Chapter 4 for the accumulated deficits of TPP4.

The government of Mongolia has been taking measures for the accumulated deficits of the energy companies such as provision of subsidy: The government provided subsidies as shown in Table. 3.2-3 to the 7 energy companies in 2011. From hearings from TPP4, it has been revealed that the government assumed 1.89 billion Tg., 21% of the outstanding balance of its loans at the end of 2011.

Table 3.2-3 Subsidy from the Government, 2011 (Unit: million Tg.)

TPP2	TPP3	TPP4	Darkhan TPP	Erdenet TPP	NETGCO	Darkhan Heat
1,080	2,980	3,738	2,280	2,280	1,800	500

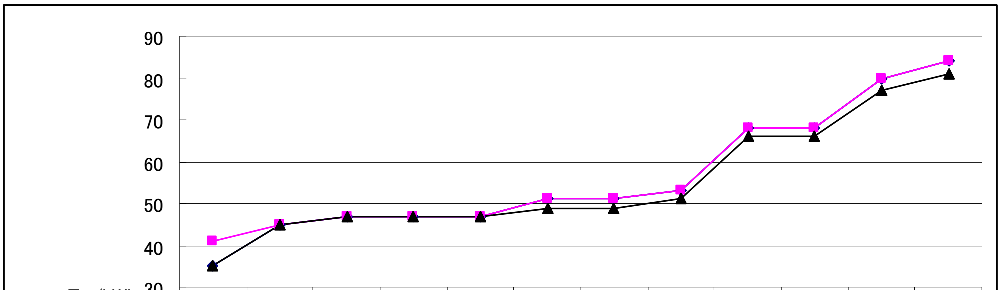
(Source: Financial and Economic Analysis 2011, ERA)

3.2.4 Energy rate system and rate level

Energy rate system has been undergoing several reforms as a step toward cost recovery. Both Interim Method introduced in 2001 and the current Permanent Methodology introduced in 2004 are based on the rate base system[3]. The rate level has been suppressed to low levels without considering depreciation costs as rate component with a view to political considerations. In Fig.3.2-17 and 3.2-18, historical trend of power tariff and heat tariff are shown respectively. In the meantime, the government of Mongolia allowed ERA to raise retail power tariff 6 times till 2011 as shown in Fig.3.2-17, under such policy as to turn the energy sector into market economy and promote participation of the private sector in the energy sector. The government has the intention to end the political gradual hikes in 2013 when the rate reaches 115Tg./kWh. From 2014 on, there is an intention of applying Price Indexation to the

[3] Rate base method: Rate = Operating costs + Interest + reasonable profit (calculated by applying the cost ratio for capital raising to the net fixed assets.

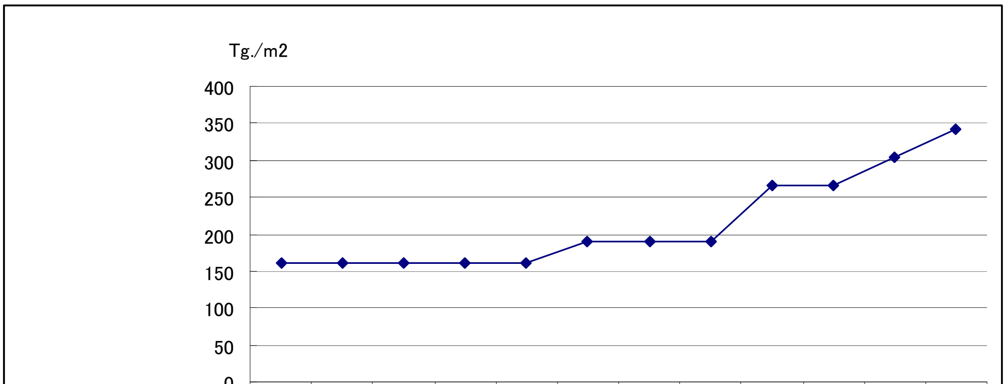
energy tariff whereby the price-cap regulation[4] will be conducted for energy companies to be freer to set their tariff. Energy companies will be able to determine their rates at their will depending on their production costs as far as they are under the price cap. At the same time, high-cost energy companies will be required to curb their production costs under the price cap. That price-cap regulation will encourage energy companies to make efforts for cost cutting. In the meantime, it is considered to be another intention of the government that the upper limit of price setting being made clear, the barrier to new entry from the private sector will be lowered. Thus, the government of Mongolia expects to promote Commercialization→Privatization from those past steps of the sector reform: Unbundling→Corporatization.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Residential	35	45	47	47	47	51	51	53.2	68	68	79.8	84
Industrial	41	45	47	47	47	51	51	53.2	68	68	79.8	84
Ger	35	45	47	47	47	48.8	48.8	51	66	66	77	81

(Source: ERA Statistics 2010)

Fig.3.2-17 History of Power Tariff



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Apartments Tg./m2	160	160	160	160	160	191	191	191	265	265	304	341

(Source: ERA Statistics 2010)

Fig.3.2-18 History of Heat Tariff

4 Usually, regional-monopolistic public utilities such as electric power and water supply adopts the rate system based on cost recovery principle. Such a system does not encourage competition, so that there are no incentives for enterprises to make efforts to curtail costs because of lack of downward pressure in price level. Incentives regulation, as countermeasures for that, will give a reward of allowing profit to those enterprises which have reduced costs and those which have not made enough efforts a penalty. Price cap regulation is one of the incentives regulation, regulate the upper limit of revenues. As far as the price is set lower than that upper limit, the enterprises are free to set their prices. Generally, the upper limit is set by the inflation rate minus the targeted cost reduction rate by the regulatory authorities.

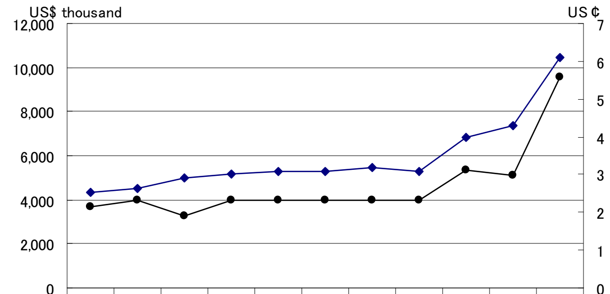
As for the tariff of the energy companies, two-part tariff is currently adopted for power, while the metered rate only is adopted for heat. Table.3.2-4 shows the tariff of the main thermal power plants, NETGCO and Ulaanbaatar Heat company.

Table 3.2-4 Tariff of Main Energy Companies[5]

	TPP2			TPP3			TPP4			NETGCO	UB Disco
Tariff	Capacity tariff million Tg /month	Energy tariff Tg/kWh	Heat tariff Tg/Gcal	Capacity tariff million Tg /month	Energy tariff Tg/kWh	Heat tariff Tg/Gcal	Capacity tariff million Tg /month	Energy tariff Tg/kWh	Heat tariff Tg/Gcal	Energy tariff Tg/kWh	Energy tariff Tg/kWh
2001		32.21	3,550		32.94	3,550		23.05	2,550	2.04	5.94
2010		64.05	8,700		60.9	8,700		35.85	8,700	3.15	16.23
2011	262.8	54.94	*	652.7	64.52	*	1,554.80	31.95	*	4.43	20.94

(Source: ERA) note: *2050-8700 Tg./Gcal depending on season for hot water and 10,600-11,870 Tg./Gcal for steam.

Fig .3.2-19 shows the prices of power import from Russia and payments to Russia.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total payment to Russia (US$ thousand)	3,659.2	3,956.0	3,286.1	3,998.5	4,003.4	3,981.9	3,975.0	3,980.4	5,338.9	5,135.3	9,552.0
Import price (US ¢ /kWh)	2.53	2.64	2.91	3	3.1	3.1	3.2	3.1	4	4.3	6.1

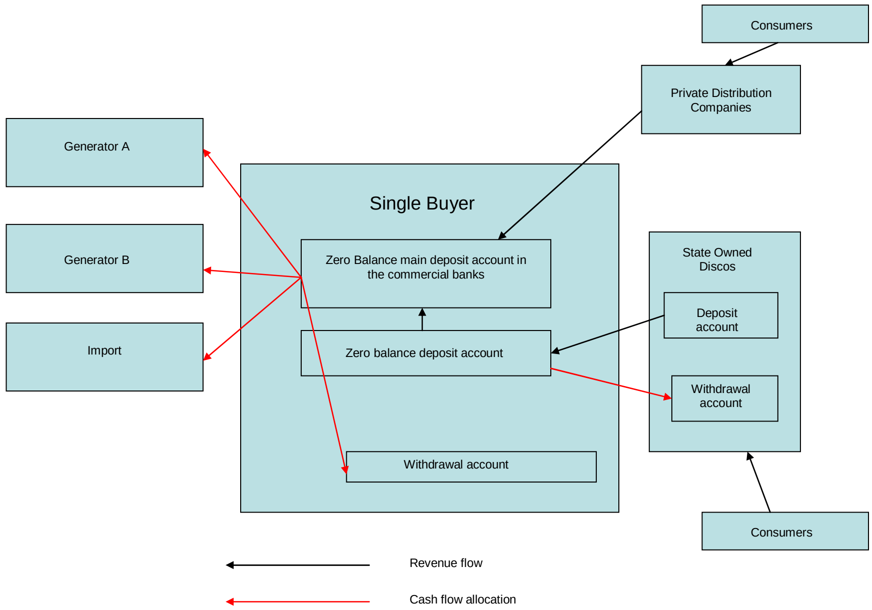
(Source: ERA Statistics 2010)

Fig.3.2-19 Historical Import Prices from Russia and Payments to Russia

As seen from the above table, the import price has been on the increase since 2008 with accordingly increased payments to Russia. According to NDC, in 2008, Russia changed the power tariff structure into two-part pricing: capacity charge corresponding to maximum demand (MW) and energy charge to quantity of imported electricity (MWh), demanding higher prices as penalty when the actual imported power exceeds the planned one at the time of contract. In the background to such a change, there has been a growing power demand in Siberia due to recent developments in Siberia.

There was another issue regarding the tariff: issue of revenue collection. Currently, a revenue collection mechanism called 'Cash Management System of Single Buyer Model' as shown in Fig.3.2-20. That mechanism is working well. To illustrate the effect of that mechanism, Fig.3.2-20 shows the historical collection rate in CES.

[5] The consumers' tariffs are set by summing up the tariff of the generating companies, the transmission company and the distribution company. The tariff of the generating companies are different from each other and there are different capacity tariffs, so that the consumer's tariffs do not result from simple addition of the tariffs in the table above.

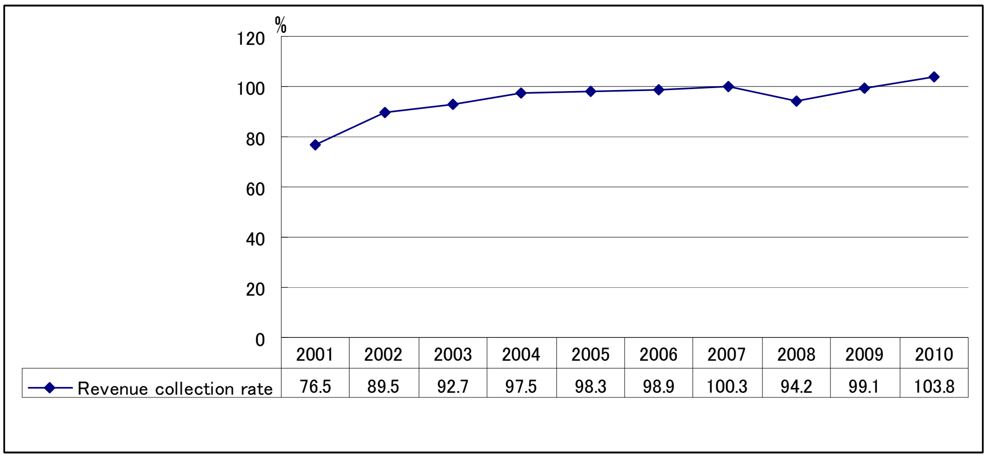


(Source: ERA Policy and Trends for Regulating Energy Prices and Power Market, 2011)

Fig.3.2-20 Cash Management System of Single Buyer Model

The above revenue collection mechanism works as follows: the bills collected by the distribution companies (Disco) are transmitted to 'Zero Balance Deposit Account', from where Disco's portion will be transmitted to them and the balance will be transmitted to 'Zero Balance Main Deposit Account' to send the respective portions to the energy companies and Russia. This mechanism works automatically by a computer program, which will not allow any company to make intentional delay in payment for their cash management.

Fig. 3.2-21 shows the bill collection rate in CES.



(Source: ERA Policy and Trends for Regulating Energy Prices and Power Market, 2011)

Fig.3.2-21 History of Revenue Collection Rate of CES

Regarding the bill collection rate of Ulaanbaatar distributing company from final consumers, according to ERC, the collection rate was recorded at levels of 70% in the 1990s and near 100% from 2001 onward.

3.3 Demand forecast

3.3.1 Power demand forecast

Table 3.3-1 shows historical power demand of CES.

Table 3.3-1 Power Supply and Demand Balance of CES

(Unit: million kWh)

	Power Generation	Power export/import			Power Supply
		Import	Export	Net import	
	I	II	III	IV (II−III)	V (I+IV)
1999	2740	195	59	136	2876
2000	2844	150	25	125	2969
2001	2898	157	18	139	3037
2002	3004	115	8	107	3111
2003	3028	131	7	124	3152
2004	3195	131	8	123	3318
2005	3320	130	15	115	3435
2006	3433	125	16	109	3542
2007	3594	130	14	116	3710
2008	3874	132	16	116	3990

(Source: Report on Mongolian Power Sector by Japan Electric Power Information Center Inc., 2010 Jan.)

CES and Russian power system are connected by 220 kV transmission lines. For system operations, power dispatching is made in such a way that the base load is met by the other power plants than TPP4 and that the uncovered base load and the middle/peak loads are covered by TPP4. The peak load not covered by TPP4 is met by import from Russia.

Table 3.3-1 shows that the generated and supplied power increased by an average annual rate of about 4% since 1999 and the import from Russia tended to decrease to 2002, and to level off from 2003 to 2008 inclusive and then to grow rapidly since 2009 as seen in Fig.3.2-7. The increase of the generated power was brought by the increased utilization of the power plants.

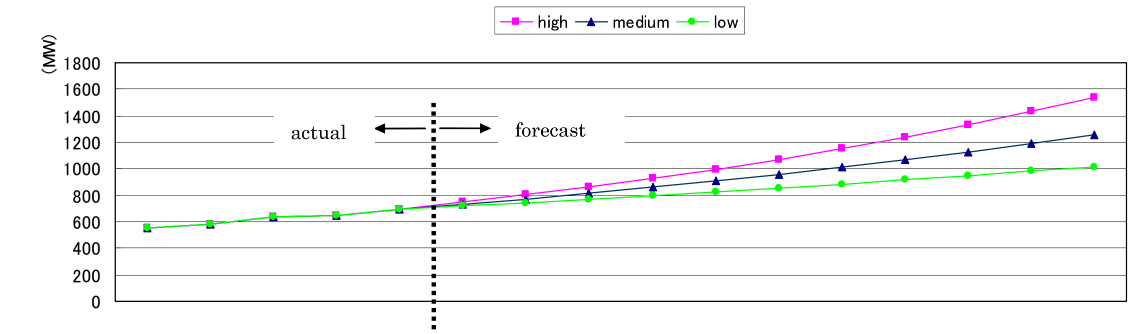
Fig.3.3-1 shows the power demand forecast of CES made by NDC (National Dispatching Center) in 2010. That forecast was made assuming yearly demand growth: high growth case-7.5%, medium growth case-5.5% and low growth case-3.5%, without considering possible demand increase due to interconnection with mining areas in South Gobi planned for 2015.

There is such a prediction that there would occur power shortage since 2019 even in the low demand growth case, assuming that, the maximum import from Russia is 200 MW which is nearly maximum of recent years as shown in Table 3.2-2 and the maximum supplying capacity of CES of 763 MW as shown in Table 3.2-1.

To that end, TPP5 has been planned as the next CHP to be built under PPP scheme in Mongolia. That plan is 2 staged development with 1st stage of the following planned capacity.

a) Power 150 MW×3 units
b) Heat 505 Gcal/h

ADB report predicts that if TPP5 is commissioned in 2015, the supply and demand can be balanced even with increased power demand from the interconnected South Gobi mining area. Table 3.3-2 shows that supply and demand balance



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
high	557	585	638	649	695	747	803	863	928	997	1072	1153	1239	1332	1432	1539
medium	557	585	638	649	695	733	773	816	860	908	958	1011	1066	1125	1187	1252
low	557	585	638	649	695	719	744	770	797	825	854	884	915	947	980	1014

(Source: JICA Report 2010)

Fig.3.3-1 Power Demand Forecast of CES by NDC

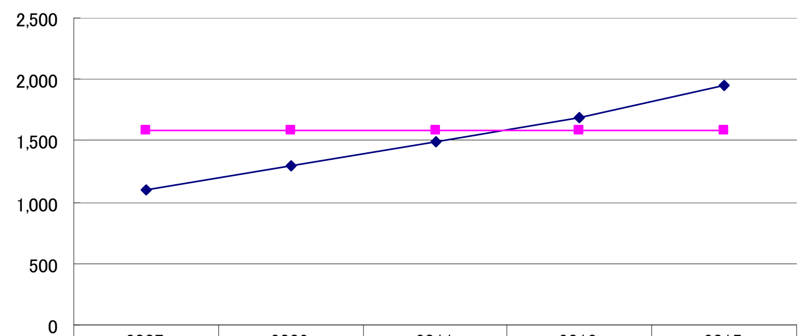
Table 3.3-2 Power Supply and Demand Forecast of CES by ADB

Years	2011	2012	2013	2014	2015*	2016	2017	2018	2019	2020	2025	2030
Central Energy System												
CHP-2 (MW)	10	10	10	0	0	0	0	0	0	0	0	0
CHP-3 (MW)	120	120	120	120	80	80	80	80	80	80	80	80
CHP-4 (MW)	510	510	510	510	510	510	510	510	510	510	510	510
Erdenet CHP (MW)	15	15	15	15	15	15	15	15	15	15	15	15
Darkhan CHP (MW)	40	40	60	60	60	60	60	60	60	60	60	60
Total generation (MW)	695	695	715	705	665	665	665	665	665	665	665	665
Original CES Demand (MW)	**762**	**819**	**862**	**934**	**1,003**	**1,074**	**1,141**	**1,214**	**1,290**	**1,376**	**1,661**	**1,933**
CHP-5 (MW)	0	0	0	0	450	450	450	450	450	820	820	820
Import/Other sources (MW)	**67**	**124**	**147**	**229**	**-112**	**-41**	**26**	**99**	**175**	**-109**	**176**	**448**
Gobi Mining Area												
Ukhaahudag CHP (MW)	36	36	36	36	40	40	40	40	100	150	150	150
Oyutolgoi diesel plant (MW)	24	0	0	0	0	0	0	0	0	0	0	0
Import/Other sources (MW)	83	128	181	196	270	280	302	290	235	202	219	238
Gobi area demand (MW)	**143**	**164**	**217**	**232**	**310**	**320**	**342**	**330**	**335**	**352**	**369**	**388**
Power Balance												
Total generation of exisitng power plant of CES (MW)	*695*	*695*	*715*	*705*	*705*	*705*	*705*	*705*	*765*	*815*	*815*	*815*
CHP-5 (MW)	0	0	0	0	450	450	450	450	450	820	820	820
Total Balace of CES (MW)	*67*	*124*	*147*	*229*	*158*	*239*	*328*	*389*	*410*	*93*	*395*	*686*
Total demand of CES (MW)	**762**	**819**	**862**	**934**	**1,313**	**1,394**	**1,483**	**1,544**	**1,625**	**1,728**	**2,030**	**2,321**

(Source: ADB TA NO.7502-MON 2011)

3.3.2 Heat demand forecast

Ulaanbaatar Heat company has a heat demand forecast as shown in Fig.3.3-2, predicting that heat shortage would occur between 2012 and 2013.



	2007	2009	2011	2013	2015
Demand Gcal/hour	1,100	1,301	1,495	1,690	1,951
Supply Capacity	1585	1585	1585	1585	1585

(Source: UB District Heating Co. 2011)

Fig.3.3-2 Heat Demand Forecast

According to Ulaanbaatar District Heating Co., there is a master plan of Ulaanbaatar for urban development, based on which housing land is being developed to build apartments for 100 thousand households. There is a plan to build a substation for heat supply of 210 MW (189 Gcal/hour) destined to developing areas in the western suburbs of Ulaanbaatar. And there is another plan considered: micro heat plants (small-sized HOB) would be built in new developed areas for heat supply.

3.4 Energy policy and power development program

As a fundamental measures for Issue C, there is a new power sources development program. The government of Mongolia prepared NDS (National Development Strategy) in 2006, in which an emphasis was given to the importance of energy cooperation, thereby building cooperative relationship with other countries with the backing of its abundant natural resources. That Strategy intends to attract foreign aid and investment by diplomacy on resources and promote domestic socio-economic development aiming to attain an annual economic growth of 14% for 15 years up to 2022 and US$ 12,000 of GDP per capita in 2012 – US$2,251 at current prices as of 2010.

The Strategy plans to push forward with infrastructure development in order to achieve that economic goal with the following 9 points as priority in the energy sector:

a) Promote energy cooperation between districts
b) Expand the power system (establish an integrated power system)
c) Supply power to South Gobi
d) Improve efficiency of the energy sector and secure reliability of energy supply
e) Develop coal mining and R&D of coal gasification and liquefaction technology
f) Expand use of renewable energies
g) Promote rural electrification
h) Hydropower development on large rivers
i) Examine introduction of nuclear power

Those policy objectives of NDS are concretized in MIPSP (Mongolian Integrated Power System Program). That Program was prepared as a long-term plan to cope with increasing power demand from Ulaanbaatar and mining in South Gobi, sanctioned by the Parliament in January of 2007. The Program is a development plan for 33 years from 2007 up to 2041. There are 3-phased development plans: 2007−2012, 2012−2020, 2020−2040, mainly including power developments in CES and establishment of the national grid.

In the 1st phase including those projects which would affect the power supply and demand balance of short/mid term are the following projects:

a) Construction of Egiin hydro power plant (220MW) with connection to CES by 220 kV transmission lines;
b) Extension of 220 kV transmission lines from Ulaanbaatar to Oyu Tolgoi via Mandalgobi in order to provide stable power in the beginning of mining developments in South Gobi areas such as Oyu Tolgo and Tsagaan Suvarga. And build a mine-mouth thermal power plant of 300 MW or over in Tavan Tolgoi to be connected with CES;
c) Construction of CHP (combined heat and power plant) of 100 MW or over in Ulaanbaatar;
d) Construction of pumped-storage hydropower plant of 50 MW or over in the central region;

e) Implementation of upgrade/expansion of Darhan thermal power plant and Erdenet thermal power plant;
f) Establishment of energy complexes in Nyalga and Choir, lignite mining areas, in order to power export;
g) Construction of 15 to 20MW power plant near Bayanteeg mine in Uvur-Khangai province and construction of 110kV transmission line from the power plant to Taishirin hydropower plant via Bayanhongor province substation
h) Construction of hydropower plant in Chargait on the river of Delger and a thermal power plant in Mogoi Gol mines, extend 110 kV transmission lines from these power plants to Uliastai city of the prefectural capital of Zavkhan province;
i) Implementation of F/S for Acht power plant near Nuurst Hotgor mine in Uvs province;
j) Construction of 110kV transmission line to Alkatantsogts-Asgat mines in Bayan Olgii province;
k) Interconnection between Dalanzadgad power plant and Tavan Tolgoi power plant;
l) Implementation of F/S of Erdenebureng a hydropower plant in Hovd river in Hovd province;
m) Implementation of full survey for utilization of geothermal energy;
n) Construction of wind power facilities to connect with CES;

The government of Mongolia would like to push forward with those specific projects according to MIPSP but no considerable progress was found at the time of this Review, 2012 March, except for TPP5 and some transmission lines. In the following, out of those 1st phase projects between 2007 and 2012 which would affect the supply and demand balance of CES, the progress of the projects mentioned below will be discussed.

a) A combined heat and power plant of 100MW or over in Ulaanbaatar
b) Hydropower plants: Egiin, Orkhon and Selenge
c) Mine-mouth thermal power plants for mining development
d) TPP5

(1) A combined heat and power plant of 100 MW or over in Ulaanbaatar

The government of Mongolia issued "Energy Sector Plan NO.139" in April 27, 2011 to instruct TPP 3 and TPP4 to commence a study on expansion. TPP4 established a working group comprising its own staff and outside experts to commence a study on addition of a 100MW-class steam turbine in its premises. The following are the current situation of the study as heard from TPP4.

a) The study results of the working group will be compiled and submitted to MMRE by June 2012
b) As power demand is growing, the works is planned to commence in 2013 for commission by March 2014, giving first priority to the schedule.

c) As for candidate of the turbine, an examination is being conducted of URAL-made steam turbine, the same as the existing. TPP4 is accustomed to that turbine in terms of operation and maintenance. A MOU was signed with URAL for mutual collaboration of study at the time of a visit to its turbine factory to have technical explanations in April 2012.
d) The finance will be requested from the Mongolian government.
e) In order to increase heat to the turbine, an examination is being made with a Russian maker to increase about 50t/h per an existing boiler. In the summer of 2012, the first boiler is planned to be remodeled. In 2015, all of the 8 boilers are planned to be completed for remodeling.
f) The existing boilers Nos. 5 & 6 were remodeled in a Chinese turbine factory, so that there is plan to adopt Chinese turbine. A technical comparison is planned to be made between Russia, China and Japan.
g) A study is being conducted on the arrangement of new steam turbine and other technical matters and construction method.

Later, in November 2012, JICA-ST got information that contract of construction of this 100MW class steam turbine was concluded between TPP4 and URAL turbine.

(2) Hydropower

Presently planned are 3 hydropower sites for large-scale development: Egiin, Orkhon and Selenge. As for Egiin (220 MW), detail design was prepared in 2007. At that time, Chinese government committed to provide a soft loan but conditions could not be met between the parties. Besides, environmental concerns and political reasons suspended that project. As for Orkhon (118MW), no progress was confirmed. Hydropower plan on the river of Selenge, with feasibility study conducted in 1970s, has surfaced for further investigation to build a hydropower plant of 200 MW to 300 MW.

Large-scale hydropower development will require a large sum of initial investment with large civil works accompanied by geological risks, hydrological risks and environmental risks. Because of such factors, the financing will be difficult and the period of investigations will be prolonged. It is quite unlikely to consider hydropower to be a measures to make up the short-term supply gap of CES.

(3) Mine-mouth thermal power plants for mining development

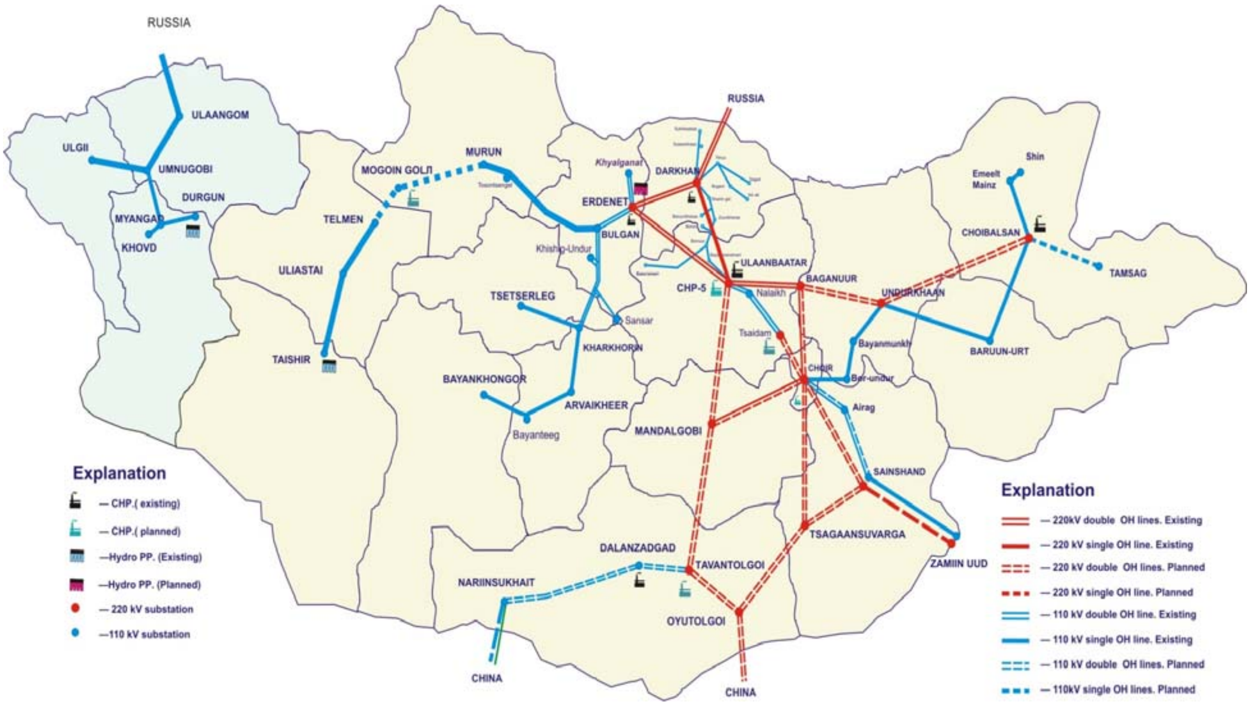
Mongolia is abound in mineral resources; in particular, mining developments for coal and copper attract the participation or interest of foreign capital from China, Russia, Korea, USA, Canada, Japan and so forth. Electric power is indispensable for mining developments. Considering that CES does not have extra supply capacity, there are the following 3 options for mining developers to secure power supply:

a) Mongolian government would build power plants;
b) Developers would build their own power plants; and,
c) Other IPP developers than mining developers would build power plants.

There are 9 plans for mine-mouth thermal power plants ranging in capacity from 300 MW to 600 MW including Chandgana. Chandgana TPP has been granted a permission for construction by Mongolian government.

Regardless of whoever would be the developer for the above options, it is difficult to raise the necessary funds in a short period.

It is dispensable for those mine-mouth thermal power plants to be connected to such a larger power system as CES for power plant operation. NETGCO has a plan of interconnection of CES with other regions as shown in the figure below.



(Source: NETGCO)

Fig.3.4-1 Planned Interconnection of CES

The present situation of main transmission line projects under construction or plan as follows.

1) Mandalgobi - Tavan tolgoi - Oyu tolgoi

   A private contractor was awarded a contract for construction of about 430 km 2-circuits 220 kV transmission lines under the Build Transfer scheme. That private contractor finances the project during construction to be paid back by the government at the time of completion. For Mandalgobi - Tavan tolgoi, the construction is under way to be completed for 2012-2013. For Tavan tolgoi - Oyu tolgoi, the construction is scheduled to start in the summer of 2012.

2) Ulaanbaatar-Mandalgobi

   This 260km transmission line project is planned under PPP scheme. The developer is not yet determined.

3) Interconnection with East regional electrical system

For 185 km between Choibasan-Baruun urt, there already exists a 110 kV transmission line. For 230 km between Undurkhaan-Baruun urt, the government constructed a 110 kV transmission line. From Baganuur to Choibalsan via Undurkhaan, the government plants to construct 2-circuit 220 kV transmission lines between 2012 and 2016.

(4) Ulaanbaatar Thermal Power Plant No.5 (TPP5)

The most expected power development project is TPP5. From hearings of this Study, it has been revealed that 4 bidders were selected out of 23 bidders and the government indicated to determine a successful bidder in May 18 this year.

ADB conducted a feasibility study on this project in May 2011. The government of Mongolia has an intention of implementing the project under PPP scheme, so that ADB's report was also prepared in that line. ADB's report estimated the construction cost at US$1,349.5 million for a combined capacity of the 1st and 2nd phases and at US$666.3 for 450 MW of 1st phase only.

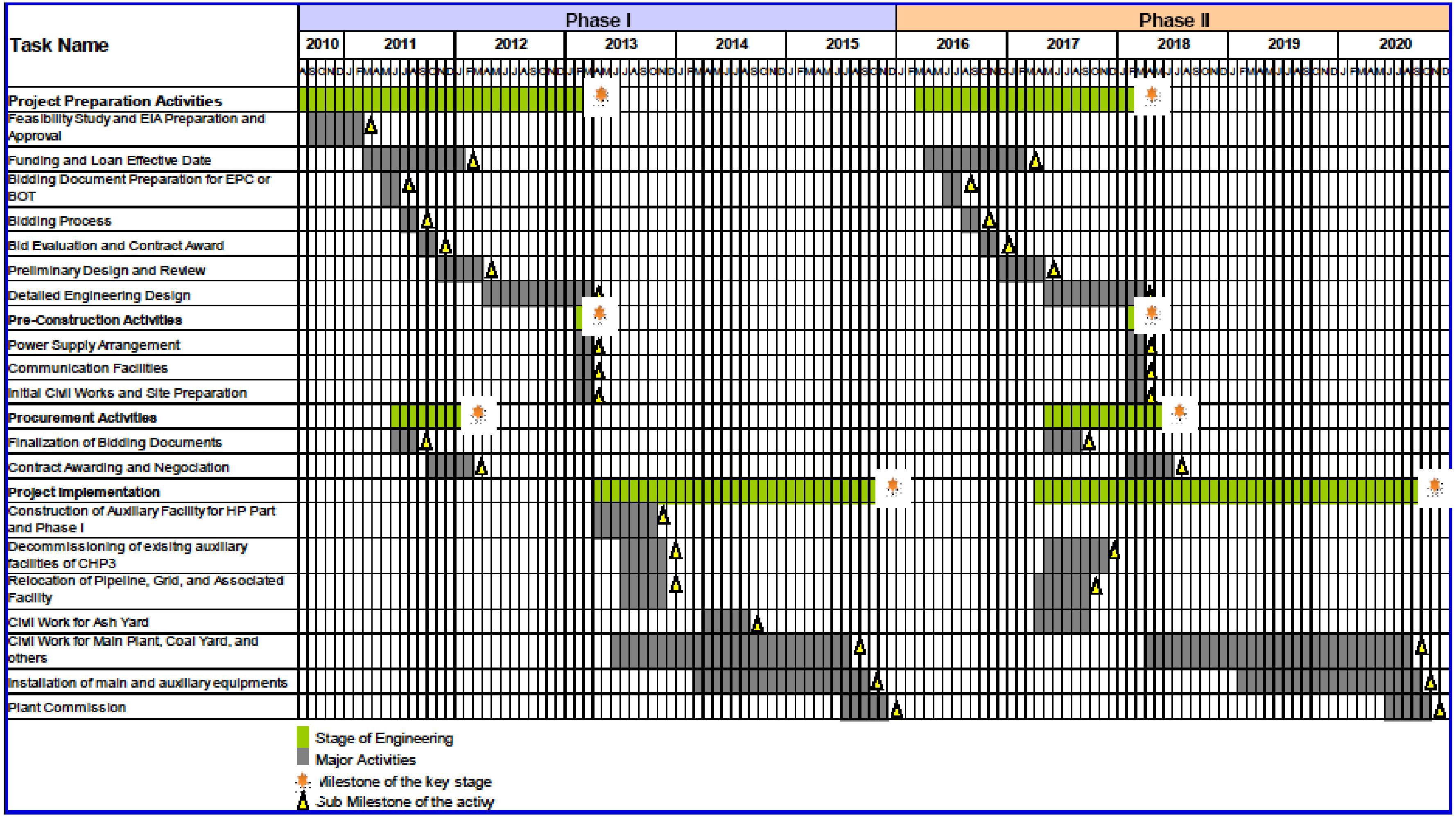
Fig.3.4-2 shows the implementation schedule shown in ADB's report. The project is to commence in 2010 and to be completed in 2015 for 1st phase and in 2020 for 2nd phase. One year was allocated for financial arrangements. Now it is 2012, so that even if the developer is determined this year, the completion of 1st phase would be in 2017 according to that schedule. The implementation schedule was prepared under PPP scheme. It would take considerable time to complete arrangements between the developer and the government such as concession agreement and sovereign guarantee. Furthermore, the required loan amount is huge for such a country as to have a nominal GDP of US$ 6 billion and a budget scale of US$ 2 billion. Hence, it would take a long time for negotiations of loan and guarantee between the developer and foreign private banks and international aid organizations.

Furthermore, the following problems have been found from the hearings of this Study:

a) The project was planned to use the vicinity of the site of the existing TPP3, which causes environmental concerns among the surrounding areas. An official environmental assessment has not been completed;
b) In the planned site in the vicinity of TPP3, which is not a vacant lot, there are factories in operation;
c) As for coal transportation, the only means are railways and the problem of the transportation capacity has not been solved;
d) Ash disposal areas have not been secured and there is no concrete idea for as utilization; and,
e) Water sources have not been secured for the plant.

If the project site is changed to another place, it would take more time.

PPP implies government participation, which has an effect of increased credibility. However, for Mongolian government, the project is the first ever experience of that scale and, for possible investors and lenders to take part in the project, there would be high risk. It follows that they would logically require high return such as loan interest, which would increase the final project cost to be passed onto power and heat rates.



(Source: ADB Ulaanbaatar Low Carbon Energy Supply Project Using a Public-Private Partnership Model Feasibility Report)

Fig.3.4-2 Implementation Plan of TPP5

Chapter 4

Current Situation and Issue of Ulaanbaatar Thermal Power Plant No.4 (TPP4)

TABLE OF CONTENTS

LIST OF TABLES

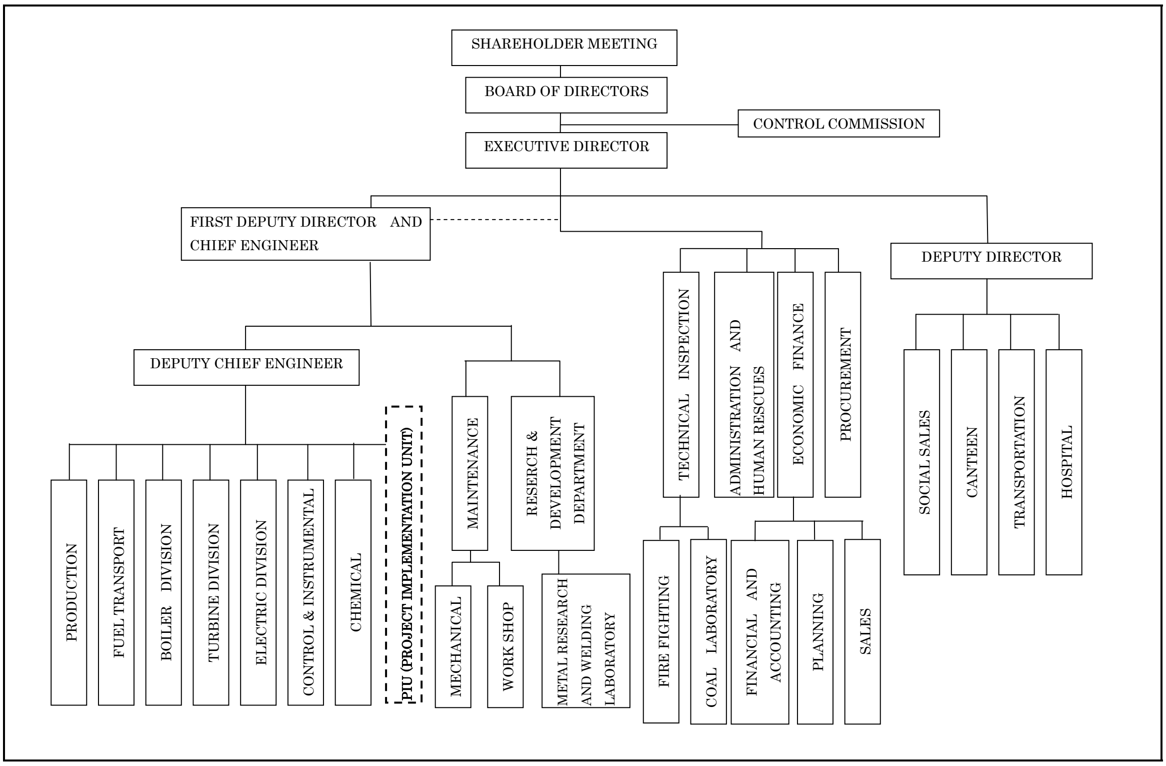
LIST OF FIGURES

Chapter 4 Current Situation and Issue of Ulaanbaatar Thermal Power Plant NO.4 (TPP4)

4.1 Business Conditions of Ulaanbaatar TPP4

4.1.1 Management Structure

The organization chart of Ulaanbaatar TPP4 is shown in Fig.4.1-1.



(Source: JICA Survey Team based on TPP4's data)

Fig.4.1-1 Organization Chart of TPP4

In TPP4, there are approx. 1,400 employees in total. Departments relating to operation and maintenance, and numbers of employees of those departments are shown in Table 4.1-1.

Table 4.1-1 Number of Operation and Maintenance People of TPP4

NO.	DEPARTMENT	OPERATION	MAINTENANCE	OTHER	TOTAL
1	FUEL TRANSPORT	80	57	119	256
2	BOILER	105	110	78	293
3	TURBINE	90	80	27	197
4	ELECTRICAL	40	60	37	137
5	CONTROL & INSTRUMENT	40	50	8	98
6	CHEMICAL	38	14	13	65
7	MAINTENANCE	0	106	11	117
8	TOTAL	393	477	293	1163

(Source: JICA Report 2010)

TPP4 is a state-owned enterprise in the form of joint stock company with the stockholders mentioned below, from which the representatives make up the management board.

Ministry of Mineral Resources and Energy: 49%
State Property Committee: 31%
Ministry of Finance: 20%

The board of directors is established as routine decision-making body, comprised of 23 director-class members from the departments of TPP4. Besides, a consultative committee is convoked to discuss a specific issue with the aforesaid management board members and persons interested in that issue.

When a large-scale renovation or expansion works are carried out, PIU (Project Implementation Unit) will be established within TPP4, as one of divisions inside power plant, in parallel with boiler division and turbine division which are directly connected with power plant operation. The project manager representing PIU is to be assigned from outside by EA (Energy Authority). Other members of PIU will be assigned from within TPP4 but shall be approved by the project manager. Currently, PIU has not yet been established since this Project is yet to be officially started, but there are 2 members assigned from the Research and Development Department of TPP4 as coordinator with JICA Survey Team.

4.1.2 Business Performance

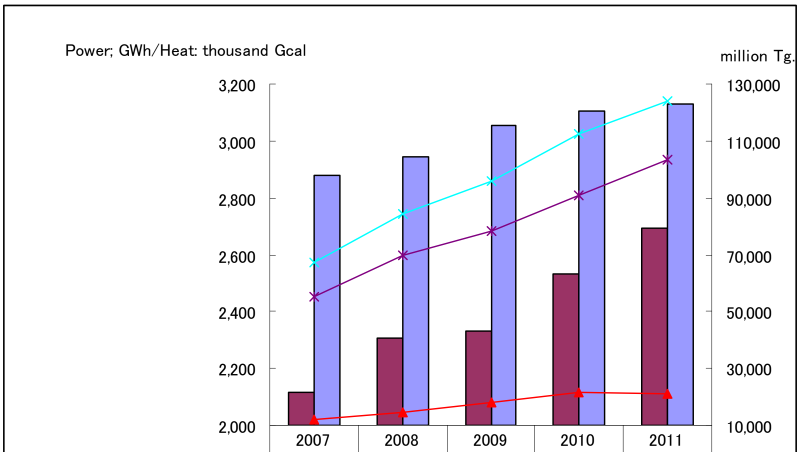
TPP4 sells its produced power to NETGCO, the single buyer of CES, and heat to Ulaanbaatar District Heating Co. Heat is also sold in small lot to neighboring factories. Table 4.1-2 shows the sales and production of TPP4 in the recent years.

Table 4.1-2 Sales and Production of TPP4

		2007	2008	2009	2010	2011
Elec. sent	million kWh	2,118	2,305	2,329	2,533	2,691
Heat sent	thousand Gcal	2,873	2,942	3,053	3,106	3,129
Sales revenue	million Tg.	67,414	84,400	96,103	115,892	124,168
Elec.	million Tg.	55,388	69,937	78,283	90,888	103,177
Heat	million Tg.	12,026	14,464	17,820	21,517	20,991
Cost						
Elec.	Tg./kWh	21.62	25.38	29.57	32.55	32.54
Heat	Tg./Gcal	7,497	9,313	10,708	11,896	12,792
Fuel consumption	Ton	2,497,296	2,616,962	2,635,911	2,880,042	2,899,685
Station use	million kWh	369	389	382	407	411
Price						
Elec.	Tg./kWh	26.16	30.34	32.93	37.87	39.17
Heat	Tg./Gcal	4,070	4,070	5,700	6,777	6,576.6
Total expenses	million Tg.	67,317	85,914	101,560	118,571	127,587
Elec.	million Tg.	45,778	58,513	68,874	81,616	87,564
Heat	million Tg.	21,539	27,401	32,686	36,955	40,023
Profit/loss (total)	million Tg.	98	-1,514	-5,455	13,594	412
Profit/loss (power)	million Tg.	9,610	11,424	9,410	24,151	19,416
Profit/loss (heat)	million Tg.	-9,512	-12,938	-14,865	-10,557	-19,004
No. of employee	Persons	1,386	1,390	1,399	1,482	1,463

(Source: TPP4)

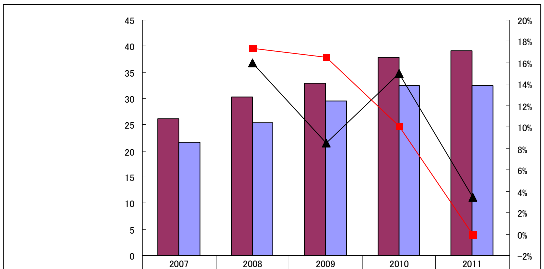
The above table was converted into Fig.4.1-2 to illustrate the history of sales of power and heat. As for the sales volume, power increased by 27% in 2011 compared to 2007 and heat by 9% at a lower rate than power. Meanwhile, for the revenue, power increased by 84% in 2011 compared to 2007 and heat by 75%. This is due to differences in price hike between power and heat. Fig.4.1-3 shows the history of prices and corresponding production cost during the same period.



	2007	2008	2009	2010	2011
Power sold (GWh)	2,118	2,305	2,329	2,533	2,691
Heat sold (thousand Gcal)	2,879	2,942	3,053	3,106	3,129
Power revenue (millionTg.)	55,388	69,937	78,283	90,888	103,177
Heat revenue (million Tg.)	12,026	14,464	17,820	21,517	20,991
Sales revenue (million Tg.)	67,414	84,400	96,103	112,404	124,168

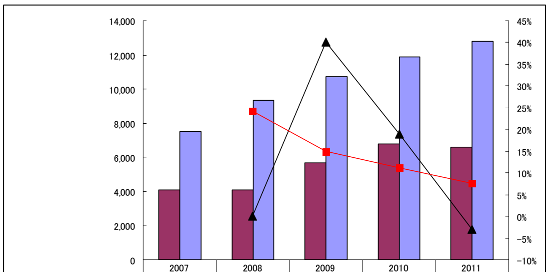
(Source: JICA Survey Team based on TPP4's data)

Fig.4.1-2 Sales of Power and Heat of TPP4



	2007	2008	2009	2010	2011
Power Tariff (Tg./kWh)	26.16	30.34	32.93	37.87	39.17
Power Cost (Tg./kWh)	21.62	25.38	29.57	32.55	32.54
Power Tariff Hike in %		16.0%	8.5%	15.0%	3.4%
Power Cost Rise in %		17.4%	16.5%	10.1%	−0.03%

(1) Power



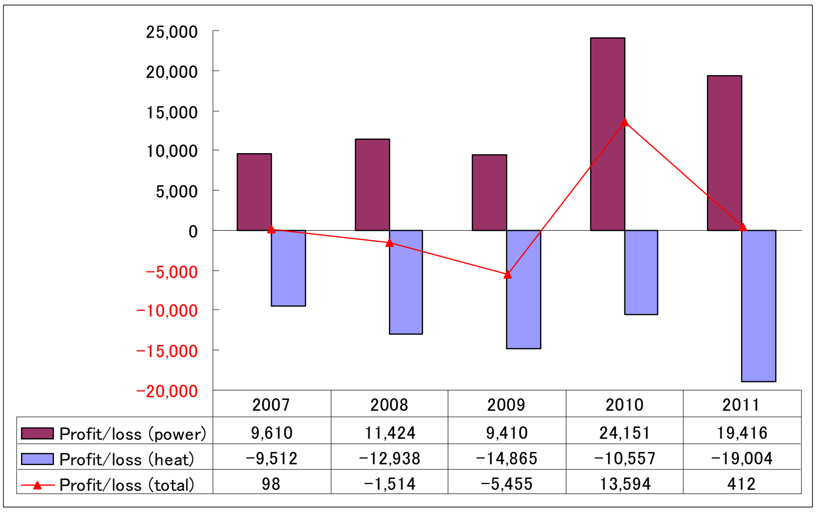
	2007	2008	2009	2010	2011
Heat Tariff (Tg./Gcal)	4,070.00	4,070.00	5,700.00	6,776.96	6,576.60
Heat Cost (Tg./Gcal)	7,496.64	9,312.92	10,707.60	11,896.21	12,791.55
Heat Tariff Hike in %		0.0%	40.0%	18.9%	−3.0%
Heat Cost Rise in %		24.2%	15.0%	11.1%	7.5%

(2) Heat

(Source: JICA Survey Team based on TPP4's data)

Fig.4.1-3 Tariff and Production Cost of Power and Heat of TPP4

Comparing 2007 and 2011, power price increased by 50% and heat by 62%, while as for production cost, power increased by 50% and heat by 71%. Power got a price hike every year except 2009 but as for heat there is no correspondence between price hikes and production cost rises. As shown in Fig.4.1-4, power contributed to profit every year but heat suffered from deficit, impairing the bottom line.



(Source: JICA Survey Team based on TPP4's data)

Fig.4.1-4　Profit and Loss of TPP4

Table 4.1-3 shows the historical production cost.

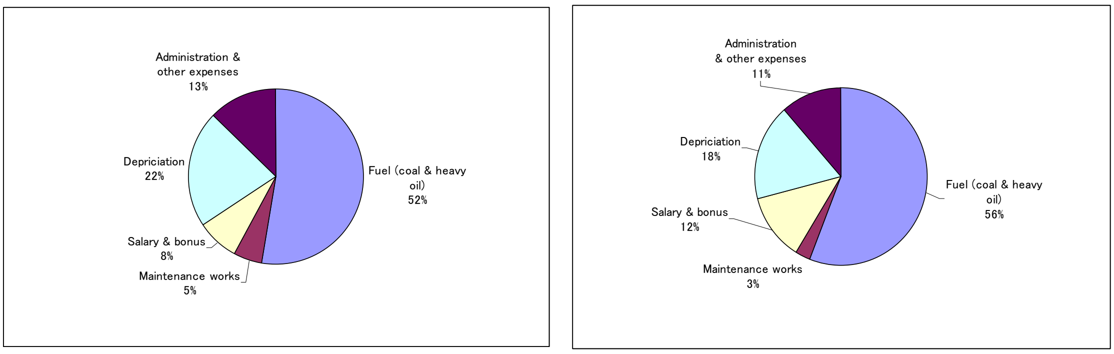
Table 4.1-3　Main Production Cost Components of TPP4

Unit: million Tg.

		Fuel (coal & heavy oil)	Maintenance works	Salary & bonus	Depriciation	Administration & other expenses	Total expenses
2007	Total	35,329	3,519	5,325	14,543	8,601	67,317
	Power	23,387	2,463	3,727	10,180	6,021	45,778
	Heat	11,942	1,056	1,597	4,363	2,581	21,539
2008	Total	46,172	2,965	7,785	18,423	10,569	85,914
	Power	30,693	2,075	5,450	12,896	7,399	58,513
	Heat	15,479	889	2,336	5,527	3,170	27,401
2009	Total	53,474	2,854	10,642	23,561	11,027	101,558
	Power	35,214	1,998	7,450	16,493	7,718	68,873
	Heat	18,260	856	3,193	7,068	3,308	32,685
2010	Total	65,348	2,553	12,375	27,680	11,964	119,920
	Power	44,360	1,787	8,662	19,376	8,375	82,560
	Heat	20,988	766	3,712	8,304	3,590	37,360
2011	Total	73,453	3,902	16,067	23,340	15,022	131,784
	Power	49,670	2,731	11,247	16,338	10,516	90,502
	Heat	23,782	1,171	4,820	7,002	4,507	41,282

(Source: JICA Survey Team based on TPP4's data)

The above table was converted into Fig.4.1-5 to illustrate the cost breakdown of 2007 and 2011. In both years, the cost composition is generally the same: fuel 50% or over, followed by depreciation about 20%, personnel about 10% and maintenance/repairs 5% or under. It would appear that financially there is under depreciation and there is concern over maintenance due to its low ratio in the production costs in spite of aged deterioration. As for the personnel cost, TPP4 retains some 1,500 employee, a large number for its size, compared to Japan, bringing its personnel cost to a large share in the production cost.



(1) as of 2007 (2) as of 2011

(Source: JICA Survey Team)

Fig.4.1-5 Composition of Production Cost of TPP4

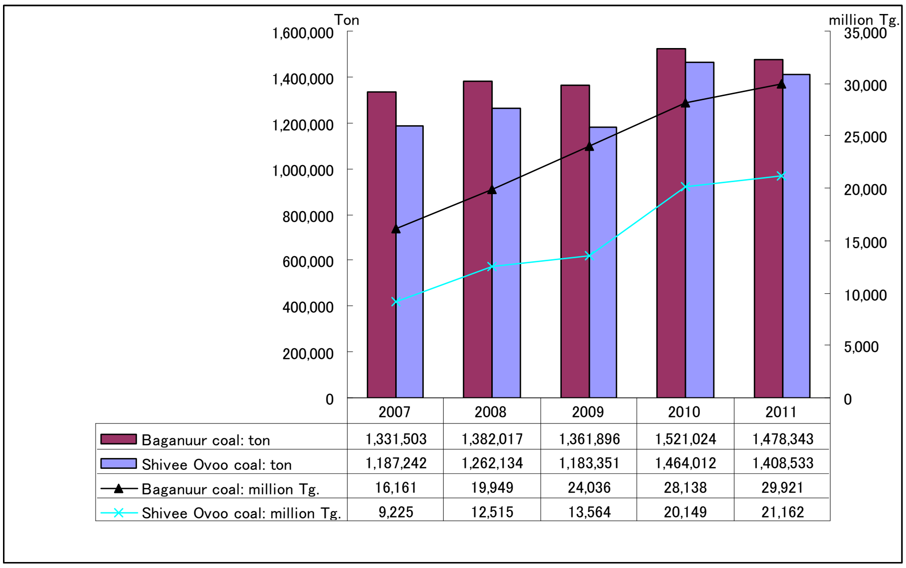
Below is the fuel cost, accounting for the largest share in the production cost. Table 4.1-4 shows the coal and heavy oil in volume and amount of purchase and the fuel transportation.

Table 4.1-4 Fuel-related Costs

	Heavy oil		Baganuur		Shivee Ovoo		Transportation (millionTg.)
	ton	amount (million Tg.)	ton	amount (million Tg.)	ton	amount (million Tg.)	
2007	2,070	1,095	1,331,503	16,161	1,187,242	9,225	5,759
2008	2,134	1,721	1,382,017	19,949	1,262,134	12,515	7,033
2009	594	536	1,361,896	24,036	1,183,351	13,564	7,984
2010	1,059	858	1,521,024	28,138	1,464,012	20,149	11,179
2011	1,236	1,062	1,478,343	29,921	1,408,533	21,162	13,828

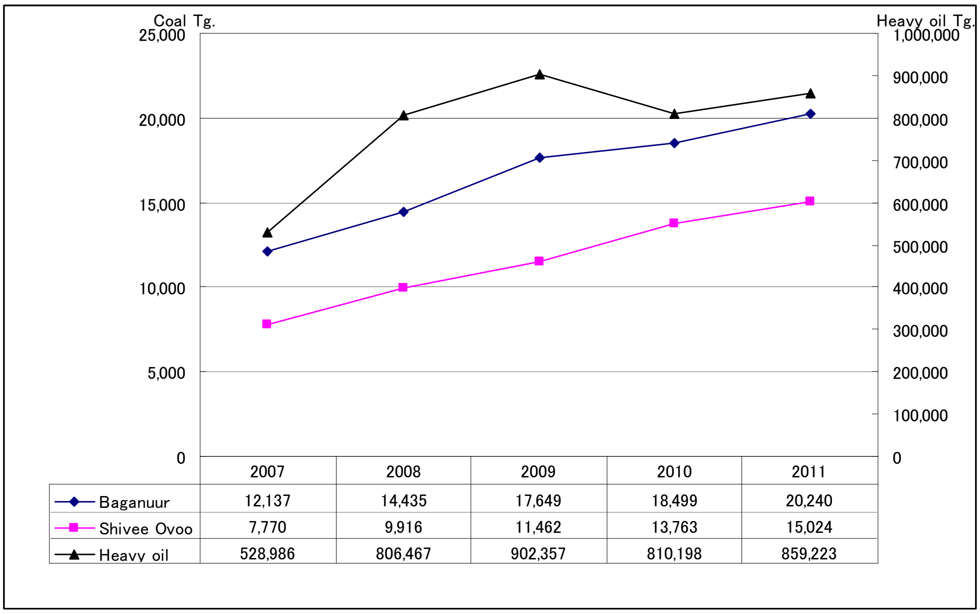
(Source: TPP4)

Fig.4.1-6 shows the history of coal purchase from Baganuur and Shivee Ovoo in volume and amount. As for the purchase volume, Baganuur coal was purchased more than Shivee Ovoo by some 10%. Looking at the amount, Baganuur coal was purchased more than Shivee Ovoo by 40% to 80%, far exceeding that difference. This is very likely due to price differences between the two coals. Fig.4.1-7 was prepared from that figure to show the unit prices of the two coals together with heavy oil.



(Source: JICA Survey Team based on TPP4's data)

Fig.4.1-6 Coal Purchase and Payment



(Source: JICA Survey Team based on TPP4's data)

Fig.4.1-7 Fuel Unit Costs

Baganuur coal was more expensive than Shivee Ovoo coal by 56% in 2007, while that difference was reduced to 35% in 2011. This is because Baganuur coal rose in price by 67% in 2011 compared to 2007, while Shivee Ovoo coal rose by 93%. Heavy oil rose in price by 62% compared to 2007 but Table 4.1-4 shows that the consumption volume decreased to 60% in 2011 from 2007 level, leaving its purchase amount almost unchanged. That table also shows the transportation cost occupying some 20% in fuel-related costs. The coal purchase volume increased by 15% in 2011 compared to 2007, while the transportation cost rose 2.4 times, likely due to price hike of transportation.

4.1.3 Financial Standing

Table 4.1-5 shows Balance Sheet and Table 4.1-6 shows Income Statement and Table 4.1-7 shows Cash Flow Statement of TPP4.

Table 4.1-5 Balance Sheet

Unit: million Tg.

	2007	2008	2009	2010	2011
Asset					
Current Assets					
Cash	958	964	650	3,811	3,693
Receivables	14,434	14,822	12,490	8,038	5,359
Doubtful Receivables	-199	-399	-379	-579	-579
Other Receivables	508	521	430	740	871
Inventory	8,231	10,151	9,412	9,706	9,344
Prepaid expenses (to maintenance co.)	1,271	4,488	4,500	1,147	8,067
Total Current Assets	**25,202**	**30,548**	**27,103**	**22,863**	**26,756**
Non-current Assets					
Fixed Assets	877,534	881,363	800,468	818,645	835,520
Less Accumulated Depreciation Cost	-562,687	-576,537	-515,754	-543,389	-556,906
Other Fixed Assets	2	0	0	0	0
Less Accumulated Depreciation Cost	-1	0	0	0	0
Construction in Progress	2,490	1,025	305	652	376
Intangible Assets	22	21	64	55	63
Investment and Other Assets	0	0	0	0	0
Total Non-current Assets	**317,361**	**305,872**	**285,084**	**275,962**	**269,053**
Total Asset	**342,562**	**336,420**	**312,187**	**298,826**	**295,809**
Liabilities and Owner's Equity					
Liabilities					
Short-term Liabilities					
Accounts Payable	14,363	12,818	10,415	7,362	4,063
Corporate Tax Payable					2
Withholding Personal Income Tax Payable					49
VAT Payable	252	0	93	0	0
Social Insurance Payable	49	7	0	0	0
Short-term Bank Loan	2,250	4,308	4,132	0	0
Other Payables	22	15	0	0	0
Prepaid Income (from small customers)	3	10	13	8	3
Total Short-term Liabilities	**16,939**	**17,158**	**14,652**	**7,369**	**4,116**
Long-term Liabilities					
Long-term Loan	100,410	108,515	129,395	108,472	89,605
Total Long-term Liabilities	**100,410**	**108,515**	**129,395**	**108,472**	**89,605**
Total Liabilities	**117,349**	**125,673**	**144,048**	**115,842**	**93,721**
Owner's Equity					
Equity (state)	66,380	66,380	66,380	66,380	74,023
Equity (private)	0	0	0	0	0
Total Equity	**66,380**	**66,380**	**66,380**	**66,380**	**74,023**
Additionally Paid Capital	7	7	7	7	
Assets Revaluation Reserve	166,324	165,435	146,686	146,413	145,110
Other Parts of Owner's Equity	7,498	7,560	7,643	7,643	7
Accumulated Profit (Loss)	-14,761	-28,634	-52,576	-37,459	-17,052
Current Period	-234	-10,366	-22,024	13,594	391
Previous Periods	-14,527	-18,268	-30,552	-51,053	-17,443
Total Owner's Equity	**225,213**	**210,747**	**168,140**	**182,984**	**202,088**
Total Liabilities and Owner's Equity	**342,562**	**336,420**	**312,187**	**298,826**	**295,809**

(Source: TPP4)

Table 4.1-6 Income Statement

(Unit: million Tg.)

	2007	2008	2009	2010	2011
Revenues from Main Activities					
Sales revenues	67,414	84,400	96,103	115,892	124,168
Total Revenues	**67,414**	**84,400**	**96,103**	**115,892**	**124,168**
Cost of Product Sold	**64,795**	**82,659**	**98,807**	**116,100**	**126,553**
Gross Profit (Loss)	**2,619**	**1,741**	**-2,704**	**-207**	**-2,385**
Operating Expenses					
Salaries and Wages	313	381	565	617	729
Social Insurance	68	51	74	82	99
Repair and Maintenance	3	14	4	3	2
Travel Expenses	4	13	12	8	9
Transportation Expenses	0	0	0	0	0
Raw Materials Expenses	73	9	12	27	29
Depreciation Expenses	47	47	39	44	48
Advertisement	2	0	0	0	4
Post and Communications Expenses	10	8	7	5	8
Fuel for Vehicles	6	8	6	7	9
Doubtful Receivables Expenses	200	200	0	203	0
Loan Interest	658	508	925	277	0
Other expenses	58	56	53	41	98
Total Operating Expenses	**1,441**	**1,295**	**1,696**	**1,313**	**1,034**
Main Activities Profit (Loss)	**1,178**	**446**	**-4,400**	**-1,521**	**-3,418**
Non-main Activities Profit (Loss)					
Revenues from Non-main Activities Sections	1,340	978	1,732	17,622	8,028
Penalties and Loss from Discounts	-9	-169	-92	-5	-43
Dividend	0	0	0	0	0
Currency Exchange Rate Profit (Loss)	-804	-8,664	-17,026	-197	-192
Other	-1,940	-2,957	-2,237	-2,306	-3,963
Total Non-main Activities Profit (Loss)	**-1,412**	**-10,812**	**-17,623**	**15,114**	**3,831**
Profit (Loss) before Tax	**-234**	**-10,365**	**-22,024**	**13,594**	**412**
Corporate Income Tax	0	0	0	0	21
Profit/Loss after Tax	**-234**	**-10,366**	**-22,024**	**13,594**	**391**

(Source: TPP4)

Table 4.1-7 Cash Flow Statement

Unit: million Tg.

	2007	2008	2009	2010	2011
From Operating Activities					
Cash Inflow	65,997	78,965	95,507	116,993	126,507
From Sales and Customers	65,007	77,267	94,792	114,571	125,108
From Non-main Activities	990	1,699	715	2,422	1,399
Cash Outflow	63,240	78,451	93,904	108,260	123,481
Salaries and Bonus	5,998	8,480	11,671	13,207	15,900
Social Insurance	2,155	2,533	3,218	3,672	4,449
Raw Materials	26,733	33,389	40,468	50,374	50,121
Fuel, Transportation and Spare Parts	19,066	20,586	20,586	25,272	33,033
Payments to Suppliers	5,921	8,125	12,856	9,989	15,391
Interest Paid	640	525	798	298	
Taxes Paid	2,727	4,812	4,306	5,448	4,588
Net Cashflow from Operating Activities	**2,757**	**514**	**1,603**	**8,733**	**3,026**
From Investment Activities					
Fixed Assets Purchased	-505	-2,436	-1,557	-1,413	-3,144
Total Cashflow from Investment Activities	**-505**	**-2,436**	**-1,557**	**-1,413**	**-3,144**
From Financial Activities					
Bank Loan	7,000	7,914	3,217	0	0
Loan Repayment	-9,052	-5,986	-3,578	-4,159	0
Net Cashflow from Financial Activities	**-2,052**	**1,929**	**-361**	**-4,159**	**0**
Total Net Cashflow	**200**	**7**	**-314**	**3,161**	**-117**
Cash and Cash Equivalents at Beginning of Year	757	958	964	650	3,811
Cash and Cash Equivalents at End of Year	**958**	**964**	**650**	**3,811**	**3,693**

(Source: TPP4)

A financial analysis was made based on the above financial statements as shown in Table 4.1-8.

Table 4.1-8 Financial Ratio

	2007	2008	2009	2010	2011
I Profitability					
1 Return on assets	-0.07%	-3.08%	-7.05%	4.55%	0.13%
2 Return on equity	-0.10%	-4.90%	-13.10%	7.43%	0.19%
2 Gross margin ratio	3.88%	2.06%	-2.81%	-0.18%	-1.92%
3 Operating profit ratio	1.75%	0.53%	-4.58%	-1.31%	-2.75%
4 Net profit ratio	-0.35%	-12.28%	-22.92%	11.73%	0.31%
5 Working ratio	55.02%	74.38%	N/A	N/A	N/A
6 Operating ratio	98.25%	99.47%	104.58%	101.31%	102.75%
II Financial soundness					
1 Current ratio	148.78%	178.04%	184.98%	310.26%	650.05%
2 Quick ratio	100.19%	118.88%	120.74%	178.55%	423.03%
3 Fixed assets to equity ratio	140.92%	145.14%	169.55%	150.81%	133.14%
4 Fixed assets to long-term capital ratio	97.46%	95.81%	95.82%	94.68%	92.24%
5 Debt ratio	52.11%	59.63%	85.67%	63.31%	46.38%
6 Debt service coverage ratio	159%	132%	55%	937%	N/A
7 Interest coverage ratio	179.03%	87.80%	-475.68%	-549.10%	N/A
8 Equity to total assets ratio	65.74%	62.64%	53.86%	61.23%	68.32%
III Asset turnover					
1Total assets turnover ratio	0.20	0.25	0.31	0.39	0.42
turnover period	61 months	48 months	39 months	31 months	29 months
2 Fixed assets turnover ratio	0.21	0.28	0.34	0.42	0.46
turnover peirod	56.5 months	43.5 months	35.6 months	28.6 months	26.0 months
3 Accounts receivable turnover ratio	4.51	5.50	7.44	13.20	19.93
turnover period	2.7 months	2.2 months	1.6 months	0.9 months	0.6 months
4 Accounts payable turnover ratio	4.69	6.58	9.23	15.74	30.56
turnover period	2.6 months	1.8 months	1.3 months	0.8 months	0.4 months
5 Inventory turnover ratio	8.19	8.31	10.21	11.94	13.29
turnover period	1.5 months	1.4 months	1.2 months	1.0 months	0.9 months

(Source: JICA Survey Team)

The above table shows summary of TPP4's finance standing looking at profitability, soundness and efficiency. As for profitability, gross margin ratio is so low that ROA and ROE as well as operating profit ratio are accordingly low. It is to be noted that in 2010 and 2011, net profit turned in surplus against deficit in gross margin and operating profit partly because of government subsidy: 3,489 million Tg. and 3,738 million Tg., respectively, in addition to tariff hike.

In financial soundness, it is said that both current ratio and quick ratio of more than 100% is desirable (ideal current ratio is around 200%), and actually both current ratio and quick ratio is high, it shows good conditions. This is because accounts payable did not decrease as same level as decrease of accounts receivable. Fixed assets to long-term ratios reveal no problem because fixed assets are covered by long-term borrowings. Debt ratio varied between 40% and 60% except 2008, leading to soundness in capital structure. In 2007, asset revaluation was done, and asset revaluation reserve is entered as reserve in equity section of the balance sheet. In 2011, the government took over 18.9billion Tg. from TPP4's debt. There exchanged a memorandum between Finance Ministry and TPP4 to the effect that such a measure shall not be repeated. Moreover, according to Energy Authority, those subsidies which were meant for price compensation will not either be provided considering the introduction of Price Indexation to the energy price system in 2014. Lack of such financial support from the government will make it necessary to make its own financing, which leads to anticipate severer financial standing for several years until revenue increase would be realized by operation of this Project.

Debt service coverage ratio, an index to see how much the cash flow comprising net profit and depreciation covers the repayment and interest of borrowing, shows over 100% except 2009, a sound level. It should be noted that in 2011 no repayment or interest was recorded. Looking at interest coverage ratio, an index to see how much the operating profit covers the interest payments, in 2008 with almost 0 in profit and in 2009 and 2010 in deficit, the interest payments could not be covered.

As for efficiency, although power utility industry is generally low in turnover, TPP4 has slower turnover in total assets and fixed assets, 3 to 5 years in a turnover, showing inefficiency. It is, however, to be noted that turnover ratio has an improving trend. In accounts receivable and payable, turnover has been improved mostly due to recent decrease in both accounts. Table 4.1-9 and Table 4.1-10 shows the historical outstanding balance of receivables and payables. The inventory mainly comprises fuels such as coal and heavy oil. Inventory level is about 1 month, an acceptable level.

Table 4.1-9 Receivables of TPP4

Unit: million Tg.

		2007	2008	2009	2010	2011
Total		15,395	15,342	12,920	8,778	6,230
Residential	Total	0	0	1	0	1
	Apartments					
	Ger houses	0	0	1	0	1
Industrial	Total	117	0	0	0	0
	Erdenet mines					
	Monrostsvetmet Co. (metal)					
	Khutucement Co.					
	Darhan Iron facotory					
	Other	117	0	0	0	0
Commercial	Total	0	0	0	0	0
	Housing Administration Co.					
	Other					
Government-owned establishments incl. schools and hospitals)	Total	0	0	0	0	0
	State level					
	Aimag/city level					
	Soum/district level					
	Other					
Power companies	Total	14,312	14,822	12,489	8,038	5,359
	Ulaanbaatar Disco.	5,209	2,726	193	193	0
	Darkhan Selenge Disco	2,646	1,324	1,069	869	620
	Erdenet Bulgan Disco	0	0	0	0	0
	Baganuur South-east Disco	0	0	0	0	0
	Single-buyer (Transco)	4,278	9,143	10,504	6,631	4,505
	Ulaanbaatar Heating Co.	2,105	1,346	385	0	0
	Darhkan Heating Co.	75	75	75	75	71
	Other		208	264	270	162
Other receivables	Total	966	521	430	740	871
	Companies	387	407	281	282	366
	Individuals	44	30	31	29	30
	Employees	1	65	90	156	426
	Other	534	19	29	274	50

(Source: TPP4)

Table 4.1-10 Payables of TPP4

Unit: million Tg.

		2007	2008	2009	2010	2011
	Total	17,303	17,158	14,653	7,369	4,116
Coal mining	Total	11,382	10,821	9,481	5,962	3,131
	Baganuur	4,268	3,833	2,901	834	0
	Shivee Ovoo	7,113	6,989	6,580	5,129	3,131
	Shariingol	0	0	0	0	0
	Aduunchuluun	0	0	0	0	0
	Tavantolgoi	0	0	0	0	0
	Other	0	0	0	0	0
Transportation	Total	0	0	0	0	0
	Ulanbaatar Railway	0	0	0	0	0
	Other	0	0	0	0	0
Taxes	Total	337	32	93	8	53
	Corporate income tax					
	Personal income tax					49
	VAT	293	0	93	0	0
	Other taxes		26	0	8	4
	Social insurance	45	7	0	0	0
	Subsidy					
Loan and interest	Total	2,879	4,308	4,175	0	0
	Project loan principals	629	0	4,132	0	0
	Project loan interest	0	0	0	0	0
	Domestic short-term loan principal	2,250	4,308	43	0	0
	Domestic short-term loan interest	0	0	0	0	0
	Other shor-term debt	0	0	0	0	0
Other	Total	2,705	1,996	905	1,399	932
	Suppliers	2,680	1,996	905	1,399	932
	Individuals					
	Wages					
	Other	25	0	0	0	0

(Source: TPP4)

Table 4.1-11 was prepared based on the fore cited balance sheet to make fund analysis.

Table 4.1-11 Source and Application of Fund

		2008	2009	2010	2011
Long-term fund	**Total Source of long-term fund**	**7,254**	**-82,511**	**21,556**	**13,754**
	Depreciation	13,849	-60,783	27,635	13,517
	Capital stock/reserves	-827	-18,666	-273	-1,303
	Retained earnings	-13,873	-23,942	15,117	20,407
	Long-term borrowings	8,105	20,880	-20,923	-18,867
	Long-term notes payable				
	Long-term allowance				
	Other long-term debt				
	Total Use of long-term fund	**2,363**	**-81,572**	**18,515**	**16,607**
	Tangible fixed assets	3,829	-80,895	18,177	16,875
	Land				
	Intangible fixed assets	-1	43	-9	8
	Construction in progress	-1,465	-720	347	-276
	Deferred assests				
	Overs and shorts	**4,891**	**-939**	**3,041**	**-2,853**
Short-term fund	**Total Source of short-term fund**	**219**	**-2,505**	**-7,283**	**-3,253**
	Notes payable				
	Accounts payable	-1,545	-2,403	-3,053	-3,299
	Short-term borrowings	2,058	-176	-4,132	0
	Short-term allowance				
	Income taxes payable	0	0	0	51
	Other current liabilities	-294	74	-98	-5
	Allowance for bad debt				
	Notes discounted/endorsed				
	Total Use of short-term fund	**5,344**	**-3,444**	**-4,240**	**3,892**
	Cash	6	-314	3,161	-118
	Notes receivable				
	Accounts receivable	188	-2,312	-4,652	-2,679
	Securities				
	Inventory	1,920	-739	294	-362
	Other current assets	3,230	-79	-3,043	7,051
	Overs and shorts	**-5,125**	**939**	**-3,043**	**-7,145**

(Source: JICA Survey Team)

Note: There are some clerical errors in balance sheet of 2007 and 2011, so that the overs and shorts in log-term and short-term fund are mismatched in 2008 and 2011

In 2008, long-term borrowings were used to acquire tangible fixed assets with the remainder used to cover the shortage of short-term fund. In the short-term fund, short-term borrowings together with the remainder of long-term fund was used to mainly acquire inventory asset and pay payables.

In 2009, long-term borrowings were made, but not sufficient to cover the use of long-term fund, which was mainly filled with collected receivables.

In 2010, internal reserve such as depreciation and retained earnings increased but was used for repayment of long-term borrowings and acquisition of tangible fixed assets, leaving smaller remainder. In short-term fund, payment of payables and repayment of short-term borrowings brought a fund shortage, which was covered by collected receivables and the remaining long-term fund to increase cash and acquire inventory assets.

In 2011, internal reserve increased and used to repay long-term borrowings and acquire tangible fixed assets. In short-term fund, collected receivables and cash were used to pay payables but acquisition of other current assets, mainly prepaid expenses to maintenance companies, brought a fund shortage.

In Mongolia, long-term loan from banks is not usual and interest rate of short-term loan is as high as some 20%. TPP4 does not borrow short-term money and mainly depends on long-term borrowings from overseas aid. In the past 2 years, repayment of long-term borrowings stands out and fund has been raised mainly from internal reserve. In the meantime, collected receivables have been covering payment of payables, which decreased the outstanding amount of receivables and payables.

4.1.4 Accounting Issues

a) Regarding depreciation, in Mongolia, depreciation period is uniformly 40 years regardless of service life period of each equipment. In order to secure an appropriate level of internal reserve, it is necessary to set a reasonable depreciation period according to service life period of each equipment.

b) In calculating production cost, classification of power and heat is made on a power and heat ratio of 7:3, applied to most of all the production costs including depreciation. Generators, for example, are used only for power production but their costs are distributed at a ratio of 7:3 to power and heat. It is advisable, therefore, to distribute production cost by classifying equipment and expenses exclusive to power production and those exclusive to heat production and common equipment and expenses, of which the last are distributed on a produced calorie basis – power should be converted into calorie – thereby, enabling more reasonable price setting of power and heat.

c) In preparation for price regulation by Price Indexation to be introduced in 2014, it will be necessary to conduct stricter cost control, which requires accurate recognition of production costs of power and heat as well as appropriate depreciation. Considering the above points (1) and (2), it is advisable to examine how to conduct cost control in collaboration with outside experts.

4.2 Facility Conditions

4.2.1 Outline of Background of TPP4

TPP4 is the largest combined heat and power plant in Mongolia (total installed capacity: 580 MW), began operation in 1983, designed and constructed by the former Soviet Union as a power plant to supply both heat energy and electric power., and has a key role to supply approx. 70% of power demand of CES around Ulaanbaatar city, and approx. 65% of heat demand in Ulaanbaatar city.

First unit of TPP4 started its commercial operation in 1983, all facilities of TPP4 were completed in 1991. Maintenance was initially conducted under the direction of former Soviet Union engineers, but after the Soviet Union collapse in 1990, they returned to their home country, and the task of maintenance was delegated to the Mongolian side. After that, deterioration of facilities quickly progressed and TPP4 began to lose its capability to maintain a stable supply of energy, due to a lack of repair funds and difficulty in acquiring spare/repair parts for equipment made in Russia (due to decreased production capacity of Russian manufacturers). Under such circumstances, Japan provided financial aid as an emergency measure through the JICA and JBIC schemes.

As for all boilers, by two times Japanese ODA loan, coal combustion system was modified from indirect firing system to direct firing system, including replacement of coal pulverizer, reliability and efficiency was increased.

In “JICA Development Study Supporting The Rehabilitation Project” which was implemented from 2001to 2002, future maintenance and rehabilitation plan was established. Some issues of this plan were already resolved, and as for renovation of turbine control system which was not yet implemented, survey was made in this survey period. Maintenance and rehabilitation plan which are proceeding by overseas donors fund are shown as follows.

a) Renovation of boiler feed water pump (2 units) and introduction of variable speed control (inverter) (Germany)
b) Condenser ball cleaning system (for 6 condensers) (Germany)
c) TV monitor of coal conveyer（Czech）
d) Renovation of water treatment system (Ion exchange→Reverse osmosis) (Germany)
e) Renovation of monitoring system of water treatment system (Czech)

TPP4 consists of 8 units of boiler and 6 units of turbine, as shown in Fig.4.2-1. In Japan most of power plants are unit system, in which boiler is corresponding with turbine one on one, however, in TPP4, main steam from 8 boilers flows to steam turbines via common steam header, and operation boilers are not corresponding with turbines one on one.

Return hot water of district heating system from Ulaanbaatar city is heated by two hot water heaters provided for each turbine, and supplied to the city again. Heating source is extraction steam from turbine. In winter season, when higher hot water supply temperature is necessary, hot water is further heated by 8 auxiliary heaters using 13 ata steam after pressure reduction of No.1, 5, 6 LMZ turbines 16 ata extraction steam, and supplied to the city.(16 ata steam can not be extracted from No.2, 3, 4 URAL turbine)

Auxiliary steam is supplied from two kinds of headers of 13ata and 16ata, 16ata steam is used for heating inside the station, and is supplied to the evaporator to generate steam for neighboring food factory. Since this steam is to be used in food processing plants, clear water which does not contain water treatment chemicals is supplied to the power plant, and sent it back to a food factory after conversion to steam in the evaporator, there is no steam supply directly to the outside from the power plant. 13ata steam is supplied to heavy fuel oil heater for plant starting, deaerator, coal mill, coal wagons (to melt the frozen coal in winter), as well as above mentioned hot water heater.

There are eight common deaerators, and it is standard operation policy to operate all of eight deaerators. As mentioned above, 13 ata steam is used for heating deaerator, deaerator heating steam is supplied only from LMZ turbines.

Table 4.2-1 shows commercial operation year of boiler and turbine, Table 4.2-2 shows major specification of boiler, Table 4.2-3 shows major specification of turbine, Table 4.2-4 shows major specification of generator, Table 4.2-5 shows major specification of district heating system, Table 4.2-6 shows major specification of cooling tower.

Table 4.2-1 Commercial operation year of Boiler and Turbine

Boiler	Year	Turbine	Year
#1	1983	#1	1983
#2	1984	#2	1984
#3	1984	#3	1985
#4	1985	#4	1986
#5	1986	#5	1990
#6	1987	#6	1991
#7	1990	–	–
#8	1991	–	–

(Source: JICA Survey Team based on TPP4's data)

Table 4.2-2 Major Specification of Boiler

Item	unit	
Maker / Type		BKZ-420-120-10S (Russia)
Steam generation	t/h	420
Pressure	MPa abs	13.73
Temperature	℃	560
Coal		Baganuur #1 - #4 Shivee Ovoo #5 - #8
Mill number per boiler		4
Firing system		Direct
Draft system		Balance
Burner		Corner firing (4×3 stage)
Air preheater		Tubular type
Dust collector		ESP EGA2-58-12-6-4 Russia
Number of Stack		1
Stack height	m	250

(Source: JICA Survey Team based on TPP4's data)

Table 4.2-3 Major Specification of Turbine

Item	unit	#1, #5, #6	#2,#3,#4
Maker / Type		LMZ PT 80-130 (Russia)	URAL T-110/120-130-4 (Russia)
Type		Extraction condensing type	Extraction condensing type
Rated / Max. output	MW	80 / 100 #5 and #6 were modified to 100 MW	100 / 120
Steam flow	t/h	500	500
Pressure	MPa abs.	12.75	12.75
Temperature	℃	555	555
Extraction pressure	MPa abs.	1.27	–
Speed	r.p.m.	3,000	3,000
Condenser pressure	kPa abs.	2.942	5.688
Condenser cooling		Cooling tower water	Cooling tower water
Condenser cooling water flow	t/h	8,000	16,000
Condenser cooling water temperature	℃	20	20

(Source: JICA Survey Team based on TPP4's data)

Table 4.2-4 Major Specification of Generator

Item	unit	#1, #2, #3, #4	#5,#6
Type		TVF-120-2U3	TVF-110-2U3
Generator Capacity	kVA	125,000	137,500
Generator Output Rated / Max.	MW	100	110
Power Factor		0.8	0.8
Voltage	kV	10.5	10.5
Frequency	Hz	50	50
Excitation System		Thyristor	Thyristor
Cooling System		Hydrogen Cooling	Hydrogen Cooling

(Source: JICA Survey Team based on TPP4's data)

Table 4.2-5 Major Specification of District Heater System

		Unit	LMZ Turbine	URAL Turbine
(1)	NO.1 Heater			
	Number		3	3
	Hot water flow	t/h	2,000	3,500
	Inlet water temp.	℃	50	50
	Outlet water temp.	℃	80	80
	Heating capacity	Gcal/h	60	105
(2)	NO.2 Heater			
	Number		3	3
	Hot water flow	t/h	2,000	3,500
	Inlet water temp.	℃	80	80
	Outlet water temp.	℃	120	120
	Heating capacity	Gcal/h	80	140
(3)	Axially Heater			
	Number		8	
	Hot water flow	t/h	1,800	
	Inlet water temp.	℃	70	
	Outlet water temp.	℃	150	
	Heating capacity	Gcal/h	144	
(4)	NO.1 Pump	Number	5	
	Flow	t/h	3,374	
(5)	NO.2 Pump	Number	5	
	Flow	t/h	3,474	

(Source: JICA Survey Team based on TPP4's data)

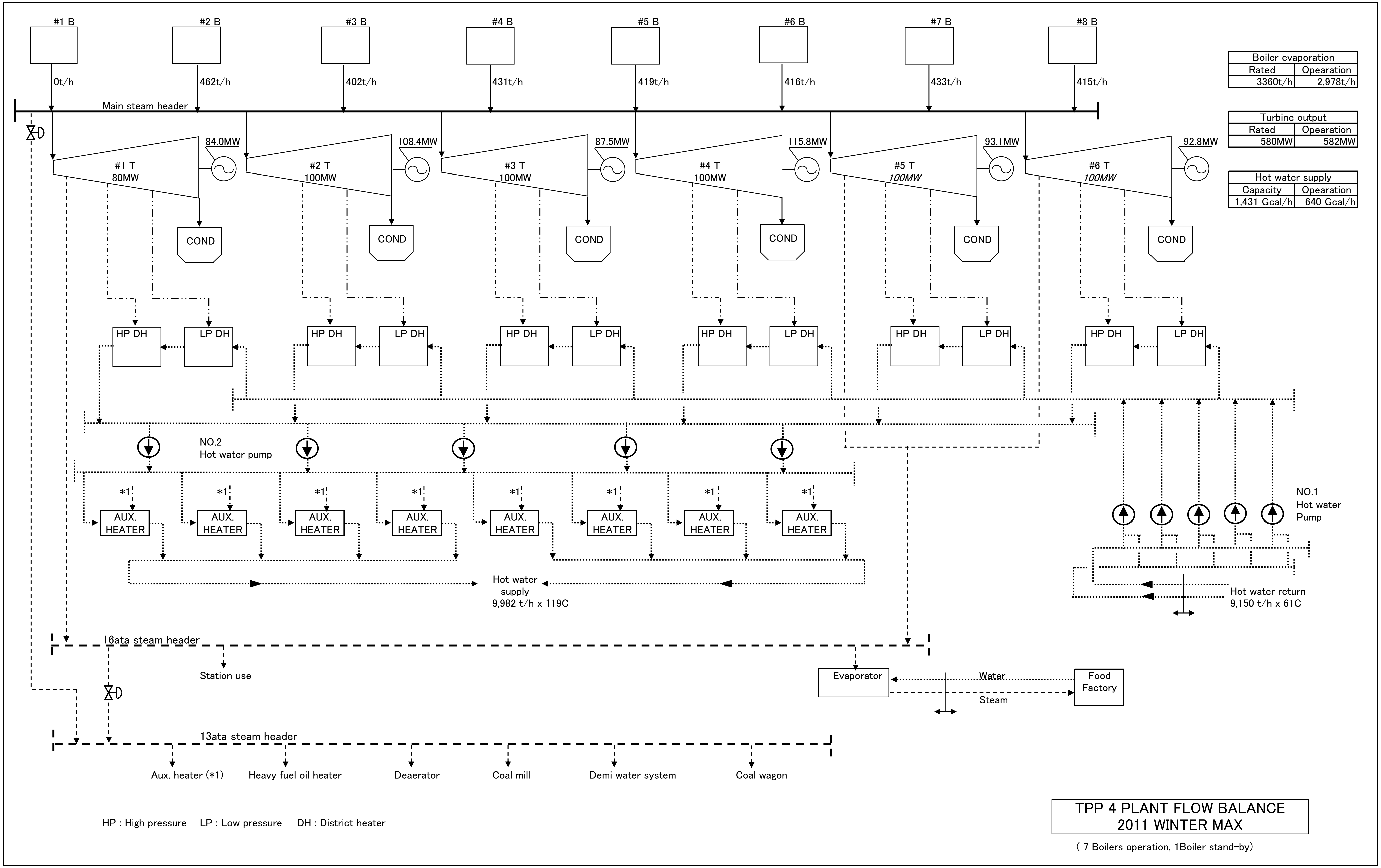
Table 4.2-6 Major Specification of Cooling Tower

		Unit	1	2	3	4
(1)	Country of origin		Russia	Russia	Russia	China
	Type		Natural draft	Natural draft	Natural draft	Natural draft
	Number		1	1	1	1
	Water flow	t/h	22,500	22,500	15,400	22,500
(2)	Cooling water pump		Large pump		Small pump	
	Number		7		3	
	Water flow	t/h	12,500		3,200	

(Source: JICA Survey Team based on TPP4's data)

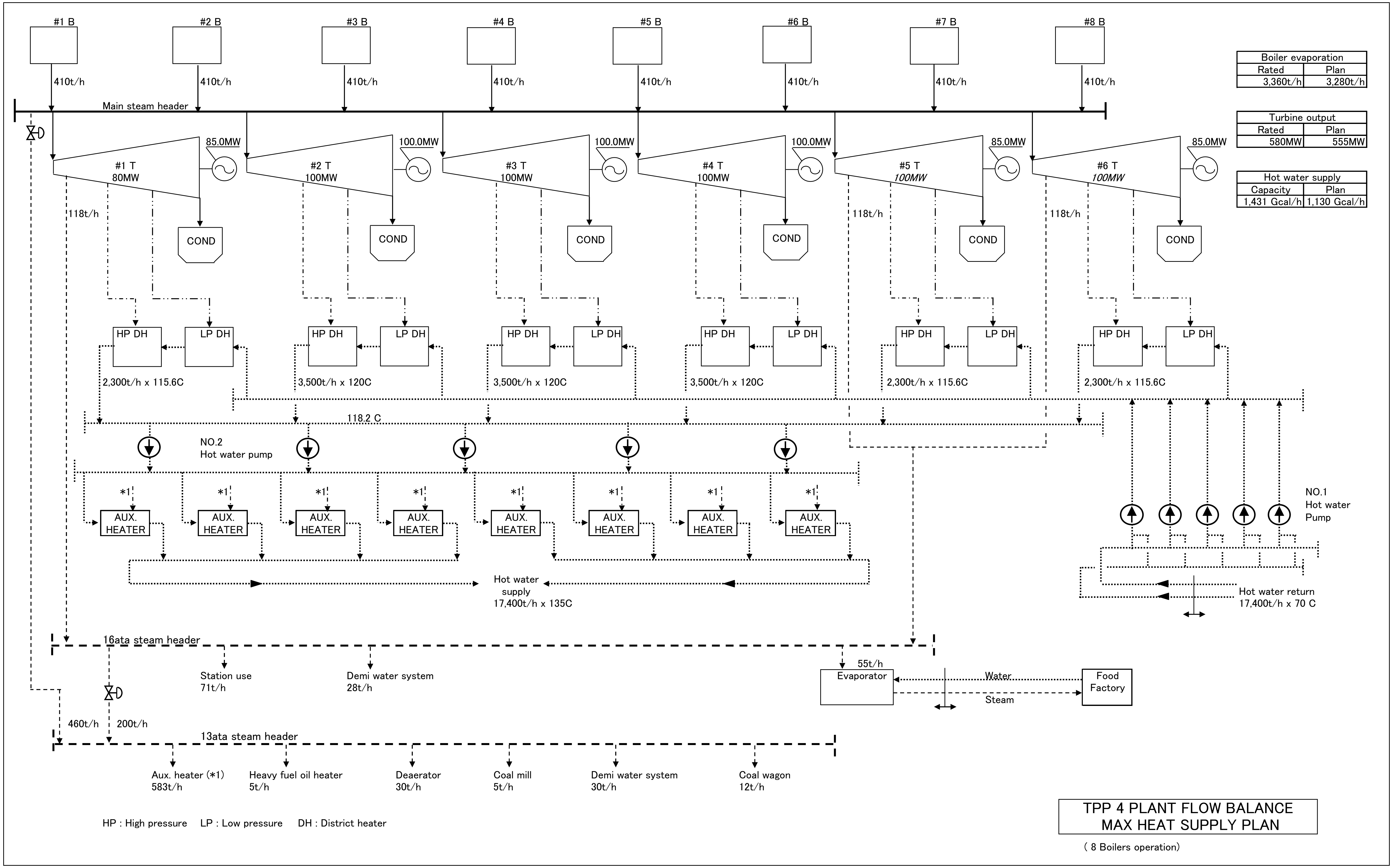
582 MW of max. power generation was recorded in 2011 winter, which was a little bit higher than 580 MW of total of rated capacity of turbines, and heat supply was 640 Gcal/h. This power and heat was supplied by such operation scheme as 7 boilers in operation, one boiler in stand-by, and 6 turbines in operation. Fig.4.2-1 shows main operation parameters at this time.

Further, Fig.4.2-2 shows plan made by TPP4 to generate 1,130 Gcal/h heat, which is nearly maximum capacity of TPP4 heat supply system. This plan is achieved by operation of all of 8 boilers.



(Source: JICA Survey Team based on TPP4's data)

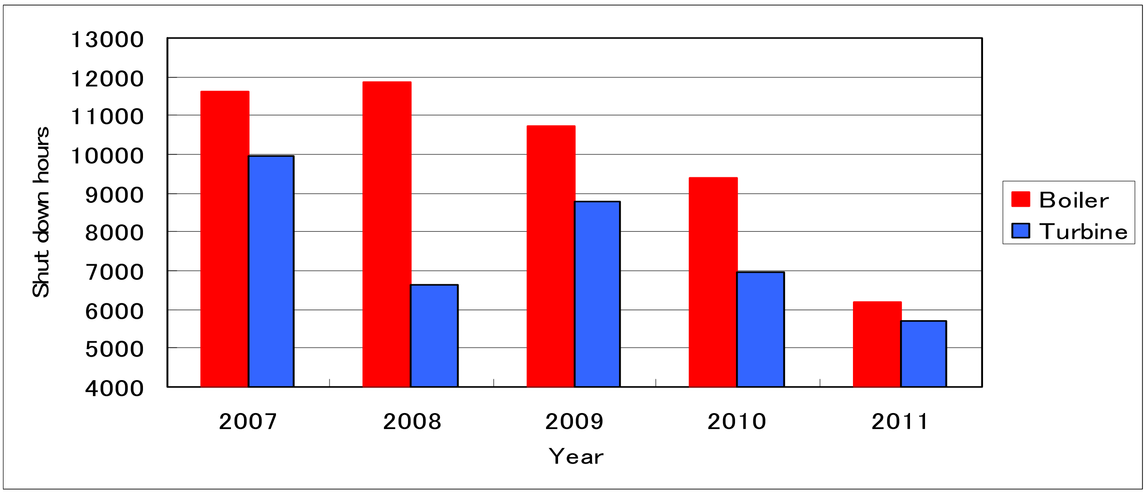
Fig.4.2-1 Flow Balance (Max. power and heat supply in 2011 winter)



(Source: JICA Survey Team based on TPP4's data)

Fig.4.2-2 Flow Balance (Max. heat supply plan)

Fig.4.2-3 shows boiler and turbine shut down hours by trouble in past 5 years. Shut down hours are decreasing year by year, but average shut down hours by trouble is approx. 33 days per boiler and approx. 40 days per turbine. According to the statistical data in Japan, shut down hours by trouble is zero in lots of units, and if there is some trouble, such shut down hours are approx. 10 days, therefore, compared with situation of Japan, even data of 2011, shut down hours of TPP4 is rather long.



(Source: JICA Survey Team based on TPP4's data)

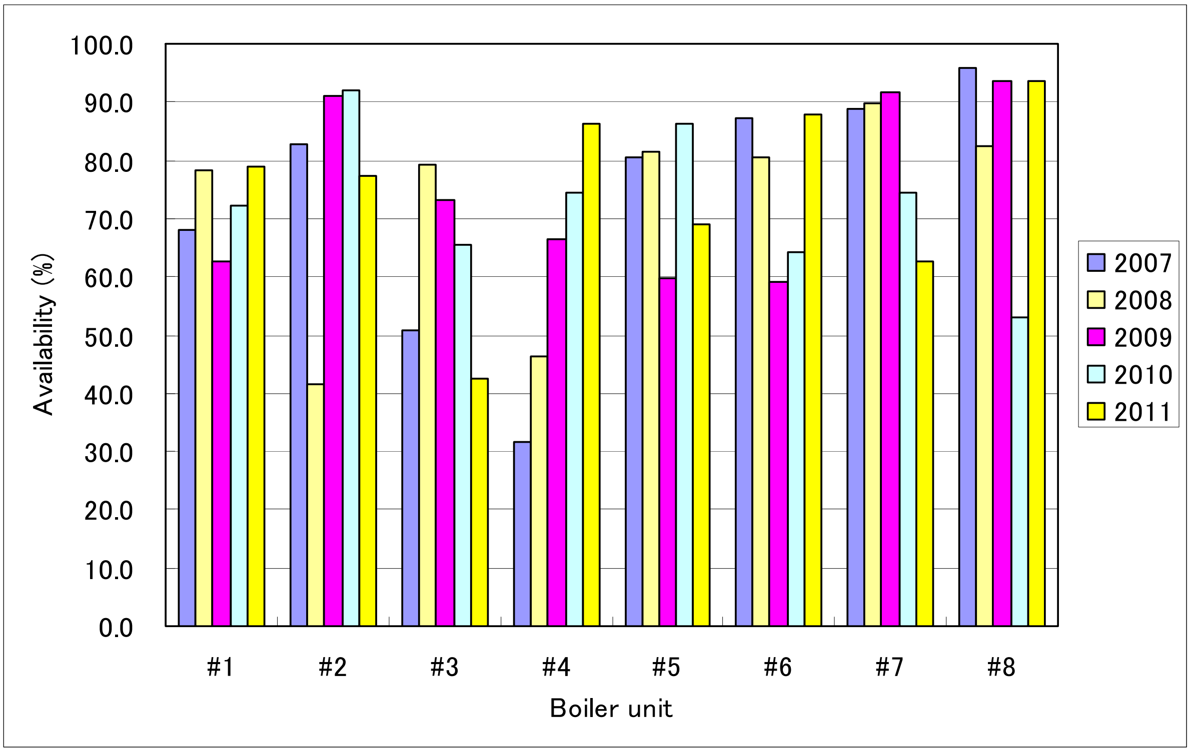
Fig.4.2-3 Shut down by Trouble

4.2.2 Boiler Facility

As a basic policy of major equipment in TPP4, total of 8 boilers evaporation is designed to have enough margin to total of 6 turbines steam consumption, taking importance of power and heat supply in winter season, even in 2011 max. power and heat supply operation, one boiler was reserved as stand by unit.

(1) Current Operation Condition

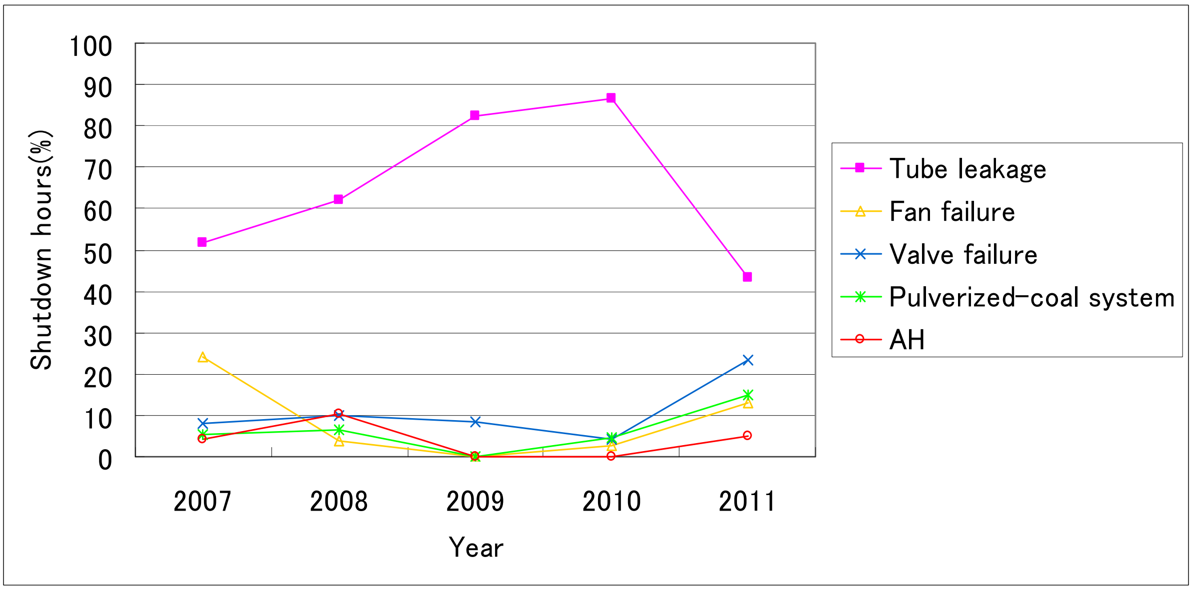
Availability of boilers in last five years is shown in Fig.4.2-4. In calculation, stand by condition was regarded as in operation. It depends on the unit, almost 80 to 90% availability is achieved. The reason for low availability, which depends on year, is mainly shut down for major overhaul.



(Source: JICA Survey Team based on TPP4's data) Availability = (operation hours + stand-by hours) / 8760 (%)

Fig.4.2-4 Boiler Availability

Fig.4.2-5 shows percentage of forced shut down hours with respect to its reason. As for forced shutdown hours, shutdown by tube leak is overwhelmingly prominent, next reason is valve failure. Reason for tube leakage is estimated to be pitting corrosion inside water wall tube and economizer tube.



(Source: JICA Survey Team based on TPP4's data) Availability = (operation hours + stand-by hours) / 8760 (%)

Fig.4.2-5 Ratio of Shutdown Hours by Major Trouble

Table 4.2-7 shows boiler operation parameters of highest power and heat supply record day in this winter. No.1 boiler was in stand by condition. Steam evaporation of No.3 and 5 boilers are less than other boilers, but there is not special problem, all boilers can generate 420 t/h of rated capacity. As for main steam temperature, compared with rated temperature of 560 degree-C, No.2, 3 and 6 boiler main steam temperature is 15 to 20 degree lower.

Table 4.2-7 Boiler Operation Data

NO.	ITEM												
1	Unit			Design	1	2	3	4	5	6	7	8
2	Time				19:00	19:00	19:00	19:00	19:00	19:00	19:00	19:00
3	Date				2011,12,25	2011,12,25	2011,12,25	2011,12,25	2011,12,25	2011,12,25	2011,12,25	2011,12,25
4	Main Steam Pressure		kg/cm2(a)	140		140	139	138	140	140	139	139
5	Main Steam Flow		t/h	420		433	333	423	393	416	424	412
6	Main Steam Temp		DegC	560		545	540	550	553	560	559	534
7	SAH Inlet Air Temp		DegC			37	35	28	33	41	33	38
8	AH Inlet Air Temp		DegC			37	35	28	33	41	48	38
9	AH Air Outlet Temperature	A	DegC			292	264	261	258	299	301	296
10		B	DegC			283	264	259	279	281	305	307
11	AH Gas Outlet Temperature		DegC			167	145	123	131	148	168	145
12	Eco Outlet Flue Gas O2 (Ave.)		%			4.3	3.1	3.8	3.6	3.2	3.8	3.9
13	Coal flow	A	t/h			27.2	0	26.6	22.4	21.8	21.7	24.2
14		B	t/h			21.4	24.5	26.6	22.3	21.5	21.8	14.4
15		C	t/h			0	12.3	0	0	21.8	21.4	18.6
16		D	t/h			27.5	24.6	26.6	22.6	21.7	21.7	23.9
17	Total		t/h			76.1	61.4	79.8	67.3	86.8	86.6	81.1

(source: JICA Survey Team based on TPP4's data)

(2) Adhesion of Ash on Heating Surface (Slugging) and Soot Blower

When operation started, 81 soot blowers per 1 boiler were installed at economizer and superheater area, and shot cleaning system using steel ball was installed at back pass (economizer, air pre heater). Fig.4.2-6.shows arrangement of existing soot blowers. But however, Baganuur coal which is design coal is low ash and it was not necessity to use soot blower or shot cleaning system and maintenance of facilities was not enough, therefore soot blower was removed.

Currently, TPP4 is firing two types of coal, Shivee Ovoo and Baganuur, and when firing of Shivee Ovoo coal, which calorific value is lower than Baganuur coal, ash adheres to the heating surface of the boiler and interfere heat transfer effect.(slugging) As for coal consumption required to generate a certain amount of steam by boiler, when firing Shivee Ovoo coal, which has lower calorific value than Baganuur coal, coal consumption increases, compared with the case of firing Baganuur coal, but the design capacity of coal pulverizer of boiler No.1 to 4 is smaller, when firing Shivee Ovoo coal, boiler No.1 to 4 can not generate rated evaporation. Therefore, in present plant operation, Baganuur coal is firing in No. 1 to 4 boilers, and Shivee Ovoo coal is firing in No. 5 to 8 boilers, of which pulverezers are bigger. In No. 5 to 8 boilers, due to problem of slugging by firing Shivee Ovoo coal, after two months continuous operation, boiler outlet steam temperature does not rise up to the rated temperature, issue of decrease of turbine output occurs.

Currently in TPP4, as an emergency measure temporally soot blowers are installed, which blow steam taken from steam drum to lower part of superheater, and they avoid ash accumulation. Fig.4.2-6 shows valve station of soot blower, Fig.4.2-7 shows penetration to furnace.

Since present temporally soot blowers do not have enough soot blowing effect, it is recommendable to install commercially available soot blowers at whole area of boiler, same as original design, including soot blower control system

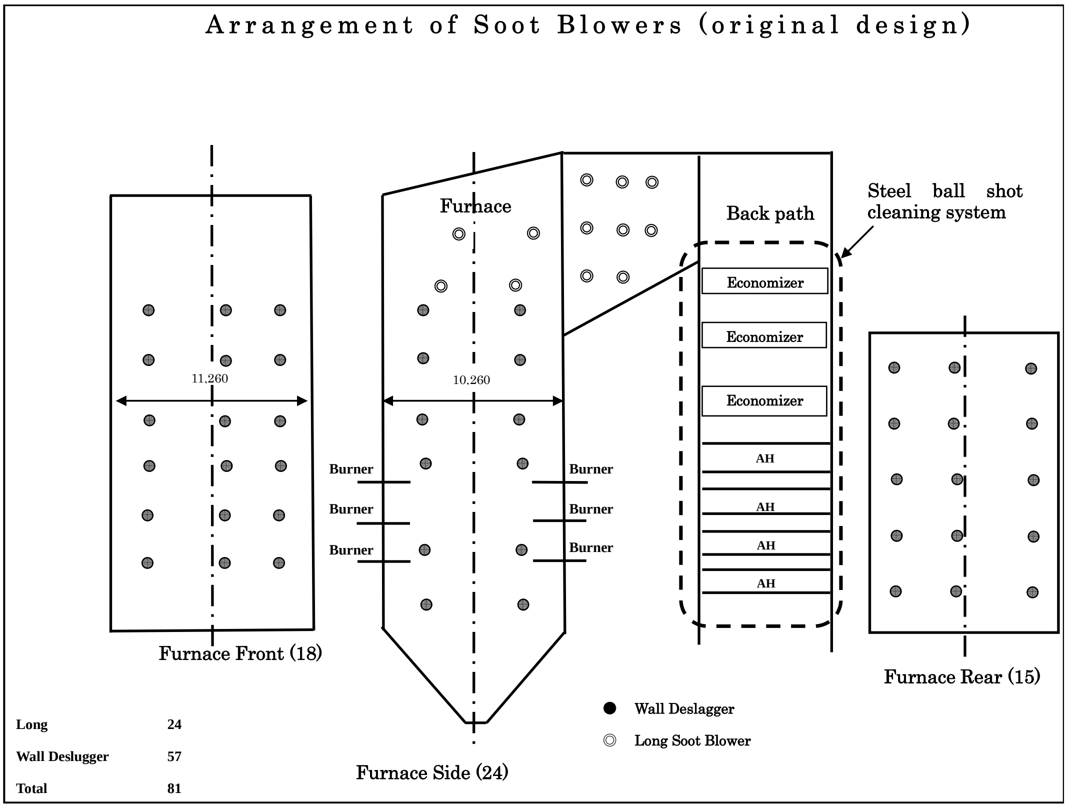


Fig.4.2-6 Arrangement of Soot Blowers

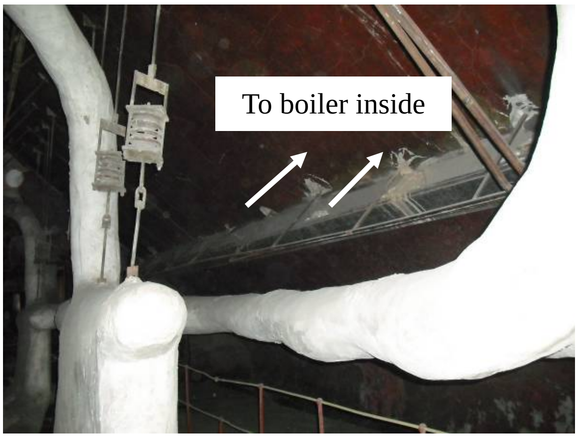


Fig.4.2-7 Valve station **Fig.4.2-8 Piping to Boiler inside**

(3) High pressure valve failure

Valve failure is ranked at the second most common cause of the boiler shut down, due to leakage of high pressure and high temperature valves boiler shut down occurs. Valves are mainly imported from Russia and China, and Survey team heard that especially quality of Chinese valves is bad, failed after one to two months operation, and can not be repaired. Fig.4.2-9 shows scrap valves. It is recommendable to purchase products of reliable valve manufacturer which can produce valves without problem in quality.

Fig.4.2-9 Scrap Valves

(4) Pulzerizer

I Fig.4.2-10 shows cross section of pulverizer of TPP4. Coal is supplied from upper part and is crushed on the table by rollers.

In TPP4, pulzerizers of No.1 to No.4 boilers were replaced by Austrian made ones at Phase-1 Japanese ODA loan project (1995-2002) and pulzerizers of No.5 to No.8 boilers were replaced by Japanese Mitsubish Heavy Industries made ones at Phase-2 Japanese ODA loan project (2001-2008).

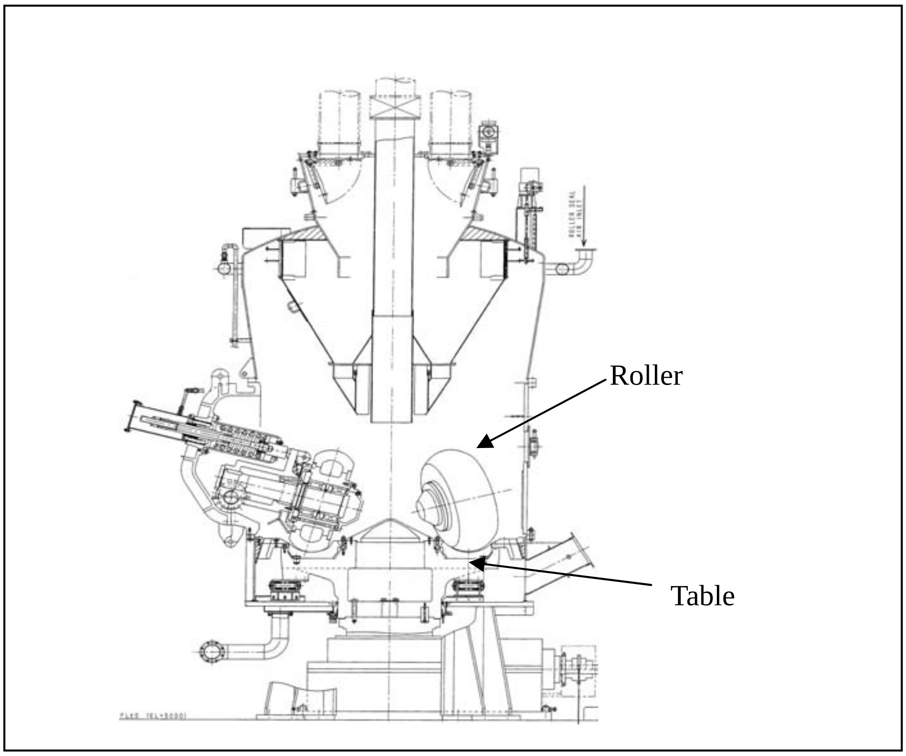


Fig.4.2-10 Cross Section of Mill

Baganuur coal and Shivee Ovoo coal, used in TPP4, contains lots of stone and sand, compared with import coal in Japan, wearing speed of pulverizer roller is fast, it is approx. 2 times of rollers used in Japan. Due to this reason, approx. every 8,000 hours weld overlay repair is necessary. Roller before repair is shown in Fig.4.2-11. Wearing is progressing into base material in this case, since large scale repair is necessary, manufacturer is recommending to replace by new roller.

Fig.4.2-11 Mill Roller before Maintenance

(5) Water Quality Control

As for tube leak, which is number one cause of boiler shutdown, the reason for tube leak is estimated to be corrosion of inner surface of boiler water tube. Recent water quality data and its comparison with Japanese JIS standard is shown in Table 4.2-8.

Table 4.2-8 Water Analysis

Item	unit	Boiler feed water		Boiler water	
		TPP4	JIS	TPP4	JIS
Conductivity	μS/cm	3.1	0.05	–	–
Hardness	mg/l	1	0	–	–
O_2	mg/l	0.005	0.007	–	–
Fe	mg/l	19	30	–	–
SiO_2	mg/l	–	–	2.9	0.3

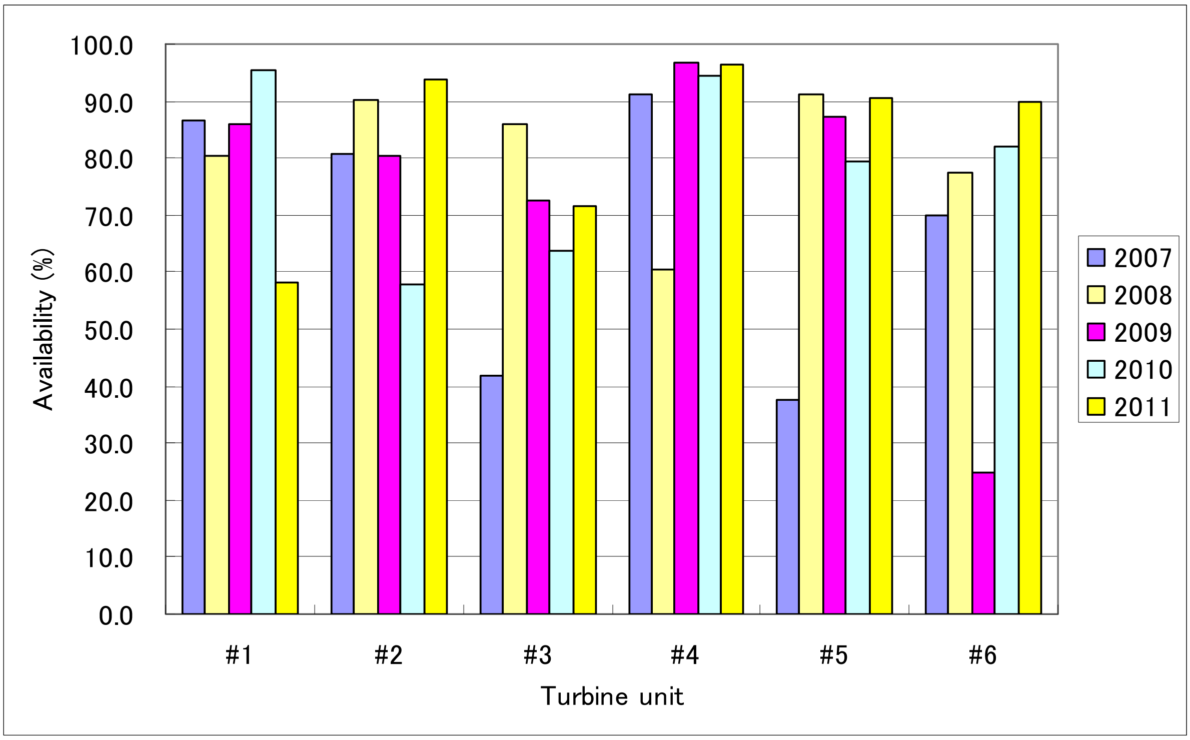
(Source: JICA Survey Team based on TPP4's data)

Conductivity and hardness in boiler feed water, and boiler water silica exceed JIS standard, it is considered that some counter measures are necessary, however, in TPP4, water treatment system will be renovated to reverse osmosis type by German KfW fund, it is expected that this issue will be resolved. On the other hand, as mentioned later, rust was observed on the surface of turbine blades of No.5 turbine under major overhaul. This rust is assumed to have been brought mainly from the boiler. In TPP4, there is a history that the plant was operated under worse water quality until around 2000 because of failure of water treatment system, it is assumed that the rust produced during those days is still remaining in the water tube of boiler, and this is the main cause of tube leak. In order to solve this problem, acid cleaning and anti-rust treatment are applicable. In TPP4, acid cleaning is carried out, but appropriate acid cleaning and post anti-rust treatment may not be carried out. Acid cleaning and anti-rust treatment technique with sophisticated technique such as study of cleaning procedure after investigation of present boiler tube conditions are well established in Japan, and acid cleaning and anti-rust treatment based on such technique are recommendable.

4.2.3 Turbine Facility

(1) Operation Condition

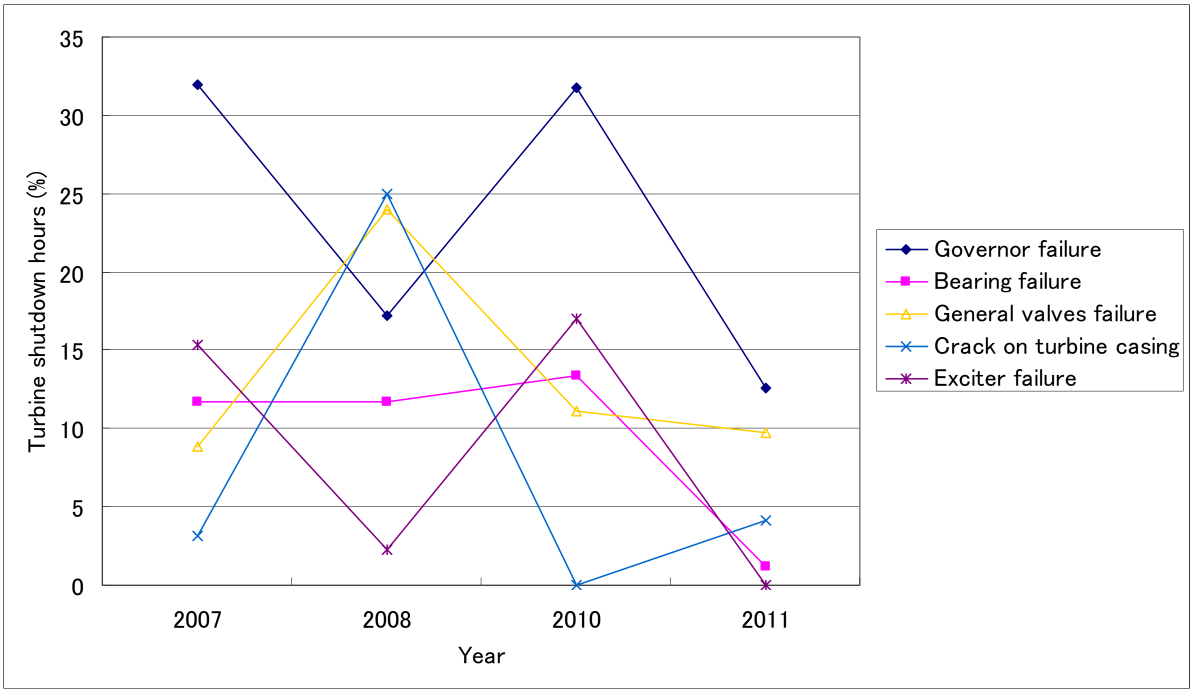
Availability of turbine in last five years is shown in Fig.4.2-12. In calculation, same as boiler, stand by condition was regarded as in operation. It depends on the unit, almost 80 to 90% availability is achieved. The reason for low availability, which depends on year, is mainly shut down for major overhaul.



(Source: JICA Survey Team based on TPP4's data) Availability = (operation hours + stand-by hours) / 8760 (%)

Fig.4.2-12 Turbine Availability

Fig.4.2-13 shows percentage of forced shut down hours with respect to its reason. As for forced shutdown hours, shutdown by governor failure and valve failure is prominent. As for exciter failure, there was No.2 and 5 exciter failures in the past, and those failures are solved now.



(Source: JICA Survey Team based on TPP4's data)

Fig.4.2-13　Ratio of Shutdown hours by Major Trouble

Table 4.2-9 shows turbine operation parameters of highest power and heat supply record day in this winter. As for No.2, 3, 4 turbine, trend of power output and main steam flow are not in consistent, and measuring instruments may not indicate correct figures.

Table 4.2-9　Turbine Operation Data

NO.	ITEM									
1	Unit		Design	2	3	4	Design	1	5	6
2	Time			19:00	19:00	19:00	19:00	19:00	19:00	19:00
3	Date			2011.12.25	2011.12.25	2011.12.25	2011.12.25	2011.12.25	2011.12.25	2011.12.25
4	Unit Load	MW		108.4	87.5	115.8		84	93.1	92.8
5	MS Pressure	kg/cm2 (a)	130	127	132	125	130	124	128	128
6	MS Temperature	Deg C	555	537	546	558	555	531	550	532
7	MS Flow	t/h		444	504	630		496	475	475
8	HPH - 7 FW Outlet Temp	Deg C		231	225	236		252	253	246
9	LPH - 4 FW Outlet Temp	Deg C		163	156	163		159	180	167
10	Condensate Water Flow	t/h		164	265	349		260	178	205
11	Condenser Pressure	kg/cm2 (a)		0.8	0.82	0.8		0.82	0.76	0.79
12	Condenser Hotwell Water Temp	Deg C		41	42	29		35	49	35
13	Condenser Cooling Water Flow	t/h		10229	10443	8668		6681	6118	4412
14	Condenser Inlet Cooling Water Temp	Deg C		15.5	16.5	17.5		16	15	15.5
15	Condenser Outlet Cooling Water Temp	Deg C		26	27.5	31.5		27	31.5	26.5

(Source: JICA Survey Team based on TPP4's data)

(2)　Governor Control Systems

The original mechanical-hydraulic governor control systems are still used since initial operation, and system configuration differs depends on URAL turbine and LMZ turbine.

1) URAL turbine:

a) Turbine is comprised of three cylinders, high-pressure (HP), intermediate-pressure (IP), and low-pressure (LP) turbines.

b) A main stop valve (MSV), four control valves (CVs), and two diaphragm valves driven by a single actuator for steam extraction control constitute turbine control valves.

c) The diaphragm valves control the LP-turbine inlet steam pressure at the downstream of the extraction to hot water heater for district heating. The purpose of this control is to regulate the upstream extraction steam pressure to hot water heaters in order to adjust the hot water temperature at the outlet of the heaters. This extraction steam pressure control is not automatic but is performed manually by the operators based on the pressure reading.

d) There is no shut-off or control valve at the steam inlet of the IP turbine.

e) The hydraulic oil pressure is regulated at 15 ata..

2) LMZ turbine

a) Turbine is comprised of two cylinders, high-pressure (HP) and low-pressure (LP) turbines.

b) A main stop valve (MSV), four control valves (CVs), four extraction control valves (ECVs) and two diaphragm valves driven by a single actuator for steam extraction control constitute turbine control valves.

c) ECV controls pressure of 16 ata steam, same as URAL turbine, the diaphragm valves control the inlet steam pressure at the downstream of the extraction to hot water heater for district heating. The purpose of this control is to regulate the upstream extraction steam pressure to hot water heaters in order to adjust hot water heater outlet hot water temperature. This extraction steam pressure control is not automatic but is performed manually by the operators based on the pressure reading.

d) There is no shut-off or control valve at the steam inlet of the LP turbine.

e) The hydraulic oil pressure is regulated at 20 ata.

3) Hydraulic and lube oil system are common system, and there are three motor-driven oil pumps: one for startup, one for startup spare, and one for emergency. The emergency oil pump is a DC-motor driven pump.

Problems such as hydraulic valve sticking and pilot jamming occur frequently though governor overhaul is carried out at major overhaul, once four years.

In order to improve the reliability of governor control system, replacement to electro-hydraulic type is recommendable. In electro-hydraulic type governor control system, speed detection and signal transmission function, which is one of the most important part of governor, is changed from hydraulic power application and mechanical mechanism to electric detector and controller. Therefore, it contributes to improvement of reliability, and turbine availability is expected to increase.

(3) Turbine Rotor

Conditions of NO.5 turbine at casing opening in major overhaul is shown below. In Fig.4.2-14 photo of low pressure rotor is shown, and in Fig.4.2-15 that of HP nozzle is shown. Serious red rust adhesion on the surface of blades is observed, and as for LP rotor a part of shroud is missing.

Fig.4.2-14 LP Rotor

Fig.4.2-15 HP Nozzle

Fig.4.2-16, 4.2-17 show last blades of LP rotor. Fig.4.2-16 is picture before repair, these blades were renewed by Chinese manufacturer about 4 years ago, but serious erosion by wet steam is observed. This is because of low quality of material. Fig.4.2-16 shows picture after maintenance, in which eroded part was removed by grinding process.

Fig.4.2-16 LP Last Blade before Repair

Fig.4.2-17 LP Last Blade after Repair

In such situation, it is estimated that the performance is deteriorating, but it is difficult to measure present performance of turbine because instruments for performance measurement are not installed in TPP4. By the calculation using the measurement by temporary instruments, turbine efficiency is relatively approx. 6 % lower compared with design value. (design value 81%, calculation value from operation data 76%)

As shown in above pictures, rust adhesion and last blades erosion are observed, and already more than 20 years passed since initial operation of turbines. Therefore, in order to extend future lifetime and recover deterioration, replacement by new rotor and inner parts based on latest high performance blade and new type seal technology is recommendable.

4.2.4 Control and Instrumentation (C&I)

The TPP4 station has independent eight boiler control systems and six turbine control systems.

The boiler control systems were renovated in three phases (Phases 1 and 2, and then follow-up) from 1996 to 2007 by Japanese ODA loan, and distributed digital control systems (DCSs) were introduced for remote automatic control from central control room (CCR). As the effects of introduction of DCSs have already reported before,[1] availability of TPP4 increased and it is highly appreciated. Fig.4.2-18 and Fig.4.2-19 show CCR before and after renovation of boiler control systems.

Fig.4.2-18 Boiler Control System before Modification

Fig.4.2-19 Boiler Control System after Modification

Regarding turbine control systems, however, original Russia-made analog control devices are still used since initial operation.

Turbines are manually operated from CCR remotely or local, and startup and shutdown require concurrent operations at CCR and local, which is imposing heavy burden on the operators. Besides, old Russia-made devices that have been used for more than 20 years are posing inevitable reliability degradation. Fig.4.2-20 shows turbine control panel in the CCR.

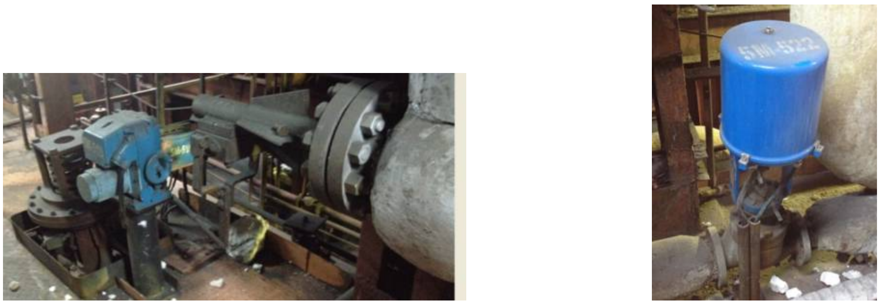
Fig.4.2-20 Turbine Control Panel in CCR

Despite such conditions, the instrumentation and control engineers at TPP4 have been making efforts for improvement through daily maintenance work on a device-by-device basis, such as replacement of

1 Final Feasibility Study Report for Development Support of Ulaanbaatar No. 4 Thermal Power Station Revamp Plan by Japan International Cooperation Agency (September 2002), published by Electric Power Development Co., Ltd. – Japanese version only available.

failed Russia-made devices with China-made devices (as shown in Fig.4.2-21) and diversion of devices which became unnecessary in the Phase-1 renovation (as shown in Fig.4.2-22).

Table 4.2-10 shows the details and frequencies of the maintenance work.



Russia-made **China-made**

Fig.4.2-21 Original Russian Control Valve and New Chinese Control Valve

Fig.4.2-22 Diverted Devices from Phase1 Renovation

Table 4.2-10 Maintenance Work and Frequency

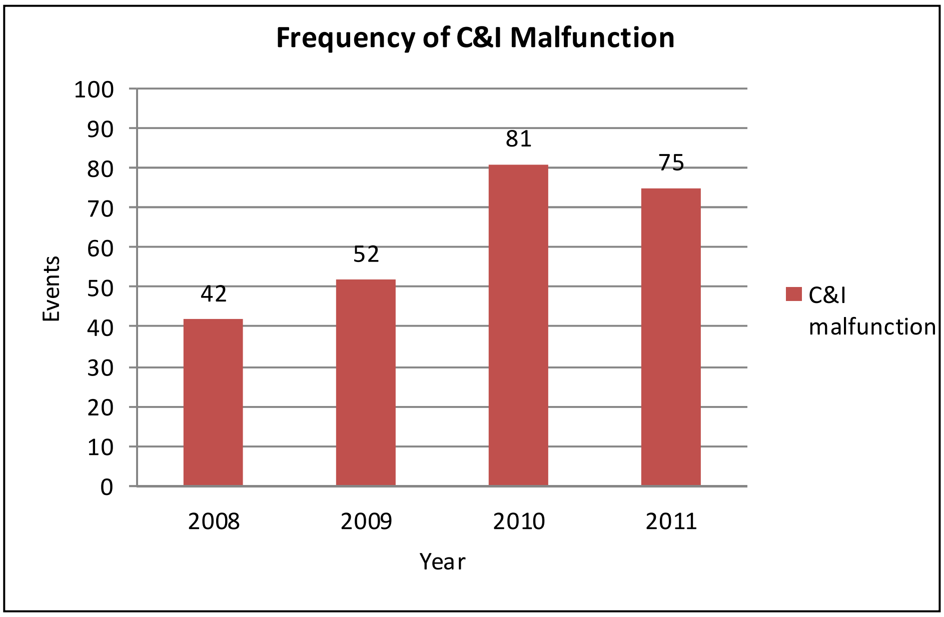
Maintenance Work Item	Frequency
Adjustment/calibration of instruments and controls	Once every two years
Zero and span check of field devices	Once every year
Function check of impulse piping, control valves, and shutoff valves	Once every four years
Check of control and protection systems	While the turbine is shut down for three days or more
Check of deviation in critical data from baseline (and adjustment where necessary)	Once every month

(Source: JICA Survey Team based on TPP4's data)

Despite the above mentioned positive maintenance activities, manufacturing of some of old original Russian devices that need to be operated continuously have already stopped and their spare parts are not available. Hence, possible maintenance work is limited. As indicated by the number of control or instrument malfunction events per year (Fig.4.2-23), and by the numbers of unexpected turbine shutdowns and those caused by a control or instrument malfunction (Fig.4.2-24), the reliability of C&I equipment is declining, thus it is contributing to plant reliability and availability decrease..

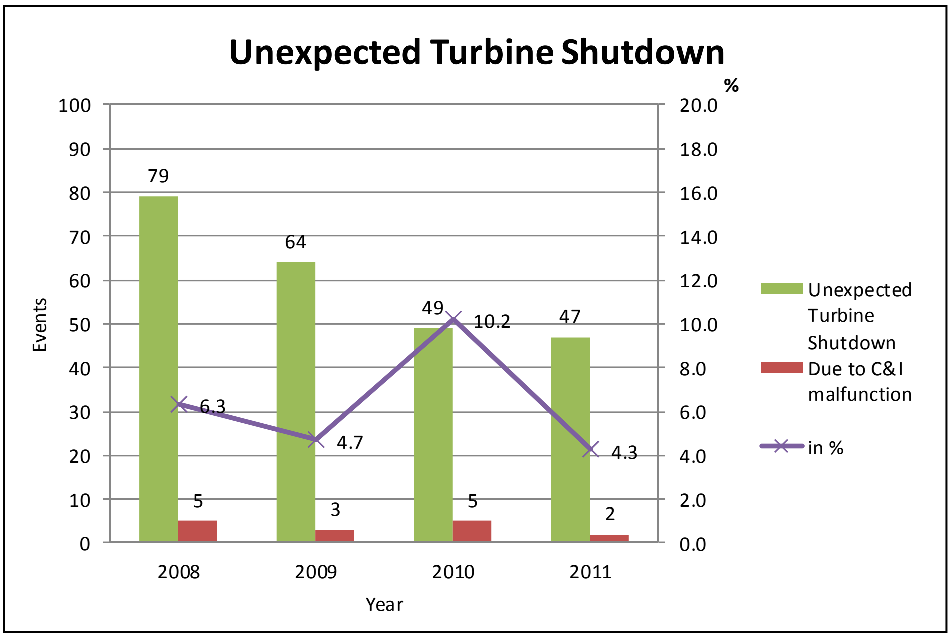
Table 4.2-11 shows the details of reasons for turbine shut down.

From above mentioned points, the upgrade of turbine control system hardware including local instruments is necessary for improving the plant reliability, availability, plant operation, maintenance and management. In addition, it is also recommendable to add the software functions such as turbine auto start stop and improvement of power and heat load following capability.



(Source: JICA Survey Team based on TPP4's data)

Fig.4.2-23 Number of Control & Instrument Malfunction



(Source: JICA Survey Team based on TPP4's data)

Fig.4.2-24 Numbers of Unexpected Turbine Shutdown

Table 4.2-11 Details of Reasons for Turbine Shutdown

Year	Times	Turbine	Cause of Shutdown
2008	1	#1	Wrong interlock action
	2	#3	Malfunction of protection controller
	3	#5	Malfunction of main steam temperature sensor
	4	Unknown	Unknown
	5	Unknown	Unknown
2009	1	#3	Step#1 Exchanger pressure transmitter
	2	#4	Vacuum drop
	3	#3	Malfunction of protection controller
2010	1	#6	Governor cable break
	2	#6	Malfunction of Vacuum transmitter
	3	#3	Malfunction of Oil temperature transmitter
	4	#4	Cable noise
	5	#1	Malfunction of protection controller
2011	1	#1	Malfunction of protection controller
	2	Unknown	Wrong action of shut off valve

(Source: JICA Survey Team based on TPP4's data）

4.2.5 Electro Static Precipitator (ESP)

Dust concentration measurement result of inlet and outlet of ESP, which was measured during 1st work and 2nd work in Mongolia is shown in. Table 4.2-12. As for NO.1 and NO.4 ESP, the measurement was not possible due to overhaul of boiler. As for NO.7 ESP, outlet dust concentration exceeded 200 mg/m^{3}N of TPP4 stack outlet dust concentration regulation, but average figure satisfies the regulation. It is suspected that the reason is temporally defect of electrical energization system.

In addition, expected ESP outlet dust concentrations in case of 100% boiler load, and in case of future 50t/h boiler capacity increase based on estimated flue gas volume, are shown in the right columns of the table. It is expected that each case can satisfy the regulation as average figure basis.

Table 4.2-12 ESP Dust Measurement Result

NO.	DATE	UNIT	Boiler load (%)	Coal	ESP Inlet (g/m3N)	ESP outlet (mg/m3N)	Efficiency (%)	ESP outlet @ 100% (mg/m3N)	ESP outlet @50t/h up (mg/m3N)
1	Mar. 21	7	86	Shivii Ovoo	3.9	13	99.7	20	27
2	Mar. 22	6	75	Shivii Ovoo	4.6	14	99.7	30	41
3	Mar. 23	3	100	Baganuur	7.5	163	97.8	163	203
4	Mar. 24	5	97	Shivii Ovoo	7.8	81	99.0	87	112
5	Apr.24	2	98	Baganuur	7.1	112	98.4	117	148
6	Apr.25	8	98	Shivii Ovoo	9.5	47	99.5	50	67
7	Apr.26	7	94	Shivii Ovoo	8.6	233	97.3	260	318
					Regulation	200		200	200
					Average	95	98.8	104	131

Table 4.2-13, 4.2-14 shows past measurement result. As for ESP outlet dust concentration, some data exceed regulation, but measured data vary widely.

Table 4.2-13 ESP Inlet Dust

No.	Year	unit	Unit-1	Unit-2	Unit-3	Unit-4	Unit-5	Unit-6	Unit-7	Unit-8
1	2004	g/m3N	3.0	—	9.8	7.1	—	9.9	—	10.8
2	2005	g/m3N	0.0	9.4	12.2	9.5	7.6	5.1	—	—
3	2006	g/m3N	6.8	3.3	—	4.8	—	6.9	6.0	8.3
4	2007	g/m3N	5.0	3.2	4.9	4.8	6.2	4.0	2.5	5.9
5	2008	g/m3N	10.0	6.7	6.5	13.2	5.0	7.5	6.2	5.9
6	2009	g/m3N	2.6	17.6	4.6	3.3	3.8	3.6	3.1	4.4
7	2010	g/m3N	5.9	3.4	9.8	5.1	6.9	4.5	4.1	7.1

(Source: JICA Survey Team based on TPP4's data)

Table 4.2-14 ESP Outlet Dust

No.	Year	unit	Unit-1	Unit-2	Unit-3	Unit-4	Unit-5	Unit-6	Unit-7	Unit-8
1	2004	mg/m3N	117	—	152	106	—	110	—	70
2	2005	mg/m3N	—	**444**	**334**	**1,486**	164	**812**	—	—
3	2006	mg/m3N	106	143	—	**233**	—	**213**	**343**	31
4	2007	mg/m3N	**285**	76	**167**	50	185	120	67	40
5	2008	mg/m3N	**520**	124	**231**	193	122	158	**241**	33
6	2009	mg/m3N	163	66	165	40	18	91	59	7
7	2010	mg/m3N	**295**	3	**375**	9	49	**216**	32	25

(Source: JICA Survey Team based on TPP4's data)

Inside of No.4 ESP is shown in Fig.4.2-25. Corrosion of collecting electrode is observed, but it is only inlet part, and there is no overall corrosion.

Fig.4.2-25 #4 ESP Inner Parts

Table 4.2-15 shows current emission regulation of TPP4. For reference, regulation of new power plant in Mongolia and guideline of World Bank are also shown. Compared with current regulation of TPP4, or SO_2 and dust regulation are more stringent in regulation of new power plant. There is no environmental protection facilities other than ESP, in TPP4.

Table 4.2-15　Emission Standard of TPP4

Item	TPP4	For New Power Plant in Mongolia	Environmental, Health, and Safety Guidelines(World Bank,2007)
CO	180 mg/m^3 (144ppm)	180 mg/m^3	N.A.
SO_2	1,200 mg/m^3 (420ppm)	400 mg/m^3	2,000 mg/m^3
NOx	715 mg/m^3 (364ppm)	1,100 mg/m^3	650 mg/m^3
Dust (SPM)	200 mg/m^3	50 mg/m^3	50 mg/m^3

4.2.6　Maintenance

In TPP4, technical level of maintenance management at major overhaul and safety management was dramatically improved, compared with situation of about 10 years ago. Picture of temporary safety barrier (Fig.4.2-26) and working condition of replacement of boiler tubes (Fig.4.2-27) are shown below. Boiler tube material is imported from China and processing in work shop in TPP4.

Regarding reasons for improvement of technical level of maintenance management and safety management, followings are considered.

a) Because of improvement of financial condition of TPP4, margin can be reserved for budget of maintenance.
b) Since budget of maintenance was increased according to instruction of TPP4 management, necessary material and equipment can be purchased enough.
c) They learned maintenance work management method through past projects by Japanese ODA loan.
d) They can get latest technical information through technical advisor of JICA.

Fig.4.2-26　Safety Enclosure

Fig.4.2-27 Replacement of Boiler Water Wall

4.2.7 Shunting locomotive

TPP4 owns three Russian made diesel locomotives in order to unload coal transported by rail way. Two are for normal use and one is spare. Coal wagons transported to shunting yard of TPP4 by Ulaanbaatar rail way company are divided into small units which consists of 12 to 16 wagons, and these units are transported to coal unloading facility by shunting locomotive, and coal is unloaded. Unloading facility sandwiches wagon from both side and turn it, and coal is discharged to downside hopper and transported to coal yard by conveyers. It takes about one hour to unload coal from 16 wagons, and capacity of one wagon is 70 ton. It is possible to unload coal from two wagons one time by unloading facility, and TPP4 owns two unloading facilities. TPP4 is planning to install two additional unloading facilities in 2014.

As for the first locomotive (NO. 1255), it was introduced at the same time of start of operation of TPP4, already approx. 30 years passed, 25th years major overhaul was carried out in 2009. Next major overhaul is scheduled to be carried out after 7.5 years. 25th years major overhaul of the second locomotive is scheduled in 2013. Since production of this type of locomotives is shut off and some new parts are not available, TPP4 uses some parts longer period, and there is no operation problem of locomotives. Table 4.2-16 shows major specification of the locomotive, and Fig.4.2-28 and Fig.4.2-29 show pictures of locomotive and coal unloading facility, respectively.

Table 4.2-16 Major Specification of Shunting Locomotive

Item	unit	
Type		TEM-2 (Russia)
Year of manufacture NO.1255 NO.1280 NO.1291		 1983 1987 1990
Track gauge	mm	1,520
Weight	ton	138
Axle arrangement		6 axles (Co-Co)
Height of coupler	mm	1,050 – 1,060
Tractive effort	kN	350
Rated engine power	kW	515
Engine capacity	cc	157,260
Cylinder		6
Max. speed	km/h	100
Major dimension Length Width Height	mm	 16,970 4,437 3,120

(Source: JICA Survey Team based on TPP4's data)

Fig.4.2-28 Shunting locomotive of TPP4

Fig.4.2-29 Coal Unloading Facility of TPP4

Chapter 5
Ulaanbaatar Thermal Power Plant NO.4
Rehabilitation Plan

TABLE OF CONTENTS

Chapter 5 Ulaanbaatar Thermal Power Plant NO.4 Rehabilitation Plan

LIST OF TABLES

LIST OF FIGURES

Chapter 5 Ulaanbaatar Thermal Power Plant NO.4 Rehabilitation Plan

5.1 Rehabilitation Plan

Based on current situation of TPP4 and request from TPP4, following rehabilitation plans may be proposed.

a) Extension of 100 MW class steam turbine
b) Renovation of turbine governor system to electro hydraulic type
c) Modification of Turbine control system to DCS (Distributed Control System)
d) Installation of soot blower
e) Renovation of mill roller
f) Acid cleaning and anti-rust treatment of boiler water tube
g) Renovation of turbine rotor and seal system
h) Replacement of high pressure valves
i) Replacement of existing diesel shunting locomotive by hybrid type locomotive

Among above items, a), f), g), h) were not requested by TPP4.

Feasibility study of item b), c), d), e) and i) were carried out hereinafter.

5.2 Feasibility study

5.2.1 Turbine Governor Upgrade from Mechanical-hydraulic Control to Elector-hydraulic Control

As mentioned in Section 4.2.3, the original mechanical-hydraulic turbine governors still remain in use, and it is frequently reported that there are unscheduled turbine shutdowns due to hydraulic equipment malfunction. Such shutdowns account for 12 to 33 percent of the total unexpected outage of turbines, indicating that hydraulic malfunction is one of two major causes of unscheduled shutdowns together with valve failure.

According to engineers of TPP4, typical malfunctions such as pilot valve sticking and pilot jamming are considered as results from aging of hydraulic equipment and deteriorated quality of oil caused by the fact that turbine lube oil is utilized for both of governor control and lubrication in a common oil system. Upgrading the mechanical hydraulic governors to electro-hydraulic governors reduces hydraulic equipment and will thus diminish hydraulic equipment malfunctions leading to turbine shutdown.

Regarding control and lube oil system, it is considered that the existing system can be used because it is not beneficial to split it into separate systems for the purpose of keeping the oil clean and preventing deterioration, from the following reasons:

a) Additional hydraulic oil pumps and piping are required. Therefore, scope of modification work increases and more time and cost is necessary.

b) Maintenance costs such as additional control oil cost will eventually increases.

c) It is rarely applied to 100 MW class turbines in Japan because of cost disadvantage.

d) It seems that some level of deterioration in cleanliness and quality of oil can be seen in Japanese power plants with similar lube oil system; however, they are well maintained and problems posed by oil deterioration are not reported.

The advantages of electro-hydraulic control over mechanical-hydraulic control include the following:

a) Better response

b) Possibility of control mode selection, such as inlet pressure control or load control
Inlet pressure control：Function to control turbine inlet steam pressure regardless of turbine inlet steam flow
Load control：Function to control generator output

c) Variable set point

d) Interface with upper-level systems (Plant control system and Turbine control system)

e) System redundancy if necessary
Redundancy：Making provision of spare system as back up, in order to maintain total function of the system, even if some failure occurs

f) Automatic startup if necessary

g) Superior maintainability

Their features are compared in Table 5.2-1.

Table 5.2-1 Comparison between Mechanical-hydraulic and Electro-hydraulic Governors

No.	Item	Mechanical-hydraulic	Electro-hydraulic
1	Speed sensor	Centrifugal weight Centrifugal hydraulic	Magnetic pulse
2	Speed signal	Displacement/oil pressure	Pulse signal
3	Speed signal transmission	Linkage/oil pressure	Analog signal
4	Speed signal amplification	Oil relay, linkage	Electronic amplifier
5	Signal converter	Hydraulic pilot	Electro-hydraulic converter
6	Valve drive	Hydraulic cylinder	Hydraulic cylinder
7	Valve position feedback	Hydraulic pilot, linkage	Linear voltage differential transformer

The proposed scope of modification to governors and governor control systems are outlined in Fig.5.2-1, namely, introducing the electro-hydraulic converters that drive the pilot actuators of hydraulic cylinders while leaving the hydraulic cylinders (for controlling governor valves), pilot actuators, and main stop valves (MSVs) unchanged. This method requires minimal modification, is widely used for upgrades to electro-hydraulic control, and contributes to improving reliability.

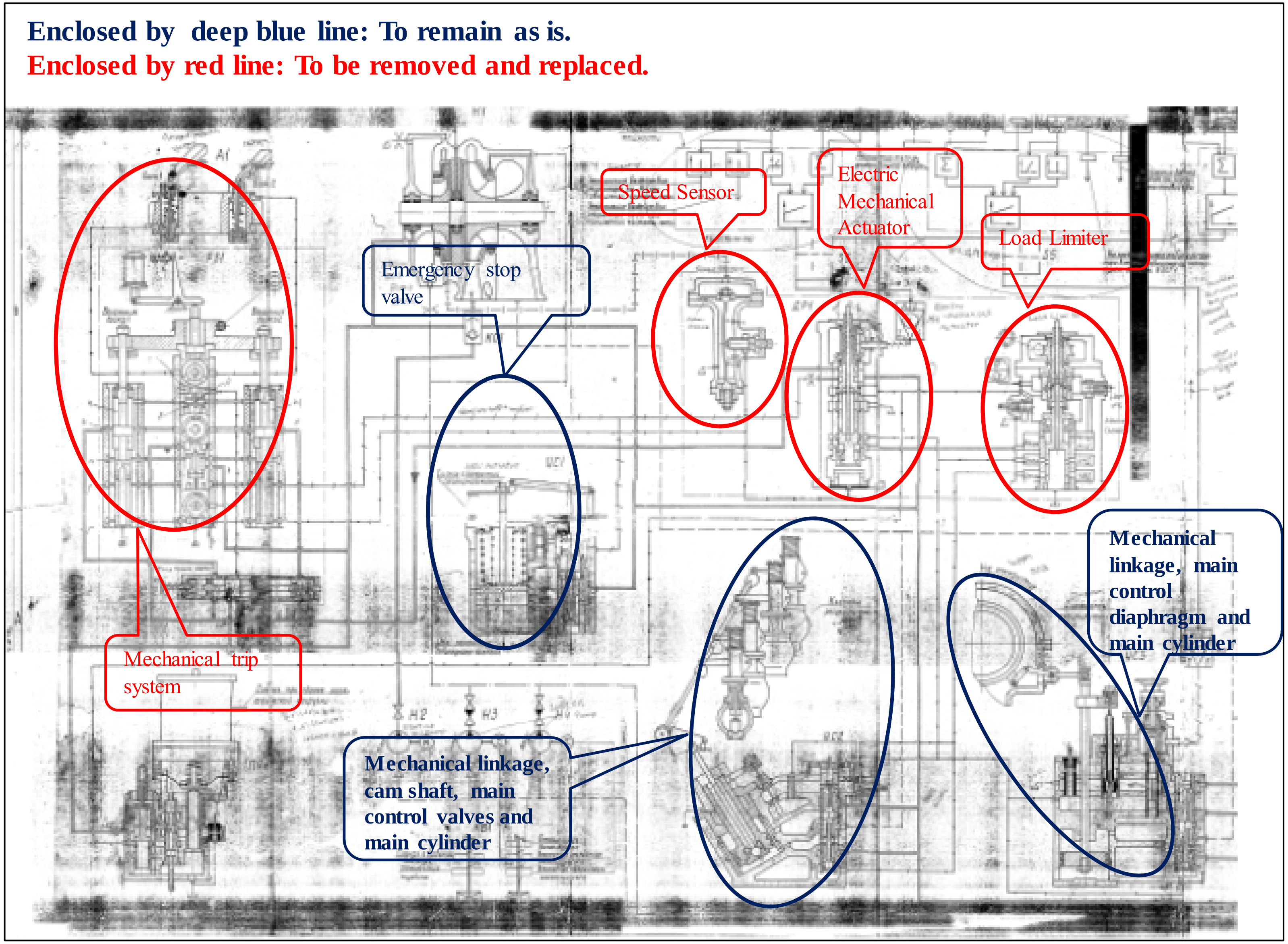


Fig.5.2-1 Scope of Modification

Table 5.2-2 shows the scope of modification work.

Table 5.2-2 Scope of Modification Work

No.	Item	Remark
1	Turbine shutdown / turning operation	
2	Removal of casing / Insulation material	Reuse
3	Removal of control valves and accessories	Ditto
4	Removal of bearing with bearing-stand	Ditto
5	Governor valve checking (maintenance work)	Ditto
6	Extraction valve checking (maintenance work)	Ditto
7	E/H convertor bracket/temporal sleeve & flange set-up	New
8	E/H convertor set-up (installing)	New
9	Removal work of existing pipeline (existing pipe cut)	Reuse and modify
10	Servo-motor set-up (installing)	New
11	Modification work of existing pipeline	Reuse and modify
12	Installation of new instrument piping	New
13	Installation of EH control panel	New
14	Installation of control desk, OPS, EMS, ACS	New
15	Installation of local panel	New
16	Installation and/or modification of conduit pipe, tray	Reuse and modify
17	Modification work of existing cables, terminals and control panels	Ditto
18	Cabling work	Ditto
19	Pre-commissioning (cable check, loop test)	
20	Re-assembling work of casing, insulation material	Reuse
21	Oil flashing	
22	Hydro pressure system, valves adjustment	
23	System step response test	
24	Interlock test	
25	Turbine start-up / no load test / synchronization	
26	EH performance test	

Regarding field devices, the sensors that are required for turbine control and protection in line with the governor upgrade need to be renewed.

Wiring and tubing related to the renewed field devices will be renewed so as to avoid reliability reduction of the entire system.

The expected benefits of upgrade to electro-hydraulic governors include the following:

a) Reduction in unexpected turbine shutdowns thanks to increased reliability
b) Efficient turbine startup and improved availability by introduction of automatic control
c) Increase of electricity and heat supply
d) Reduction in burdens on operators and maintenance staff — abstract effects

5.2.2 Replacement of Turbine Control Systems with Distributed Control Systems (DCSs)

Regarding turbine control systems, the original Russia-made control devices are still mainly used. The turbines are manually operated from CCR remotely or local. The Russia-made devices that have been used for more than 20 years are posing reliability degradation. In spite of maintenance done by the instrumentation and control engineers in TPP4, some of those devices are no longer in production, and applicable maintenance is limited. Therefore, as already mentioned in Section 4.2.4, unexpected turbine shutdowns due to malfunctions of turbine control system devices sometimes occur. It is an urgent need to modify hardware including field devices as well as control systems.

Meanwhile, the old turbine control systems do not have automatic operation function, thus imposing a heavy burden on the operators. Further, there are data loggers for performance management, but there are no devices necessary for turbine performance calculation. Functions to improve this situation need to be added.

The followings are the scope of modification in terms of both hardware and software.

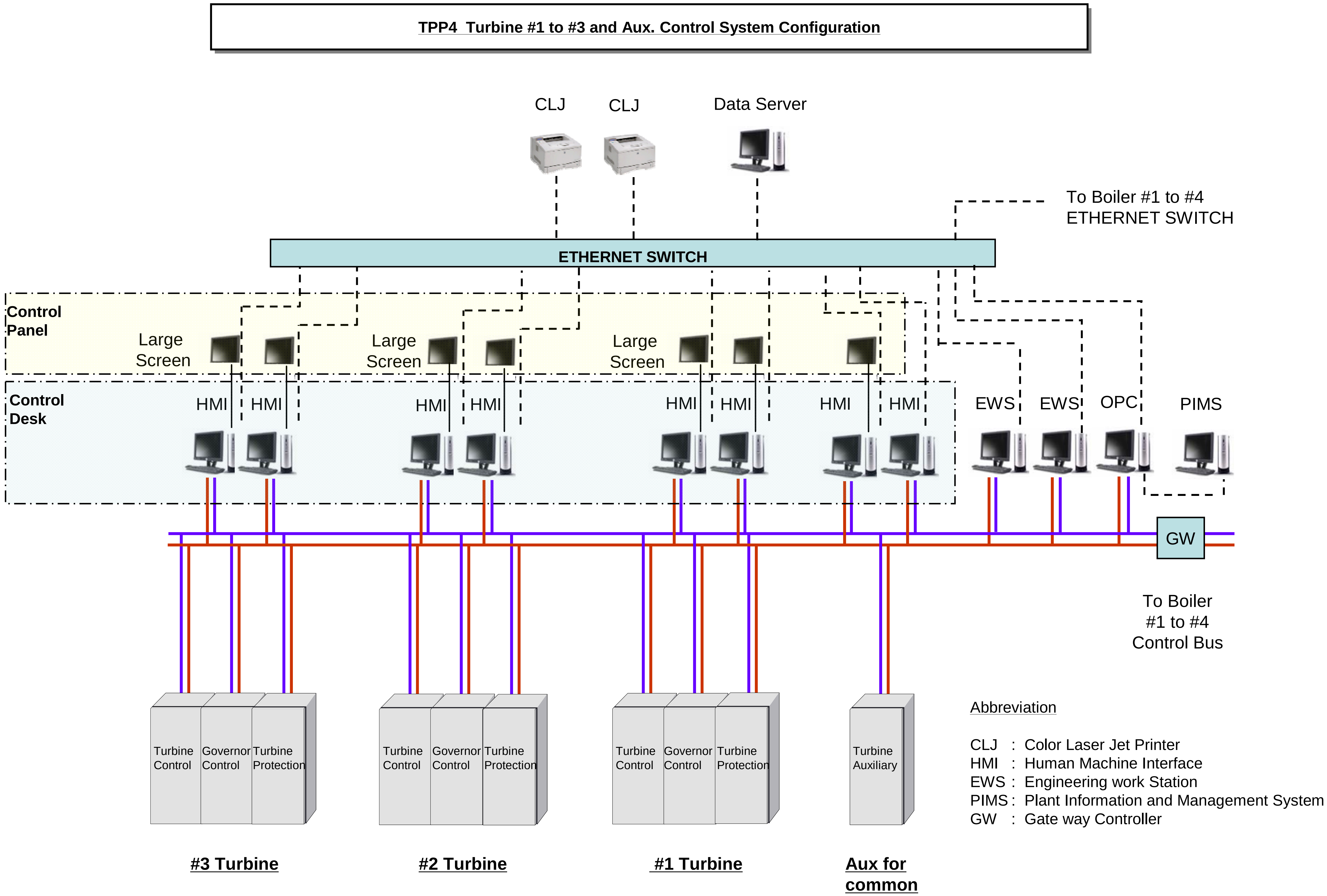
(1) Hardware

New turbine control systems comprise followings.

a) DCS for turbine monitoring and control
b) Desks and panels for turbine monitoring and control
c) Field devices (remote I/O panels, temperature sensors, transmitters, and control valves)
d) Instrument wiring and tubing required accordingly

In addition, an offline training simulator should also be included for training of operators who are used to switch-based operations:

From operation and maintenance point of view, it is desirable that the turbine monitoring and control systems are distributed to each turbine and capable of interfacing with the renewed electro-hydraulic governor control systems. Interface with the existing boiler control systems should also be considered. The new turbine control systems (DCSs) should be installed in CCR after the existing turbine control systems are removed. Fig.5.2-2 outlines the configuration of new turbine control systems.



Note

1. This drawing shows the turbine control system of #1 to #3 and ,for #4 to #6 turbine, the control system is similar .
2. This drawing is only for reference and subject to change in future.

Fig.5.2-2 System Configuration of Turbine Control System

There are video monitors for operation and monitoring and emergency operation switches on the turbine control desks, and large-screen video monitors are to be installed on the panel behind the desks.

JICA-ST prioritizes the replacement order of systems and devices for remote monitoring, control and protection (security) to realize stable operation as well as continuous use of recently replaced instruments, and proposes the following scope.

Regarding field devices, transmitters, temperature sensors, and switches should be replaced, but field gauges are out of the scope. For reference, Table 5.2-3 shows general figures of new devices per URAL turbine. It should be noted that temperature sensors built into equipment, such as sensors for motor winding temperatures, are not included.

Table 5.2-3 General Figures of New Devices

Type	Quantity
Flow transmitters	10
Level transmitters	30
Pressure transmitters	20
Temp. sensors (thermocouples, etc.)	80
Flow switches	5
Level switches	15
Pressure switches	30
Temperature switches	5

(Source: JICA Survey Team based on TPP4's data)

Regarding control valves, the original Russia-made control valves should be replaced first. Although TPP4 engineers mentioned that China-made valves also malfunctioned frequently, they have already been repaired; hence they are excluded from the proposed scope. Tables 5.2-4 to 5.2-6 show a list of control valves which were studied. Smaller number in the priority column indicates higher priority. The proposed scope includes replacement of valves at priority level 1 only.

Not all instrument wiring and tubing need to be renewed; however, those for the devices that send or receive a signal to/from a DCS should be renewed in order to ensure the reliability of the entire system.

Remote I/O (RI/O) panels are to be installed near the respective turbines. RI/O panels contain I/O processing units of DCS and send signals to the central processing unit (CPU) of DCS installed in the CCR. Fiber optic cable is used to reduce the total amount of cables to be installed and mitigate adverse effects associated with electric signal transmission.

Table 5.2-4 Control Valves for URAL T-110 Turbine

Item	Tag No.	Made in	Nominal diameter (DN)	Nominal pressure (PN)	Priority
LP Heater #1 Level	M-513	Russia	100/80	25	1
LP Heater #2 Level	M-514	Russia China	100/80 80	25 25	1 2
LP Heater #3 Level	M-515	Russia	80	25	1
LP Heater #4 Level	M-516	Russia	100/80	25	1
HP Heater #5 Level	M-510	Japan	100	25	3
HP Heater #6 Level	M-511	Japan	100	25	3
HP Heater #7 Level	M-512	Japan	100	25	3
Drainage LP Heater #2 Level	M-519	China	80	25	2
Heating Water # 1 Level	ПС-500	Germany	200	63	3
Heating Water # 2 Level	ПС-501	Germany	200	63	3
Sealing Steam	M-509	China	150	63	2
Condenser Level (Aux.)	M-520A	China	80	25	2
Condenser Level (Main)	M-520	China	300	25	2
Turbine Oil Temp	M-325	China	300	25	2
From Water Storage Tank to LP Heater #2	M-558	Russia	50	25	1

(Source: JICA Survey Team based on TPP4's data)

Note:

1. Regarding LP heater #1/2 level control valves, only those for #2 turbine are DN100.
2. Regarding LP heater #2 level control valves, only that for #3 turbine was made in China.
3. Regarding LP heater #4 level control valves, only that for #4 turbine is DN80.

Table 5.2-5 Control Valves for LMZ T-80 Turbine

Item	Tag No.	Made in	Nominal diameter (DN)	Nominal pressure (PN)	Priority
LP Heater#2 Level	M-519	Russia China	150 150	63 25	1 2
LP Heater#3 Level	M-518	Russia China	80 80	25 25	1 2
LP Heater#4 Level	M-517	Russia	80	25	1
HP Heater#5 Level	M-516	Japan	100	25	3
HP Heater#6 Level	M-515	Japan	100	25	3
HP Heater#7 Level	M-514	Japan	100	25	3
Drainage LP Heater #2 Level	M-522	Russia China	100 80	25 25	1 1
Heating Water# 1 Level	ПС-500	Germany	150	63	3
Heating Water# 2 Level	ПС-501	Germany	150	63	3
Condenser Level	M-523	China	200	25	2
Sealing Steam	M-513	China	80	40	2
Sealing Steam (Outlet)	M-550	Russia China	250 250	25 25	1 2

(Source: JICA Survey Team based on TPP4's data)

Note:

1. Regarding LP heater #2 level control valves, only that for #1 turbine is PN63.
2. Regarding LP heater #2/3 level control valves, only those for #1 turbine were made in Russia.
3. Regarding Drainage LP Heater#2 level control valve, only that for #1 turbine was made in Russia and its nominal size is DN100.
4. Regarding Sealing steam (outlet) control valves, only that for #1 turbine was made in Russia.

Table 5.2-6 Control Valves for Turbine Common

Item	Tag No.	Made in	Nominal diameter (DN)	Nominal pressure (PN)	Priority
Deaerator Pressure	ny-500	China	300	25	3
	2ny-500	China	300	25	3
Deaerator Level	MU-557	China	200	25	3
	KU-557	China	200	25	3
	2KU-557	China	200	25	3
Pressure Reducing 140/13K Pressure	PO-501	Russia	175	140	1
Pressure Reducing 140/16K Pressure	PO-500	Russia	175	140	1
Pressure Reducing 140/13K Pressure	PO-502	Russia	175	140	1
Pressure Reducing 140/13K Temperature	PO-504	Russia	65	230	1
Pressure Reducing 140/16K Temperature	PO-503	Russia	65	230	1
Pressure Reducing 140/13K Temperature	PO-505	Russia	65	230	1
Pressure Reducing 14/12K Pressure	PO-506	Russia	250	25	1
Pressure Reducing 16/13K Pressure No. 1	PO-507	China	300	25	3
Pressure Reducing 16/13K Pressure No. 2	PO-508	China	300	25	3
Pressure Reducing 16/13K Pressure No. 3	PO-509	China	300	25	3

(Source: JICA Survey Team based on TPP4's data)

Note:

1. In the table above, the China-made control valves are less prioritized because they were replaced in 2012.

(2) Software

To increase the turbine control, monitoring, and management capabilities, JICA-ST proposes that at least the following functions should be implemented in the new turbine control systems (DCSs):

a) Automatic turbine startup and shutdown
b) Remote turbine control for the portions that are currently performed locally
c) Improved characteristics of load following (how well the turbine can track to the demand)
d) Others

The degree of implementing automation of turbine startups and shutdowns depends on the types of field devices used, such as control valves. JICA-ST considers semi-automatic operations involving manual operations and confirmations in the field. Thus, in principle, the automated operation procedures with new systems will require operator interventions at predefined breakpoints, and the details should be determined when the modification project is put into action.

Although part of turbine local controls has been modified and renewed by engineers at TPP4, it is proposed that the controls listed in Table 5.2-7 are to be implemented in each DCS.

Table 5.2-7 Remote Controls Implemented in DCS

Item	Item
Condenser level control High-pressure feed-water heater level control Low-pressure feed-water heater level control Deaerator level control Turbine lube oil temperature control	Startup auxiliary steam pressure reducing and de-superheating Auxiliary steam pressure reducing and de-superheating Auxiliary steam pressure reducing

(Source: JICA Survey Team based on TPP4's data)

At present, TPP4 is using data loggers for data management purposes but does not have measuring instruments required to monitor turbine performance. Hence, the instruments for measurement listed in Table 5.2-8 should be added along with the proposed modification to enable performance calculations.

Table 5.2-8 Instruments for Turbine Performance Measurement

for 6 turbines

NO.	Item	Unit	Q'ty
1	HPH - 7 Steam Temp	Deg C	6
2	HPH - 7 Steam Press	kg/cm^2	6
3	HPH - 7 FW Inlet Temp	Deg C	6
4	HPH - 7 FW Outlet Temp	Deg C	6
5	HPH - 7 Drain Temp	Deg C	6
6	HPH - 6 Steam Temp	Deg C	6
7	HPH - 6 Steam Press	kg/cm^2	6
8	HPH - 6 FW Inlet Temp	Deg C	6
9	HPH - 6 Drain Temp	Deg C	6
10	HPH - 5 Steam Temp	Deg C	6
11	HPH - 5 Steam Press	kg/cm^2	6
12	HPH - 5 FW Inlet Temp	Deg C	6
13	HPH - 5 Drain Outlet Temp	Deg C	6
14	LPH – 4 Steam Temp	Deg C	6
15	LPH – 4 Steam Press	kg/cm^2	6
16	LPH – 4 FW Inlet Temp	Deg C	6
17	LPH – 4 FW Outlet Temp	Deg C	6
18	LPH – 4 Drain Temp	Deg C	6
19	LPH – 3 Steam Temp	Deg C	6
20	LPH – 3 Steam Press	kg/cm^2	6
21	LPH – 3 FW Inlet Temp	Deg C	6
22	LPH – 3 Drain Temp	Deg C	6
23	LPH – 2 Steam Temp	Deg C	6
24	LPH – 2 Steam Press	kg/cm^2	6
25	LPH – 2 FW Inlet Temp	Deg C	6
26	LPH – 2 Drain Outlet Temp	Deg C	6
27	13ata steam flow	t/h	3
28	HPH - 7 outlet feed water flow	t/h	6
29	Condenser Hotwell water Temp	Deg C	6
30	Condenser Inlet Cooling Water Temp	Deg C	18
31	Condenser Outlet Cooling Water Temp	Deg C	18

(Source: JICA Survey Team TPP4's data)

In TPP4, the main steam from eight boilers is introduced to main steam header and supplied to individual turbines. The function to vary the amount of fuels fed to each boiler automatically in accordance with changes in steam pressure in the common header is provided and was verified in past Phase 2 follow-up project.

However, in actual operation, the operators manually vary the amount of the fuel fed to each boiler in line with changes in electricity and steam generation demands. This is because the operators consider that with the existing automated control, the amounts of steam generated cannot respond to the changes in demands quickly enough. Therefore, they make manual interventions proactively to suppress the fluctuations in steam pressure in the common header. Implementing the turbine control in a DCS enables the boiler control to incorporate changes in demands as a feed-forward signal so as to suppress the changes in steam pressure in the common header, just like the operators do. This will improve the controllability.

Besides, there was a request from TPP4 to implement the electrostatic precipitators (ESPs) operation and monitoring functions in boiler control systems. In TPP4, the ESP control system of Boiler #7 has been replaced with a Russia-made programmable logic controller (PLC). The communication function (RS485) of this PLC can be used for remote control and monitoring from the boiler control system. As TPP4 has plans to replace ESP control systems of other boilers in future, provisions should be made for boiler control systems to be able to communicate with PLCs.

Furthermore, for generator monitoring, it is necessary that input of alarms from the hydrogen coolant leak monitors, winding temperatures, and so on to turbine control systems should be possible .

(3) Expected effects

The following effects can be expected from implementation of automated turbine control in DCSs:

a) Reduction in unexpected turbine shutdowns thanks to increased reliability
b) Increase in electricity and heat supply resulting from the reduced outage
(Since hot water is heated by extraction steam from turbine (taking out steam from intermediate stage of turbine), when turbine operation time increases, heat supply also increases.)
c) Improvement of controllability, accordingly lengthened duration of turbine operation at the rated pressure and temperature
d) Reduction in burdens on operators and maintenance staff — intangible effects

5.2.3 Installation of Soot Blower

(1) Specification

As mentioned in Chapter 4, at present, all soot blowers and shot cleaning system is removed. In this plan, according to the request from TPP4, same as original plan, JICA-ST planed to install soot blowers in the whole boiler area. Table 5.2-9 shows plan of number of soot blower. Rotary-type (stationary type) is installed at economizer, and rake-type (air heater cleaner) is installed in tubular type air heater. Openings at boiler furnace wall are necessary to install soot blowers, but currently there are no openings and modification of boiler furnace wall is also required. Further, as for NO.7 and NO.8 boiler, since there is no platform for soot blowers, additional platforms will be necessary.. This modification work is to be carried out by LCB.

Table 5.2-9 Number of Soot Blower (new plan)

Location	Type	Number
Furnace	Wall Deslugger	33
Front		(9)
Side		(18)
Rear		(6)
Superheater	Long Retractable (one side)	12
Economiser	Rotary	12
Air Heater	Air Heater Cleaner	16
Total		69

As steam source, steam from superheater is utilized to avoid drain after pressure reduction at steam blow, since drain may make erosion of boiler tube. As for soot blower arrangement, there are two options, one is both sides arrangement in which insertion is from both sides of furnace width, and the other is one side arrangement in which insertion is from one side. For the furnace width of approx. 11 m, soot blower of one side arrangement can be manufactured, and total number of soot blowers can be decreased compared with both sides arrangement, which requires double number of soot blowers, taking economical impact and maintenance into consideration, proposed plan is based on one side arrangement soot blowers.

Basic engineering of piping is carried out by soot blower supplier, but installation work, including procurement of piping and valves, is to be carried out by TPP4.

Further, electric power for soot blower motor and others, one low voltage feeder is necessary, per boiler. This feeder is provided from existing distribution board.

Fig.5.2-3 shows long retractable soot blower, Fig.5.2-4 shows rotary-type (Stationary type) soot blower and Fig.5.2-5 shows air heater cleaner, and Fig.5.2-6 shows arrangement plan.

(2) Scope of ICB package

a) Wall deslagger (stationary type) (33 / boiler, including motor)
b) Long retractable soot blower (12 / boiler, including motor)
c) Rotary soot blower (stationary type) (12 / boilers, including motor)
d) Air preheater cleaner (retractable type) (i16 / boiler, including motor)
e) Control Panel (one unit/ boiler, including breaker function)

(3) Scope of LCB package

a) Modification of boiler furnace
b) Piping material, work
c) Platform and support of soot blower
d) Power feeder for soot blower
e) Electrical and control cable material and cabling work

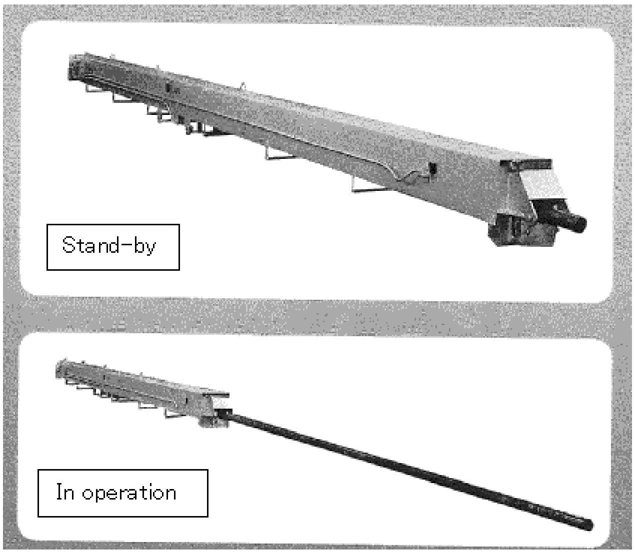


Fig.5.2-3 Long Retractable Soot Blower

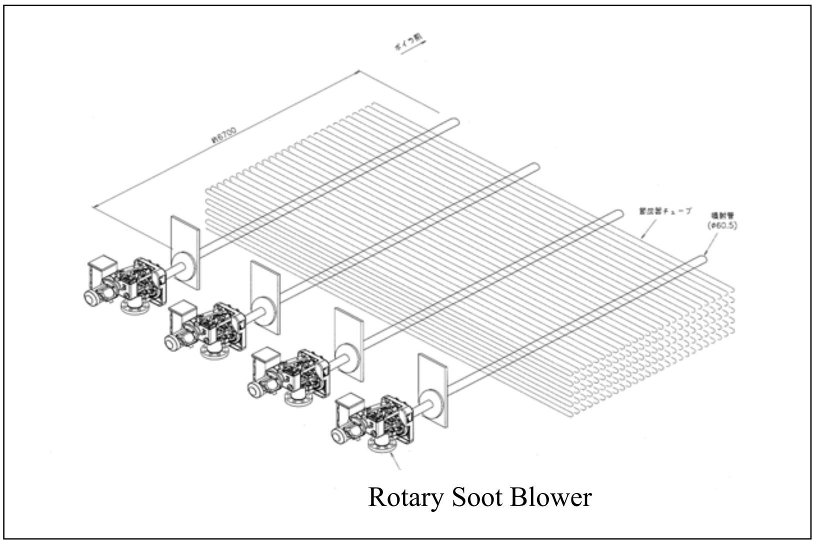


Fig.5.2-4 Rotary Soot Blower

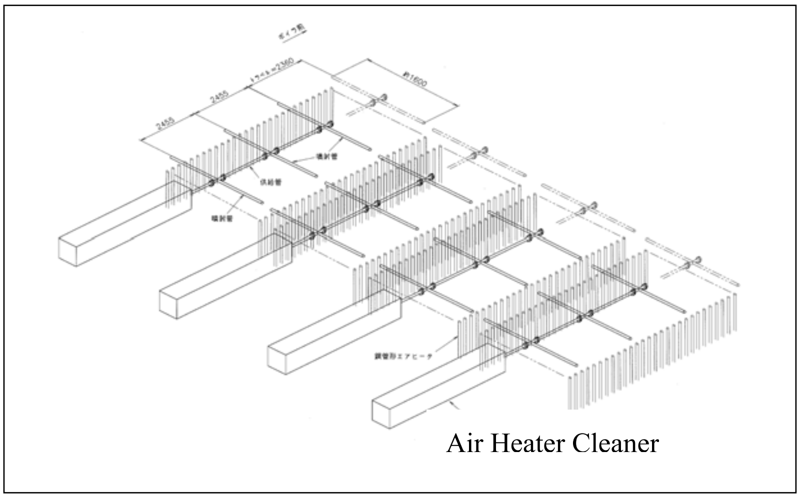


Fig.5.2-5 Air Heater Cleaner

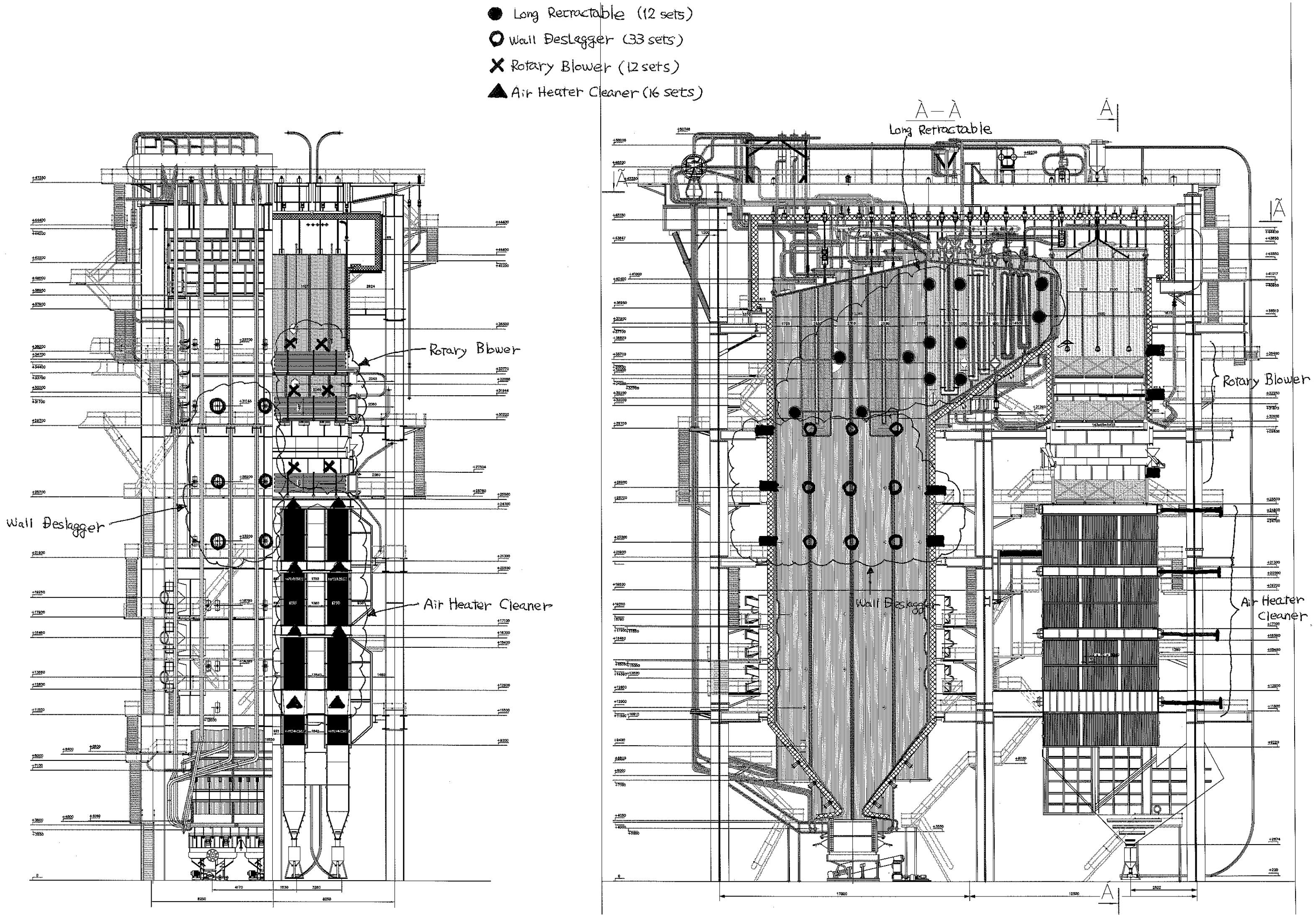


Fig.5.2-6 Soot Blower Arrangement

5.2.4 Renovation of Mill Roller

Repair of mill roller weld overlay is troublesome work, but recentry Japanese manufacturer recommends wear resistant mill roller made by high chrome cast steel mixed with ceramic, which does not require weld overlay. Cross section of material is shown in Fig.5.2-7. This material is also applied to table liner.

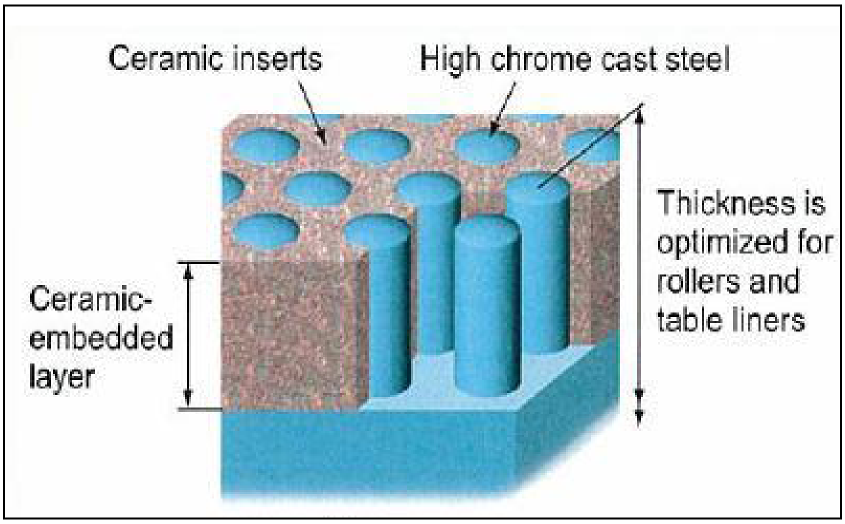


Fig.5.2-7 Cross Section of Ceramic Material

Comparison of existing roller and ceramic roller is shown in Fig.5.2-8. Colored parts in right side figure are provided. As for Journal housing, material is not changed, but fixing method is changed from key method to loose fitting, site modification is required.

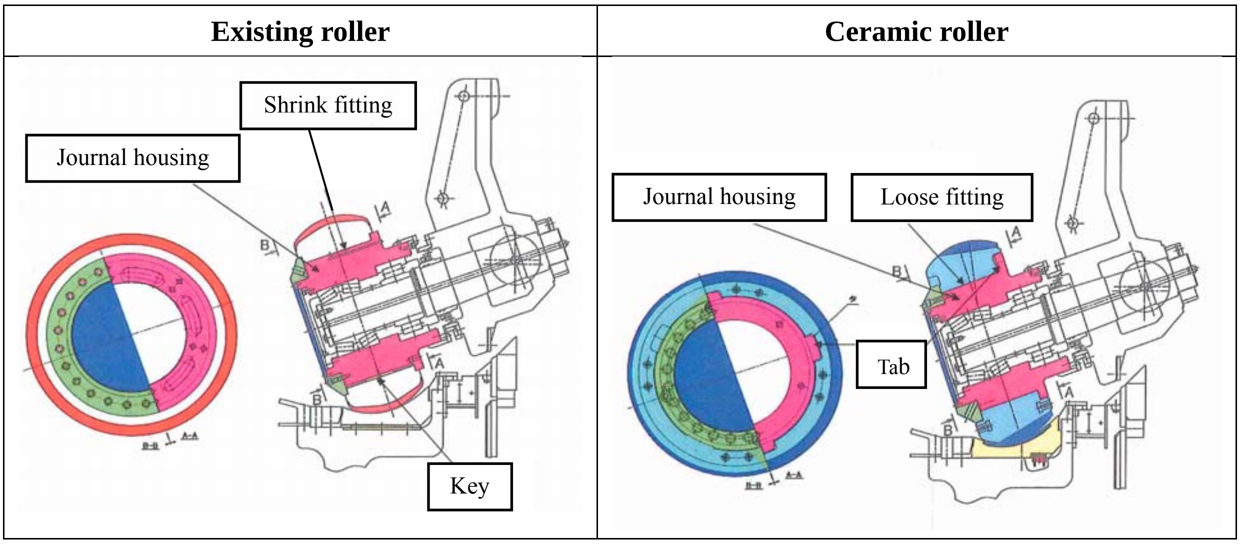


Fig.5.2-8 Comparison between Existing Roller and Ceramic Roller

4 mills are provided to one boiler. In case of NO.1 to NO.4 boiler, since cheaper rollers supplied by non-OEM are available, merit of change to ceramic roller is not expected. Therefore, rehabilitation of mills is planned for NO.5 to NO.8 boilers, and total number of rollers and table liners are as follows.

a) Roller
3 pcs/mill × 4 units/boiler × 4 boilers = 48 pcs

b) Table liner
1 set/mill × 4 units/boiler × 4 boilers = 16 sets

Example of ball park comparison between weld overlay type and ceramic roller of NO.5 to NO.8 boiler mills is shown in Fig.5.2-9 In this figure, according to the survey of existing mill, as for weld overlay type, it is assumed that five times weld overlay repair is possible, and roller is replaced after five times repair, on the other hand, ceramic roller can use for six years. Compared with weld overlay type roller, cost of ceramic roller is approx. half, and approx. 50% cost reduction is estimated during 20 years operation. Further, since ceramic roller does not require weld overlay repair, man power cost is also reduced, it is obvious that ceramic roller is beneficial.

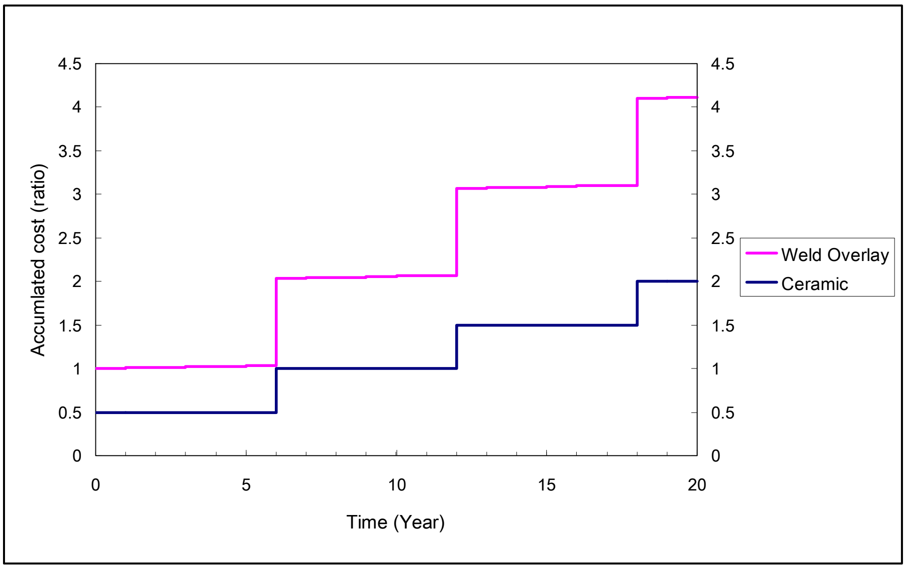


Fig.5.2-9 Cost Comparison

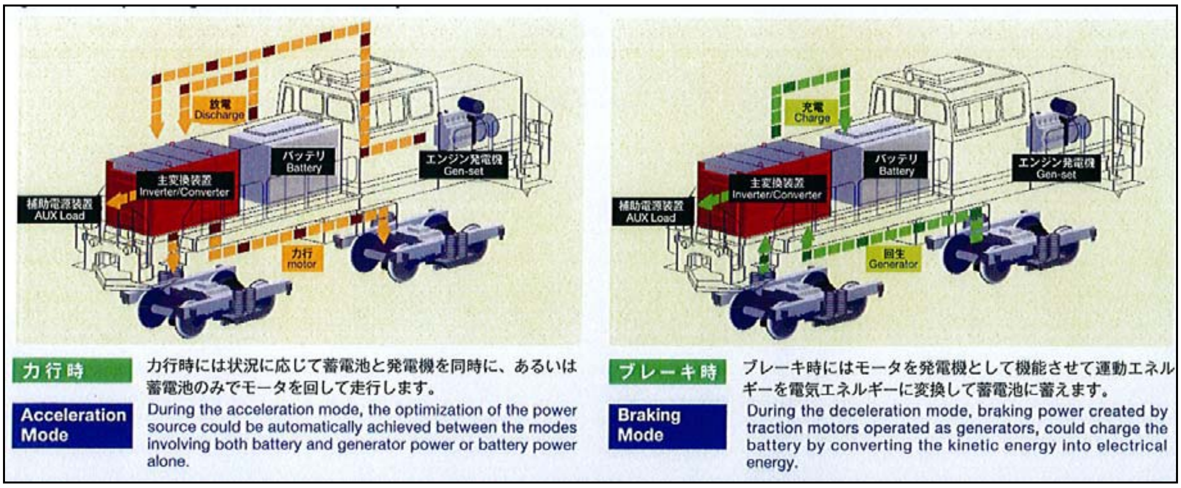
5.2.5 Shunting locomotive

TPP4 requested to replace existing diesel locomotive by hybrid diesel locomotive. Hybrid diesel locomotive has following characteristic in comparison with conventional diesel locomotive.

1) Low NOx
2) Low noise
3) Low fuel consumption

The hybrid diesel locomotive which is developed for practical use is only Japanese HD300 in the world. The locomotive mainly consists of generator set, battery and inverter/converter. Fig.5.2-10 shows hybrid system. During the acceleration mode, the optimization of the power source can be automatically achieved between the modes using both battery and generator, or battery power alone.

During the deceleration mode, using motor as generator, braking power is converted to electrical power by traction motor, and the power can be charged to battery.



（Source: Toshiba brochure)

Fig.5.2-10 Hybrid System

Table 5.2-10 shows major specification of HD300.

Table 5.2-10 Major Specification of HD300

Item	unit	
Type		HD300
Track gauge	mm	1,067
Weight	ton	60
Axle arrangement		4 axles (Bo-Bo)
Height of coupler	mm	880
Tractive effort	kN	196
Rated engine power	kW	500
Max. speed	km/h	110
Major dimension Length Width Height	mm	 14,300 2,950 4,088

（Source: Toshiba brochure)

Economic comparison between conventional diesel (existing type) and hybrid locomotive is shown below. Table 5.2-11 shows calculation result of the merit by the difference of fuel consumption. Operating hour is the maximum operating hour of conventional diesel locomotive in TPP4.

Table 5.2-11 Comparison of Fuel Cost

Item / Locomotive	Operation (hr/year)	Fuel consumption (ℓ/h)	Fuel price (Yen/ℓ)	Fuel Cost/year (1000Yen)
1.Diesel type (Existing type)	4500	17.00	95	7,268
2.Hybrid type	4500	10.88	95	4,651
Balance				2,617

Furthermore, Table 5.2-12 shows maintenance cost of conventional diesel locomotive in the case of adoption of same maintenance cost of diesel locomotive used in TPP4 in 10 years.

Table 5.2-12 Maintenance Cost

Year	1	2	3	4	5	6	7	8	9	10	Total
Maintenannce cost (1000 Yen)	1,200	5,200	6,500	5,200	6,500	1,200	5,200	6,500	5,200	6,500	49,200

From above, assuming maintenance cost of hybrid diesel locomotive is zero, its merit of fuel cost and maintenance cost during 10 years is approx. 52 million yen. It is said that the price of hybrid diesel locomotive is about two times of conventional diesel locomotive in Japan. Further, in case of use in Mongolia, modification of truck and coupling height is necessary to meet Mongolian specification, some initial development cost must be added, and this cost will give big impact to the price. Therefore, based on above mentioned cost difference, it seems that hybrid diesel does not have economical merit, JICA-ST does not include this item in the project.

5.2.6 Project Schedule

(1) Preparation of procurement and contract for project

Implementation plan of this project is studied based on the conditions of L/A of the end of February, 2013. Based on JICA's guidelines for procurement, considering project size, major items and their schedule are shown below.

Selection of consultant	5 months
Preparation of bid documents	2 months
Bid, evaluation, JICA's concurrence, effectiveness of contract	7 months
	(Total 14 months)

(2) Design, manufacturing, transportation, construction

As for site work of electro hydraulic governor and turbine control system modification to DCS, it is necessary to shut down existing turbines, schedule is studied based on the following conditions.

a) First modification is carried out in 2016 and modification of next unit is planed to start in 2017 in order to make it possible to reflect the modification result to the next unit.
b) Turbine shut down for modification work is not conducted from December to the end of February, when heat supply is indispensable.

Regarding to mill roller and soot blower, shut down of boiler is carried out sequentially. Scaffolding work, stage and support erection work, electrical work is to be carried out during boiler operation, as much as possible.

(3) Site construction work

Though it is necessary to consider weather condition of Mongolia enough, as for this project, it is not necessary to carry out outdoor concrete work and erection work, and all work is only indoor work, therefore, site work is not affected by weather condition.

(4) Overall schedule

Fig 5.2-11 shows standard project schedule based on JICA's procurement guideline.

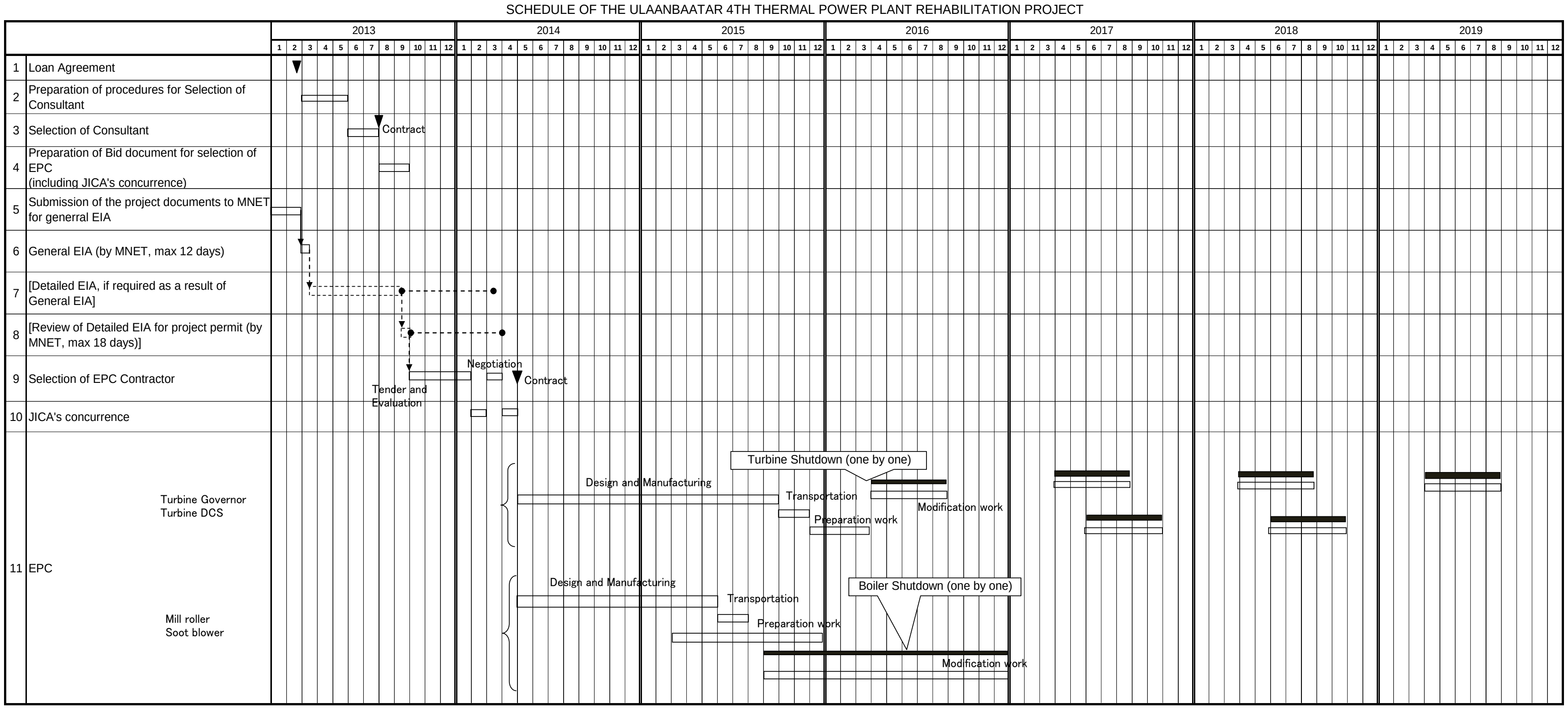


Fig.5.2-11　Project Schedule

5.3 Operational Effect Index

Operational Effect Index set as follows.

	Index	Situation	Target value (2021) 【After two(2) years of project completion】
Steam Turbine Generator #1	Availability factor (%)	58.0	61.5
	Net Power Generation（GWh/year)	252.9	270.1
Steam Turbine Generator #2	Availability factor (%)	93.6	97.1
	Net Power Generation（GWh/year)	699.0	724.8
Steam Turbine Generator #3	Availability factor (%)	71.6	75.0
	Net Power Generation（GWh/year)	426.8	447.8
Steam Turbine Generator #4	Availability factor (%)	96.5	99.9
	Net Power Generation（GWh/year)	615.1	638.1
Steam Turbine Generator #5	Availability factor (%)	90.4	93.8
	Net Power Generation（GWh/year)	369.0	386.1
Steam Turbine Generator #6	Availability factor (%)	90.0	93.4
	Net Power Generation（GWh/year)	428.7	447.2
Boiler #1	Availability factor (%)	79.0	80.5
Boiler #2	Availability factor (%)	77.4	79.0
Boiler #3	Availability factor (%)	42.5	43.4
Boiler #4	Availability factor (%)	86.4	88.1
Boiler #5	Availability factor (%)	69.1	70.4
Boiler #6	Availability factor (%)	87.8	89.5
Boiler #7	Availability factor (%)	62.7	63.9
Boiler #8	Availability factor (%)	93.7	95.6

Availability Factor : including standby time

5.4 Economic and Financial Evaluation

An economic and financial evaluation is made based on the Project construction cost and its effects shown in the previous section. Following are the assumptions.

5.4.1 Project Cost

Table 5.4-1 shows evaluation condition, Table 5.4-2 shows cost break down of each project items. Indicated costs are not finalized ones, and cost will be finalized by tender. Project Cost and Annual Fund Requirement are shown in Table 5.4-3, 5.4-4, 5.4-5.

Table 5.4-1 Common Terms for Appraisal

(1) Yen/$	US$ 1 =	78.2	Yen			
(2) LC/$	US$ 1 =	1394.8	Tg			
(3) Yen/Tg	Tg 1 =	0.06	Yen			

Price Escalation

(1) FC	2.1%	LC	9.0%

Physical Contingency

Construction	5.0%	Consultant	5.0%

Base Year for Cost Estimation: 2012/11

Schedule Start 2013/1 End 2019/12

Billing Rate of Consultant

	FC Yen	LC Tg
Pro-(A)	2,562,000	0
Pro-(B)	0	8,540,000
Supporting Staff	0	1,670,000

Others

Rate of Tax

VAT	10.0%	Import Tax	5.0%

Rate of Administration Cost

5.0%

Rate of Interest During Construction

Construction	1.40%	Consultant	0.01%

Rate of Commitment Charges

0.1%

Payment Method for Interest during construction and Commitment charge

loan-covered

Fiscal Year

Jan - Dec

Table 5.4-2 Cost Break Down for Package

Governor, DCS

item	unit	Quantity	Unit Price		Cost		Total
			Foreign	Local	Foreign	Local	
			yen	Tg	yen	Tg	yen
Governor	1	1	426,400,000	0	426,400,000	0	426,400,000
DCS	1	1	1,149,000,000	0	1,149,000,000	0	1,149,000,000
Erection	1	1	90,262,000	6,017,300,000	90,262,000	6,017,300,000	451,300,000
Transportation	1	1	24,000,000	600,000,000	24,000,000	600,000,000	60,000,000
Civil	0	0	0	0	0	0	0
Total					1,689,662,000	6,617,300,000	2,086,700,000

Soot blower

item	unit	Quantity	Unit Price		Cost		Total
			Foreign	Local	Foreign	Local	
			yen	Tg	yen	Tg	yen
Soot blower	1	8	190,000,000	500,000,000	1,520,000,000	4,000,000,000	1,760,000,000
Erection	1	1	0	4,000,000,000	0	4,000,000,000	240,000,000
Transportation	1	1	30,000,000	1,000,000,000	30,000,000	1,000,000,000	90,000,000
Civil	0	0	0	0	0	0	0
			0	0	0	0	0
Total					1,550,000,000	9,000,000,000	2,090,000,000

Mill roller and table

item	unit	Quantity	Unit Price		Cost		Total
			Foreign	Local	Foreign	Local	
			yen	Tg	yen	Tg	yen
Roller and table for #5 to #8 boiler	1	4	60,000,000	0	240,000,000	0	240,000,000
Erection	1	1	0	4,000,000,000	0	4,000,000,000	240,000,000
Transportation	1	1	10,000,000	330,000,000	10,000,000	330,000,000	29,800,000
Civil	0	0	0	0	0	0	0
Total					250,000,000	4,330,000,000	509,800,000

Table 5.4-3 Project Cost (Cost by Item)

Unit : FC, Total (Mil Yen)
LC (Mil Tg)

	Breakdown of Cost	Foreign Currency Portion			Local Currency Portion			Total		
		Total	JICA Portion	Others	Total	JICA Portion	Others	Total	JICA Portion	Others
1	Governor, DCS	1,690	1,690	0	6,617	6,617	0	2,087	2,087	0
2	Soot Blower	1,550	1,550	0	9,000	9,000	0	2,090	2,090	0
3	Mill roller and table	250	250	0	4,330	4,330	0	510	510	0
4	Price Escalation	304	304	0	7,668	7,668	0	764	764	0
5	Physical Contingency	190	190	0	1,381	1,381	0	273	273	0
6	Consulting Services	198	198	0	1,848	1,848	0	309	309	0
7	Land Acquisition	0	0	0	0	0	0	0	0	0
8	Administration Cost	0	0	0	5,026	0	5,026	302	0	302
9	VAT	0	0	0	10,053	0	10,053	603	0	603
10	Import Tax	0	0	0	3,319	0	3,319	199	0	199
11	Interest during construction	330	330	0	0	0	0	330	330	0
12	Commitment Charge	45	45	0	0	0	0	45	45	0
13	**Total**	4,556	4,556	0	49,242	30,844	18,398	7,510	6,406	1,104

Table 5.4-4 Project Cost (Cost by Year)

Unit : Mil Yen

Breakdown of Cost	Total	JICA Portion	Others
2013	46	41	5
2014	1,331	1,127	204
2015	1,578	1,345	233
2016	2,087	1,772	315
2017	901	771	129
2018	936	803	133
2019	632	548	84
Total	7,510	6,406	1,104

Table 5.4-5 Annual Fund Requirement

Unit : FC, Total (Mil Yen)
LC (Mil Tg)

Item	Total			2013			2014			2015			2016			2017			2018			2019		
	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
A. ELIGIBLE PORTION																								
Ⅰ) Procurement / Construction	3,983	28,996	5,723	0	0	0	764	4,819	1,053	741	8,646	1,260	1,175	8,040	1,658	492	2,673	652	502	2,913	677	308	1,905	422
Governor, DCS	1,690	6,617	2,087	0	0	0	338	331	358	253	993	313	0	993	60	422	1,654	522	422	1,654	522	253	993	313
Soot Blower	1,550	9,000	2,090	0	0	0	310	1,800	418	310	4,500	580	930	2,700	1,092	0	0	0	0	0	0	0	0	0
Mill roller and table	250	4,330	510	0	0	0	50	1,732	154	100	866	152	100	1,732	204	0	0	0	0	0	0	0	0	0
Base cost for JICA financing	3,490	19,947	4,687	0	0	0	698	3,863	930	663	6,359	1,045	1,030	5,425	1,355	422	1,654	522	422	1,654	522	253	993	313
Price escalation	304	7,668	764	0	0	0	30	727	73	43	1,876	155	89	2,233	223	46	891	100	56	1,120	123	40	822	89
Physical contingency	190	1,381	273	0	0	0	36	229	50	35	412	60	56	383	79	23	127	31	24	139	32	15	91	20
Ⅱ) Consulting services	198	1,848	309	25	160	35	36	287	53	30	264	46	34	295	51	28	306	46	25	300	43	21	235	36
Base cost	174	1,246	249	23	140	32	33	230	46	27	194	38	29	199	41	24	190	35	21	170	31	18	122	25
Price escalation	14	514	45	0	13	1	1	43	4	2	57	5	3	82	7	3	102	9	3	115	10	3	101	9
Physical contingency	9	88	15	1	8	2	2	14	3	1	13	2	2	14	2	1	15	2	1	14	2	1	11	2
Total (Ⅰ + Ⅱ)	4,181	30,844	6,032	25	160	35	800	5,106	1,106	771	8,911	1,306	1,209	8,335	1,709	520	2,979	699	527	3,213	720	329	2,140	458
B. NON ELIGIBLE PORTION																								
a Procurement / Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Base cost for JICA financing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Price escalation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Physical contingency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
b Land Acquisition	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Base cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Price escalation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Physical contingency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
c Administration cost	0	5,026	302	0	29	2	0	922	55	0	1,088	65	0	1,424	85	0	582	35	0	600	36	0	381	23
d VAT	0	10,053	603	0	58	3	0	1,843	111	0	2,176	131	0	2,848	171	0	1,164	70	0	1,200	72	0	763	46
e Import Tax	0	3,319	199	0	0	0	0	637	38	0	618	37	0	979	59	0	410	25	0	419	25	0	256	15
Total (a+b+c+d+e)	0	18,398	1,104	0	87	5	0	3,401	204	0	3,882	233	0	5,252	315	0	2,157	129	0	2,219	133	0	1,401	84
TOTAL (A+B)	4,181	49,242	7,136	25	247	40	800	8,507	1,310	771	12,793	1,539	1,209	13,587	2,024	520	5,136	828	527	5,432	853	329	3,541	542
C. Interest during Construction	330	0	330	0	0	0	15	0	15	33	0	33	56	0	56	66	0	66	77	0	77	84	0	84
Interest during Construction(Const.)	330	0	330	0	0	0	15	0	15	33	0	33	56	0	56	66	0	66	77	0	77	84	0	84
Interest during Construction (Consul.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D. Commitment Charge	45	0	45	6	0	6	6	0	6	6	0	6	6	0	6	6	0	6	6	0	6	6	0	6
GRAND TOTAL (A+B+C+D)	4,556	49,242	7,510	31	247	46	821	8,507	1,331	810	12,793	1,578	1,271	13,587	2,087	592	5,136	901	610	5,432	936	419	3,541	632
(1000 US$)	58,255.7	37,781.9	96,037.6	401.1	189.3	590.5	10,494.1	6,527.4	17,021.5	10,360.3	9,815.6	20,175.9	16,258.5	10,424.6	26,683.1	7,576.7	3,940.6	11,517.3	7,804.8	4,167.6	11,972.4	5,360.2	2,716.7	8,076.9
E. JICA finance portion incl. IDC (A + C + D)	4,556	30,844	6,406	31	160	41	821	5,106	1,127	810	8,911	1,345	1,271	8,335	1,772	592	2,979	771	610	3,213	803	419	2,140	548

5.4.2 Consideration of conditions

(1) Exchange rate

The evaluation was made on a US dollar basis, using the following exchange rates when necessary as indicated by JICA.

US$1 = Tg.1,394.8
US$1 = ¥78.2
Tg.1 = ¥0.06

(2) Consideration of conditions

a) As for grade up of governor system and turbine control system modification to DCS, it is assumed that additional 91MW power supply and 100 Gcal/h heat supply per one turbine are possible in 300 hours per year, by reliability improvement.
b) As for soot blower, it is assumed that availability of boilers would be improved by 2% per year, thereby increasing annual power generation and heat supply by 2%. Additionally, because of elongation of boiler operation hour, decrease of heavy oil consumption resulting from three times decrease of boiler start up per year is considered.
c) As for renovation of mill roller and table to ceramic type, JICA-ST regards difference of maintenance cost between existing weld overlay type and ceramic type, as a benefit.

(3) Project Effects

Table 5.4-6 shows the Project effects and the maintenance cost. In this table, effect of alternative plan in the economic evaluation is also indicated.

Table 5.4-6 Project Effects

Rehabilitation Project	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Power (GWh)	89.3	143.9	198.5	225.8	225.8	225.8	225.8	225.8	225.8	225.8	225.8	225.8	225.8
Heat (Gcal)	92,000.0	152,000.0	212,000.0	242,000.0	242,000.0	242,000.0	242,000.0	242,000.0	242,000.0	242,000.0	242,000.0	242,000.0	242,000.0
Coal consumption (1000 ton)	88.2	143.7	199.2	227.0	227.0	227.0	227.0	227.0	227.0	227.0	227.0	227.0	227.0
Water consumption (1000 ton)	252.0	372.0	492.0	552.0	552.0	552.0	552.0	552.0	552.0	552.0	552.0	552.0	552.0
Heavy oil (1000 ton)	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06
OM Cost ($thousand)	1,066	1,066	1,066	1,066	1,066	1,066	1,066	1,066	1,066	1,066	1,066	1,066	1,066
Decrease in OM Cost ($thousand)	0	-41	-41	-41	-41	-41	-3,085	-41	-41	-41	-41	-41	-3,085
Diesel Power Plant													
Power (GWh)	166.3	218.0	218.0	218.0	218.0	218.0	218.0	218.0	218.0	218.0	218.0	218.0	218.0
Heavy oil (1000 ton)	38.0	50.8	50.8	50.8	50.8	50.8	50.8	50.8	50.8	50.8	50.8	50.8	50.8
OM Cost ($thousand)	2,145.5	2,813.3	2,813.3	2,813.3	2,813.3	2,813.3	2,813.3	2,813.3	2,813.3	2,813.3	2,813.3	2,813.3	2,813.3
HOB													
Heat (Gcal)	92,000	152,000	212,000	241,994	241,994	241,994	241,994	241,994	241,994	241,994	241,994	241,994	241,994
Coal (1000 ton)	39.0	64.4	89.8	102.5	102.5	102.5	102.5	102.5	102.5	102.5	102.5	102.5	102.5
Station use (GWh)	6.4	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9
OM Cost ($thousand)	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0

Rehabilitation Project	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
Power (GWh)	225.8	225.8	225.8	225.8	225.8	225.8	225.8	225.8	225.8	225.8	225.8	225.8
Heat (Gcal)	242,000.0	242,000.0	242,000.0	242,000.0	242,000.0	242,000.0	242,000.0	242,000.0	242,000.0	242,000.0	242,000.0	242,000.0
Coal consumption (1000 ton)	227.0	227.0	227.0	227.0	227.0	227.0	227.0	227.0	227.0	227.0	227.0	227.0
Water consumption (1000 ton)	552.0	552.0	552.0	552.0	552.0	552.0	552.0	552.0	552.0	552.0	552.0	552.0
Heavy oil (1000 ton)	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06
OM Cost ($thousand)	1,066	1,066	1,066	1,066	1,066	1,066	1,066	1,066	1,066	1,066	1,066	1,066
Decrease in OM Cost ($thousand)	-41	-41	-41	-41	-41	-3,085	-41	-41	-41	-41	-41	-41
Diesel Power Plant												
Power (GWh)	218.0	218.0	218.0	218.0	218.0	218.0	218.0	218.0	218.0	218.0	218.0	218.0
Heavy oil (1000 ton)	50.8	50.8	50.8	50.8	50.8	50.8	50.8	50.8	50.8	50.8	50.8	50.8
OM Cost ($thousand)	2,813.3	2,813.3	2,813.3	2,813.3	2,813.3	2,813.3	2,813.3	2,813.3	2,813.3	2,813.3	2,813.3	2,813.3
HOB												
Heat (Gcal)	241,994	241,994	241,994	241,994	241,994	241,994	241,994	241,994	241,994	241,994	241,994	241,994
Coal (1000 ton)	102.5	102.5	102.5	102.5	102.5	102.5	102.5	102.5	102.5	102.5	102.5	102.5
Station use (GWh)	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9
OM Cost ($thousand)	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0

5.4.3 Economic Evaluation

(1) Assumptions

The evaluation method is the least cost method by use of alternative equivalent to the Project. Without the Project, it would be necessary to build an alternative with effects equivalent to those which the Project would bring about. A comparison was made between the Project and the alternative in terms of present value with the cost (construction cost + fuel cost + OM cost) of the alternative for the evaluation period as benefit stream and the cost (construction cost + fuel cost + OM cost) of the Project as the cost stream. The discount rate to calculate the present value was 10%.

A Diesel power plant and a HOB were adopted as the alternative with equivalent capabilities to the Project in terms of incremental energy production of power and heat.

The evaluation period is from 2013 to 2041, when is after 25 years service life, from 2017 of construction commencement of modification of first unit turbine DCS and governor, soot blower installation and mill roller replacement.

In calculating the benefit and cost, 0.98 was adopted as Standard Conversion Factor (SCF) as calculated in Table 5.4-7 to be applied to local portion for conversion to economic cost except fuel cost such as coal, heavy oil and water.

Table 5.4-7 Standard Conversion Factor

Standard conversion factor					
		2007	2008	2009	2010
Import amount	(US$ million)	2,062	3,245	2,138	3,200
Export amount	(US$ million)	1,948	2,535	1,885	2,909
Import duty	(Tg. million)	96,262	132,056	111,233	193,132
	(US$ million)	82	113	77	142
Export duty	(Tg. million)	6,218	8,782	4,755	190
	(US $million)	5	8	3	0
Export subsidy	(Tg. million)	0	0	0	0
	(US $million)	0	0	0	0
Standard conversion factor		0.981	0.982	0.982	0.977
	Exchange rate	1,169.85	1,166.06	1,437.91	1,355.93
	Average SCF= 0.98				

(from Mongolian Statistical Yearbook 2010)

The prices of coal, heavy oil and water used in the Project and the alternative were determined as follows.

a) Coal

Coal used for boilers of TPP4 and HOB was considered. The coal price was determined as the average price of Baganuur and Shivee Ovoo coals with 1:1 of consumption ratio. US$30/ton, assumed mine-mouth coal price used in the economic evaluation for TPP5 by ADB, was adopted as a basis. Added to that price, the transportation cost of US$ 3.43/ton, average price converted to US dollar of Tg. 4,523/ton for Baganuur and Tg. 5,032/ton for Shivee Ovoo, is considered and US$ 33.43/ton is used as coal price for this evaluation.

b) Heavy oil

Heavy oil used for start up of TPP4 boilers and for diesel power plant in alternative is considered. Heavy oil is purchased from private companies importing oil from abroad, so that the actual price paid by TPP4 of Tg. 777,931/ton, and US$ 558/ton was adopted after conversion in dollar .

c) Water

Water used for make up of cooling tower which cools turbine condenser cooling water, is considered. As for water, Tg.1,000/ton, and US$0.72/ton price used in the economic evaluation for TPP5 by ADB was adopted after conversion in dollar.

(2) Cost setting

The costs comprised the project construction costs, shown in the section 5.4.1, net of tax and price contingency, O&M costs and fuel costs. The station use of power was deducted from the power production.

(3) Evaluation

Evaluation indices are IRR for profitability, NPV for excess benefit and B/C for benefit-cost ratio.

Setting the following parameters, the results are shown in Table5.4-8.

- Project construction cost 100%=US$ 69.19 million (SCF was applied to the local currency portion of the Project construction cost of US$ 69.58 million)
- Alternative construction cost 100%=US$ 41.5 million (SCF was applied to the local currency portion of the Project construction cost of US$ 41.86 million)
- Coal price=US$ 33.43/ton
- Heavy oil price=US$ 558/ton
- Water price=US$ 0.72/ton
- Discount rate=10%

Table 5.4-8 Economic Evaluation with Alternative Diesel and HOB

(Unit: US$ in thousands)

No. of years from		Calendar year	Cost				Benefit						(D) - (A)
			Rehabilitation Project				Alternative Diesel Power & HOB (B)				Other Benefit (C)	Total Benefit (D=B+C)	
Construction	COD		Constr. Cost	O & M Cost	Fuel Cost	Total (A)	Constr. Cost	O & M Cost	Fuel Cost	Total	Decrease in Maintenance Costs		NET BENEFIT
1		2013	445			445	462			462		462	17
2		2014	13,685			13,685	4,634			4,634		4,634	-9,050
3		2015	15,157			15,157	24,381			24,381		24,381	9,223
4		2016	19,588	0	0	19,588	12,024	0	0	12,024	0	12,024	-7,564
5	1	2017	7,816	768	2,913	11,497		2,273	22,490	24,763	41	24,804	13,307
6	2	2018	7,759	1,334	4,767	13,860		2,941	30,485	33,425	41	33,466	19,607
7	3	2019	4,744	1,420	6,621	12,785		2,941	31,334	34,274	41	34,315	21,531
8	4	2020		1,463	7,548	9,011		2,941	31,758	34,699	41	34,740	25,729
9	5	2021		1,463	7,548	9,011		2,941	31,758	34,699	41	34,740	25,729
10	6	2022		1,463	7,548	9,011		2,941	31,758	34,699	3,085	37,784	28,773
11	7	2023		1,463	7,548	9,011		2,941	31,758	34,699	41	34,740	25,729
12	8	2024		1,463	7,548	9,011		2,941	31,758	34,699	41	34,740	25,729
13	9	2025		1,463	7,548	9,011		2,941	31,758	34,699	41	34,740	25,729
14	10	2026		1,463	7,548	9,011		2,941	31,758	34,699	41	34,740	25,729
15	11	2027		1,463	7,548	9,011		2,941	31,758	34,699	41	34,740	25,729
16	12	2028		1,463	7,548	9,011		2,941	31,758	34,699	3,085	37,784	28,773
17	13	2029		1,463	7,548	9,011		2,941	31,758	34,699	41	34,740	25,729
18	14	2030		1,463	7,548	9,011		2,941	31,758	34,699	41	34,740	25,729
19	15	2031		1,463	7,548	9,011		2,941	31,758	34,699	41	34,740	25,729
20	16	2032		1,463	7,548	9,011		2,941	31,758	34,699	41	34,740	25,729
21	17	2033		1,463	7,548	9,011		2,941	31,758	34,699	41	34,740	25,729
22	18	2034		1,463	7,548	9,011		2,941	31,758	34,699	3,085	37,784	28,773
23	19	2035		1,463	7,548	9,011		2,941	31,758	34,699	41	34,740	25,729
24	20	2036		1,463	7,548	9,011		2,941	31,758	34,699	41	34,740	25,729
25	21	2037		1,463	7,548	9,011		2,941	31,758	34,699	41	34,740	25,729
26	22	2038		1,463	7,548	9,011		2,941	31,758	34,699	41	34,740	25,729
27	23	2039		1,463	7,548	9,011		2,941	31,758	34,699	41	34,740	25,729
28	24	2040		1,463	7,548	9,011		2,941	31,758	34,699	41	34,740	25,729
29	25	2041		1,463	7,548	9,011		2,941	31,758	34,699	41	34,740	25,729
T O T A L			69,194	35,717	180,350	285,261	41,500	72,851	782,989	897,341	10,157	907,498	622,237
Present Value						98,564						241,263	
										EIRR			84.65%
										NPV			142,698
										B / C			2.45

The indexes are as follows:

Evaluation index	Result
EIRR	85%
NPV	US$ 143 million
B/C	2.45

5.4.4 Financial evaluation

(1) Assumptions

A benefit-cost analysis was made with incremental energy revenues as cash inflow and with the Project construction cost, O&M costs and financial costs as cash outflow.

As for discount rate, financial evaluation generally adopts WACC (Weighted Average Cost of Capital) as discount rate. TPP4 is state-owned and not listed in stock market, while Mongolia does not issue government bonds with long maturity such as 10 years, which usually shows the country's risk-free rate. Those factors do not allow calculation of WACC. However, setting the assumptions cited in the footnote to this page, WACC resulted in 8%[1], which was assumed to be temporary discount rate.

The evaluation period was from 2013 up to 2041 inclusive. The evaluation was made on a US dollar basis with the same exchange rates as for the economic evaluation. In calculating cash flow, market prices were adopted.

i) Benefit setting

In calculating incremental energy revenues for benefit, the incremental energy production was multiplied by the sales prices of power and heat shown below. As for sales prices, considered was the Price Indexation to be introduced from 2014, which will allow to gain a certain profit on a cost-recovery basis as long as price hike does not exceed the cap regulated by ERC. In order to equalize the imbalance between the power and heat prices, the prices were set in such a way as to add 10% of profit to the production costs in 2011.

a) Power

The sales price was Tg.39.17/kWh (US$ 0.028) in 2011, a level allowing about 20% of profit over the production cost of Tg.33/kWh (US$ 0.024). In the meantime, the heat sales price was below the production cost as stated below. In order to equalize the imbalance, 10% of profit was added to the production cost of power and the price thus arrived was converted to US dollar, which was US$0.026 to be power sales prices for 2011. Escalating that price by 2.1% annually – escalation rate for foreign portion indicated by JICA, the price resulted in US$0.029 to be the price for 2017.

b) Heat

The sales prices of heat for 2011 was Tg.6,576.6/Gcal(US$ 4.71), a level recovering about 50% of the production cost of Tg.12,792/Gcal (US$ 9.17). In order to gain 10% of profit over the

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[1] WACC=CAPM x E/(E+D) + average debt interest x (1-tax rate) x D/(E+D)
(WACC: weighted average cost of capital CAPM: capital cost E: capital D: debt) (E:D=Debt Equity Ratio TPP4 has E:D=7:3 in 2011)
CAPM=Riskfree rate + β x Risk premium TPP4 is state-owned and not listed. Assuming that there is no risk premium being state-owned, CAPM becomes equal to long-term government bond (adopting 11% of average rate of the Central Bank bonds from 2000 to 2011). The weighted-average capital cost was calculated by multiplying 11% by 7/10 to arrive at 7.7%. As for debt interest, currently TPP4 borrows mostly yen credit and assuming the interest rate at 1.4% and considering tax avoiding effect of corporate income tax (25%), the debt interest rate becomes 1%. For weighted average, that 1% was multiplied by 3/10 resulting in 0.3%. WACC is accordingly 8%.

production cost, US$ 10.09 was calculated to be heat sales price for 2011. Escalating that price by 2.1% annually, the price resulted in US$11.4 to be the price for 2017.

ii) Cost setting

The costs comprised the Project construction cost, O&M costs and financial costs. Fuel costs of coal and heavy oil were set as follows.

Baganuur coal was Tg.20,083.8/ton in 2011 and Shivee Ovoo Tg.14,993.4/ton. With 1:1 as consumption ratio of both coals, the average coal price converted in US dollar was calculated at US$ 12.57/ton. Escalating that price by 2.1% annually to be the price for 2017, the price resulted in US$ 14.23/ton. Adding the transportation cost similarly calculated of US$ 3.7/ton to that price, US$ 17.94/ton was set as coal price for 2017.

As for price of heavy oil, same price as used for economic evaluation, US$ 558/ton was set.

Financial costs were calculated with the following borrowing conditions considering possible ODA loan and assuming borrowing of the Project cost not covered by ODA loan from a commercial bank.

a) Loan amount: about 85% of Project construction cost
b) Interest rate:
   ODA: 1.4%/year (0.01%/year for consulting services)
   Commercial bank: 11% (assumed interest rate used in the financial evaluation of TPP5 by ADB)
c) Repayment period:
   ODA:30 years (grace period: 10 years)
   Commercial bank: 20 years (grace period: construction period)
d) Interest during construction:
   ODA: Included in ODA loan
   Commercial bank: self-finance
e) Commitment charge:
   ODA: 0.1%/year
   Commercial bank: 0.5%/year

(2) Evaluation

Evaluation indices are IRR for profitability, NPV for excess benefit, B/C for benefit-cost ratio and DSCR for soundness of repayment of principal and interest.

The case was set with the following parameters, the results are shown in Table5.4-9.

- Project construction cost 100%=US$ 96.04 million

- Sales price of power=US$ 0.029/kWh
- Sales price of heat=US$ 11.4/Gcal
- Coal price=US$ 17.94/ton
- Heavy oil price =US$ 558/ton
- Commercial interest rate=11%
- Income tax:=25%
- Discount rate=8%

Table 5.4-9 Financial Evaluation

Unit: US$ in thousand

Years from start of construction	Years from COD	Calendar year	Cash Inflow				Cash Outflow			Cash Balance		Commercial loan coverage	IRR Calculation
			Fund Injection	After-tax Profit	Depreciation	Total (A)	Disbursement	Debt Repayment	Total (B)	Yearly (A)-(B)	Accumulation	DSCR for loan	
-1		2013	590	-43	0	548	598	0	598	-50	-50		-598
1		2014	17,021	-398	0	16,623	17,316	0	17,316	-693	-743		-17,316
2		2015	20,176	-900	0	19,276	20,798	0	20,798	-1,522	-2,265		-20,798
3		2016	26,683	-1,551	0	25,132	27,748	0	27,748	-2,616	-4,881		-27,748
4	1	2017	11,517	-4,424	3,424	10,516	12,765	0	12,765	-2,248	-7,129		-11,738
5	2	2018	11,972	-3,417	3,424	11,979	13,407	0	13,407	-1,428	-8,557		-11,068
6	3	2019	8,077	-2,392	3,424	9,109	9,630	0	9,630	-521	-9,078		-6,019
7	4	2020	0	-1,034	3,424	2,390	783	0	783	1,607	-7,471		3,464
8	5	2021	0	-1,204	3,424	2,220	0	356	356	1,864	-5,607	1.78	4,247
9	6	2022	0	-1,165	3,424	2,259	0	356	356	1,903	-3,704	1.81	4,247
10	7	2023	0	1,439	3,424	4,862	0	3,320	3,320	1,542	-2,162	1.29	6,811
11	8	2024	0	-1,045	3,424	2,378	0	3,320	3,320	-941	-3,103	0.82	4,247
12	9	2025	0	-965	3,424	2,459	0	3,320	3,320	-861	-3,964	0.83	4,247
13	10	2026	0	-884	3,424	2,540	0	3,320	3,320	-780	-4,744	0.84	4,247
14	11	2027	0	-803	3,424	2,620	0	3,320	3,320	-700	-5,444	0.86	4,247
15	12	2028	0	-723	3,424	2,701	0	3,320	3,320	-619	-6,063	0.87	4,247
16	13	2029	0	1,801	3,424	5,225	0	3,320	3,320	1,905	-4,158	1.40	6,691
17	14	2030	0	-561	3,424	2,862	0	3,320	3,320	-458	-4,615	0.90	4,247
18	15	2031	0	-481	3,424	2,943	0	3,320	3,320	-377	-4,992	0.92	4,247
19	16	2032	0	-400	3,424	3,023	0	3,320	3,320	-296	-5,289	0.93	4,247
20	17	2033	0	-320	3,424	3,104	0	3,320	3,320	-216	-5,505	0.95	4,247
21	18	2034	0	-239	3,424	3,185	0	3,320	3,320	-135	-5,640	0.97	4,247
22	19	2035	0	2,164	3,424	5,588	0	3,320	3,320	2,268	-3,372	1.53	6,570
23	20	2036	0	-78	3,424	3,346	0	3,320	3,320	26	-3,346	1.01	4,247
24	21	2037	0	2	3,424	3,426	0	3,320	3,320	106	-3,240	1.03	4,246
25	22	2038	0	63	3,424	3,486	0	3,320	3,320	166	-3,073	1.04	4,226
26	23	2039	0	123	3,424	3,547	0	3,320	3,320	227	-2,846	1.06	4,206
27	24	2040	0	184	3,424	3,607	0	3,320	3,320	287	-2,559	1.07	4,186
28	25	2041	0	244	3,424	3,668	0	2,964	2,964	704	-1,856	1.20	4,166
			96,038	-17,008	85,591	164,621	103,044	63,432	166,476	-1,856			<1%
		Present value		-11,820	29,012		81,521	NPV	-47,296	Average DSCR=		1.10	
								B/C	0.42		Minimum DSCR=	0.82	

The indexes are as follows:

Evaluation index	Result
FIRR (after tax)	<1%
(before tax)	<1%
NPV (after tax)	US$ -47.3 million
(before tax)	US$ -46.7 million
B/C (after tax)	0.42
(before tax)	0.43
DSCR (after tax)	
Average	1.10
Minimum	0.82
DSCR (before tax)	
Average	1.12
Minimum	0.82

5.5 Conclusion

Project items, cost and expected effect are shown in below table.

These project items will contribute to power supply increase, reliability improvement of power and heat supply in CES around Ulaanbaatar city and improvement of financial situation of TPP4 by reduction of maintenance cost.

NO.	Project Item	Quantity	Renovation / Extension	Contents	Cost (Mil yen)	Expected effect
1	Turbine governor upgrade	6	Renovation	Upgrade of turbine speed governor system from mechanical hydraulic governor to electro-hydraulic governor	2,090	Approx. 3% availability increase by improve of turbine operation stability
2	Replacement of turbine control systems	6	Renovation	Upgrade of turbine control system from existing system to Distributed Control System (DCS)		Approx. 1% availability increase by improve of turbine operation stability
3	Installation of soot blower	8	Extension	Installation of soot blower system	2,090	Approx. 2% availability increase by improve of boiler operation stability
4	Renovation of mill roller	4	Renovation	Upgrade of coal mill roller and table from existing weld overlay type to ceramic type	510	Approx. 50% decrease of maintenance costs of mill roller and table

Chapter 6

Environmental and Social Consideration

TABLE OF CONTENTS

Chapter 6 Environmental and Social Consideration

LIST OF TABLES

LIST OF FIGURES

Chapter 6 Environmental and Social Consideration

6.1 Basic Aspects of Environmental and Social Conditions

6.1.1 Land Use

The topography of Ulaanbaatar City is mainly moderately rolling land. The vegetation is predominately steppe grassland except the urbanized central area and some of the hills around Ulaanbaatar City are covered with coniferous forests. Ulaanbaatar is located on the foothills of the Khentein Mountain with an average elevation of 1,350 meters above sea level and is surrounded by the following four mountains: Bogd Mountain (2,268 m) and Songino Khairkhan (1,652 m) to the south, Chingelte Mountain (1,949 m) to the north, and Bayan Zurkh Mountain (1,834 m) to the east.

Recent land use changes are shown in Table 6.1-1, comparing that the land use before 1990 and that in 2008. It is seen that the most significant increase occurred in ger districts, commercial areas, and warehouse areas, between pre-1990 period and 2008, while some decrease in area occurred for houses, dams and water.

The land use change on the national level is similar to that of Ulaanbaatar descried above. Land degradation in the last 4 years in Mongolia is shown in Table 6.1-2. “Pasture and other wood land” has been the major area suffering degradation, and “forest resources land” also shows a decreasing trend in the last 4 years.

Table 6.1-1 Land Use Changes Occurred in Ulaanbaatar City Before 1990 and in 2008

Land Use Class	Before 1990 (m^2)	2008 (m^2)	Changes (m^2)
Houses	7120	5214	-1906
Ger Districts	82730	147862	65132
Commercial Areas	1772	21241	19469
Central Government and Public Organizations	3850	5107	1257
Warehouse Areas	1920	55668	53748
Roads	9521	19508	9988
Dams	18000	16000	-2000
Water	23758	20758	-3000
Free Area	231001	54520	-176481
Overall	380886	380886	-

(Source: Amarsaikhan et al., 2011 Journal of Geography and Regional Planning 4: 471-481.)

Table 6.1-2 Land Degradation of Recent Years in Mongolia

	2007	2008	2009	2010
Area affected by degradation	14076.6	12341.4	11167.6	7359.6
Cultivated area	350.1	184.3	250.5	184.5
Pasture and other wood land	12305.4	11379.8	10015.4	6775.3
Cities, villages and other settlements	17.4	28.1	13.3	8.5
Forest resources land	1356.9	696.5	834.2	375.7
Water resourrces land	3.6	2.4	8.5	0.9
Digged and damaged land				
Due to geology exploration and prospectiong	1.7	2.6	2.7	1.9
Due to mineral resourses exploration	14.6	22	16.9	16.1
Due to defence and security operation	25.5	25.2	25.3	0.3
Due to construction of buildings	0.3	0.3	0.1	0.1
Due to construction and repair of roads	1.2	0.3	0.6	1

(Source: National statistical office of Mongolia. 2010 Mongolian Statistical Yearbook.)

6.1.2 Natural Environment

(1) Climate

In Mongolia, 2.8 million people live in a vast land (area of 1.56 million km^2) under severe climate conditions. The land spreads at high latitudes, over 1,500 meters above sea level, and is located up-country far from the sea, which results in significant temperature fluctuations over the year. It is extremely severe in the wintertime, with the temperature ranging from -10ºC to -30ºC in the daytime during mid-winter (late December and January) and the temperature can drop to as low as -40ºC at night. The long and harsh winter weather necessitates an unusually long heating season, with a total of eight months from mid-September to mid-May the next year. Ulaanbaatar City is the coldest capital city in the world, where almost half of the country's population resides. The Ulaanbaatar residents depend on a properly functioning heating system both to survive and to lead daily life. Reliable heating service is not merely a utility for residents and business entities; it is a matter of life and death.

The average annual precipitation in Ulaanbaatar City ranges from 249 to 261 mm, 75-80% of which occurs during the warm season, especially in July and August. In winter, threre is a precipitation of 5-7 mm. It rains for 40-70 days each year, it snows 25-30 days, and snow coverage is observed for 140-170 days. During the spring from April to May, it is dry and windy and the relative humidity is only 47% and 45% in April and May, respectively. The average annual relative humidity is 62%.

Air pollution is a major issue of the city, particularly in winter due to the pollution from old combined heat and power plants, coal-fired heat only boilers (HOBs) and stoves and in the spring due to sandstorms. It is estimated that 40% of the air pollution is from the household stoves, 30% from vehicle emission, 20% from HOBs in urban buildings, and 10% is from the existing coal-fired plants (Guttikunda, 2007)[*].

*Guttikunda, S. (2007). Urban Air Pollution Analysis for Ulaanbaatar, The World Bank Consultant Report.

(2) Surface and Ground Water

Mongolia is a water shortage country, compared to other countries. The country's environmental conditions present some challenges in the development and management of water resources. The average annual precipitation in the country is 250 mm, ranging from 400 mm in the north to less than 100 mm in the South Gobi region. Approximately 90% evaporates, 3.6% infiltrates into the soil, and only 6.3% forms surface water, which is transformed into usable water resources in surface water bodies (in most cases, the streams and reservoirs are completely frozen for a considerable portion of the year). Water resources in Mongolia are limited, highly vulnerable to climatic conditions, and unevenly distributed within the country. There are three main hydrological basins such as the Arctic and Pacific Oceans and Central Asian Endo-Archaic Basins. Rainfall is the principal source of water for the rivers of the region, while water from melting snow makes up 15-20% of the total annual runoff. About two-thirds of the surface runoff flows out of the territory of Mongolia.

(3) Geology

From the geological perspective, Ulaanabaatar City mainly consists of metamorphic, magmatic, and clastic complexes of all the geological ages. The surface of the mountain structures usually has Precambrian and Paleozoic Geosynclinal complexes, characterized to a significant extent by deformations and metamorphic changes. Mesozoic rocks and Cenozoic sediments cover the folded and faulted foundations. Small masses of granitic rocks also occur at various locations.

(4) Ecological Conditions

Vegetation coverage around the Ulaanbaatar Mountain and its surrounding area consists of a forest zone commonly called the Mountain Forest Steppe, which is a kind of coniferous forest, with Larchs (Larix siberica), Pine (Pinus sylvestrs), etc. According to the General Dendrologist of Ulaanbaatar City, the total area of the city's forest resources is 266,900 ha, 70% of which (188,900 ha) is covered by forests. These forests are comprised of various species, including Larch (Larix sibirica), Stone Pine (Pinus sibirica), Spruce (Picea ovobata), Pine (Pinus sylvestris), Aspen (Populus tremula), White Birch (Betula platyphylla), Poplar (Populus diversifolia), and Willow (Salix spp.).

The major animals reported in and around Ulaanbaatar City are: Tolai Hare (Lopus tolai), House Mouse (Mus musculus), Brandt's Vole (Microtus brandtii), Narrow-skulled Vole (Microtus gregalis), Daurian Pica (Ochotona daurica), Mongolian Toad (Bufo raddei), Siberian Salamander (Hynobius keyserlingi), Japanese Treefrog (Hyla japonica), Amur Frog (Rana amurensis), House Fly (Musca domestica), Siberian Moth (Dendrilimus superans), Gypsy Moth (Lymanthria dispar), Moth (Orgya antiqua), Jacobson's Spanworm (Erannis jacobsoni), Longicorn Beetles (Monochamus sutor and Acanthocinus carinulatus), Larch Bark Beetle (Ips subelongatus), Siberian Bark Beetle (Scolytus morawitzi). The major bird species reported in the area are: Black Kite (Milvus migrans), Horned Lark (Eremophila alpestris), Carrion Crow (Corvus corone), Raven (Corvu corax), Rook (Corvu frgilegus), Magpie (Pica pica), Pigeon (Columba livia), House Sparrow (Passer domesticus), Tree Srarrow (Passer mnotanus), Red-billed Chough (Pyrrhocorax pyrrhocorax), Eurasian Sparrowhawk (Accipiter nisus), Daurian Jackdaw (Corvus daurica). The major fish species enlisted in the Tuul River are :Siberian Grayling or Umber (Thymallus arcticus), Siberian Loach (Nemacheilus barbatus toni), Northern Pike (Esox lucius), Lenok (Brachymystax lenok), Spiny Loach-Siberian (Cobitus teania), Burbot (Lota lota), and River Perch (Perca fulviatilis). Occasionally, a few rare fish species are reported in the Tuul River, viz. Taimen (Hucho taimen), Siberian Roach (Rutilis rutilis), Mirror (Cyprinus carpio), and Amur Catfish (Parasilurus asotus).

The Red Data Book was compiled by the Mongolian government in 1999 to conserve the rare species of wildlife and later the researchers of the Netherlands, funded by the World Bank, renewed the red lists for mammals, fishes, amphibians, and reptiles in 2006, followed by the revision of the Red Data Book of Mongolia on Endangered Bird Species by the joint researchers' team, consisting of 50 researchers from 9 countries, including Mongolia and Japan in 2012.

6.1.3 Areas Inhabited by Indigenous People and Ethnic Minority

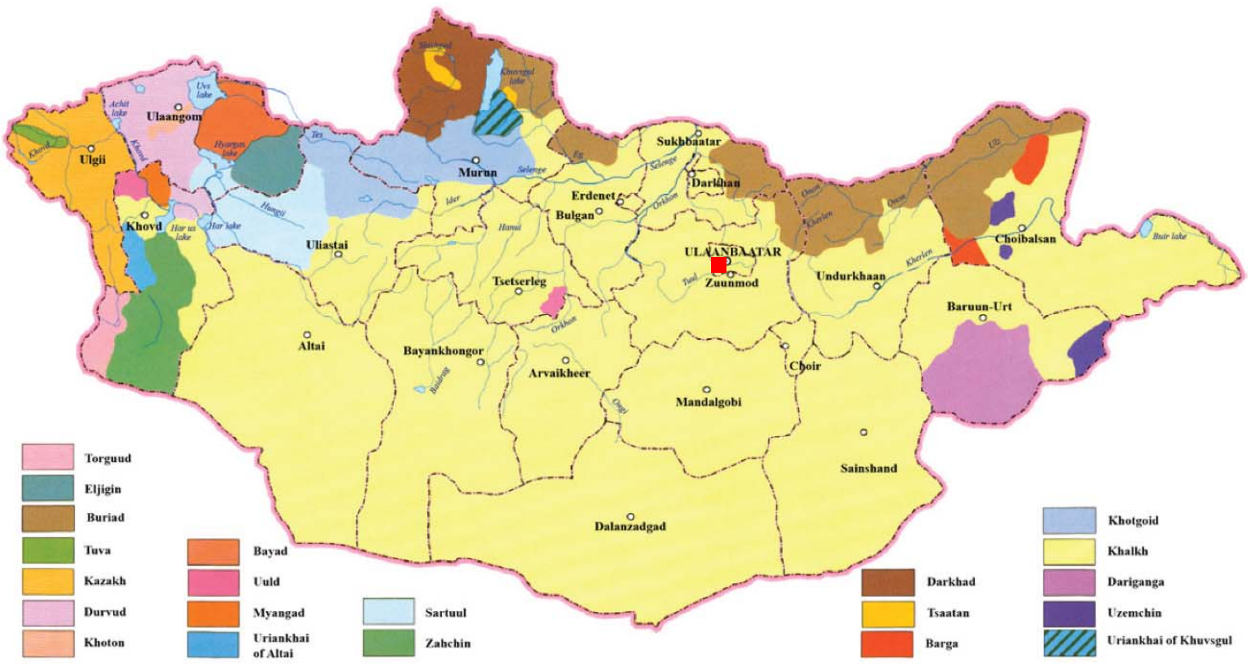
Mongolia has a small population that is spread over a vast area and most of its many cultures are deeply rooted in nomadic or semi-pastoral traditions. The core Mongolian ethnic group, Khalkha, is distributed all over the territory of the country, making up 80 per cent of the population (Table 6.1-3), although there are numerous ethnic minorities, including the Barga, Bayad, Buryat, Durbet and Tsaatan. Non-Mongolian communities, such as the Muslim Kazakhs inhabiting the western regions of the country, are composed of a number of ethnic divisions, such as the Dukha, Evenk, Tuvan and Urianhai, all of which have distinct languages and dialects.

The main residential area of these ethnic groups and the location of the proposed project are shown in Fig.6.1-1. There is no main residential area of ethnic minorities in Ulaanbaatar City, where the project is proposed.

Table 6.1-3 Major Ethnic Groups in Mongolia

Ethnic group	Population, thousands	% of total population
Mongolian citizens (all)	2,365.4	99.7
Halh	1,934.7	81.5
Kazakh	103	4.3
Dorvod	66.7	2.8
Bayaad	50.8	2.1
Buriad	40.6	1.7
Dariganga	31.9	1.3
Zahchin	29.8	1.3
Urianhai	25.2	1.1
Others	82.6	3.5
Foreigners	8.1	0.3
Total	2,373.5	100

(Source: Population and Housing Census 2000 Mongolia)



■: Location of the proposed project

(Source United Nation's Trust Fund for Human Security (2011). Comprehensive Community Services to Improve Human Security for the Rural Disadvantaged Populations in Mongolia.)

Fig.6.1-1 The Areas Where Major Ethnic Minorities Inhabited

6.1.4 Socio-economic Conditions

The key social indicators of Ulaanbaatar City are summarized in Table 6.1-3. Poverty incidence of Ulaanbaatar City has been lower than that of the national average since the 1990s and the difference between Ulaanbaatar City and the national average has been dramatically large since 2002.

Table 6.1-4 Key Social and Economic Indicators of Ulaanbaatar

Item	Indicator
Population	Total population in UB: 1,151,500 (total population of Mongolia: 2,780,800)
Land	Total area: 1564,9 km^2 with the urban area of 46 km^2
Administrative divisions	9 districts and 132 khoroos in UB ; 329 soums, 1,568 bags
Economy	･ GDP: 8255060.9 million tug (Per Capita 2,968.6) ･ Major industrial products: wool, cigarettes, pharmaceutical ･ Major crops: wheat, barley, corn, oats, potato, vegetables, fodder crops, technical crops ･ Major mineral resources: coal, gold, molybdenum, copper
Education and medical service	･ General educational schools in Mongolia: 751 (732,000 students) ･ General educational schools in UB: 207 ･ Vocational schools: 63 (46,100 students) ･ Higher educational institutions, colleges and universities: 108 (240,400 students) ･ State hospitals: 362 ･ Private hospitals: 1,113 ･ Family hospitals: 218

(Source: Mongolian Economic Yearbook 2010)

Table 6.1-5 Poverty Incidence (%) by Location

Lacation	1995	1998	2002	2006	2010
Urban	38.5	39.4	30.3	27.7	32.2
Ulaanbaatar	35.1	34.1	27.3	20.1	29.8
Aimag center	41.9	45.1	33.9	36.2	36.2
Rural	33.1	32.6	43.4	38.0	47.8
National average	36.3	35.6	36.1	32.6	39.2

(Source: Mongolian Economic Yearbook 2010)

6.2 Organizations Related to Environmental and Social Consideration

6.2.1 Laws and Guidelines Related to Environmental and Social Consideration

(1) Mongolian Law on Environmental Impact Assessment

The domestic laws of Mongolia are legislated based on the spirit of the Constitution of Mongolia and the provisions given in the international conventions ratified by the Mongolian government. The environment law system of Mongolia functions based on the Law on EIA and other laws related to typical environmental pollutions.

The purpose of the Law on Environmental Impact Assessment (established in 1998; revised in 2004) is the environmental protection, the prevention of ecological imbalance, the control of natural resource use, and the assessment of environmental impacts of projects and procedures for decision-making regarding the implementation of projects. The terms of the law apply to all new projects, as well as the rehabilitation and expansion of existing industrial, service, or construction activities and projects that use natural resources. The type and size of the planned activity define the responsibility of the relevant authority, which may be either the Ministry of Natural Environment and Tourism or the relevant aimag government (provincial government).

The processes required for EIA are illustrated in Fig.6.2-1. There are two types of EIA defined in the law: General EIA and Detailed EIA. To initiate a General EIA, the project undertaker submits a brief description of the project, including the feasibility study, technical details, drawings, and other information, to the MNET (or aimag government). The General EIA may lead to one of four conclusions: (i) no Detailed EIA is necessary; (ii) the project may be completed pursuant to specific conditions; (iii) a Detailed EIA is necessary; or (iv) cancellation of the project. The General EIA is free and usually takes up to 12 days. The scope of the Detailed EIA is defined by the General EIA. The Detailed EIA report must be produced by an authorized Mongolian company approved by the MNET by means of a special procedure. The developer of the Detailed EIA should submit it to the MNET (or aimag government). An expert from the organization that was involved in conducting the General EIA should make a review of the Detailed EIA within 18 days and present it to the MNET (or aimag government), which means an additional month is required in addition to the Detailed EIA process for MNET's inspection. Based on the conclusion of the expert, the MNET (or aimag government) makes a decision about the approval or disapproval of the project.

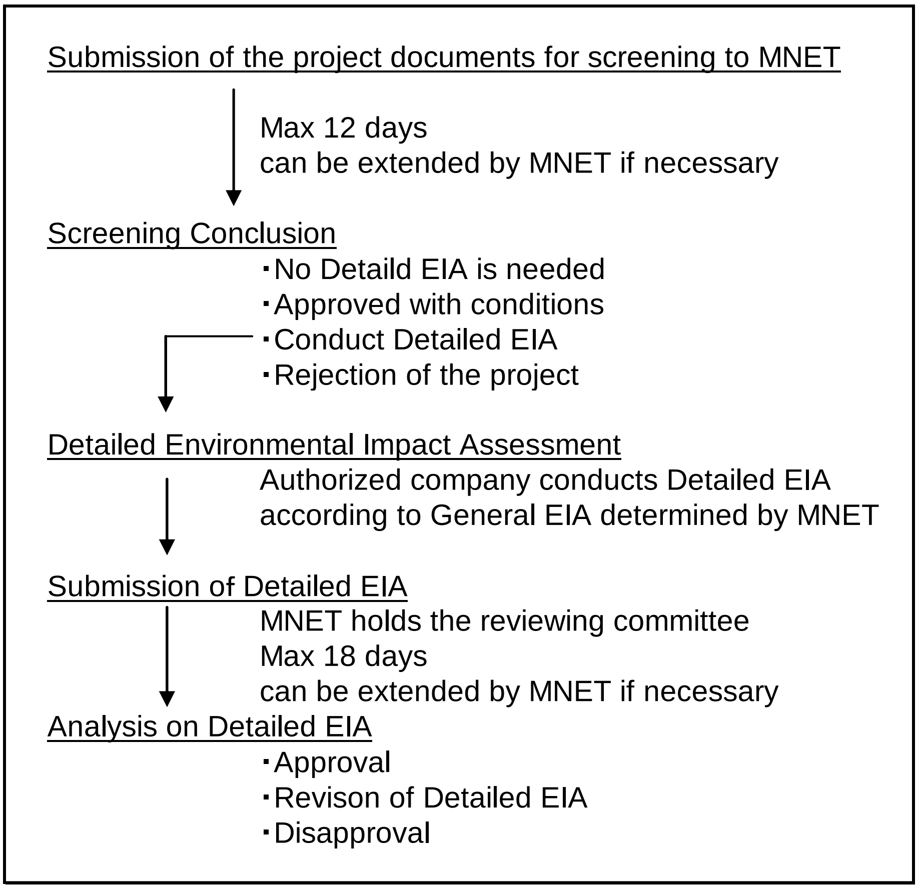


Fig.6.2-1 Environmental Impact Assessment Process of Mongolia

Table 6.2-1 shows the basic information about other environmental laws. According to MNET, some of these laws, including the EIA Law, are in the revision process; therefore, the revisions of these laws (date of enforcement, additional regulations, etc.) need to be checked again when an EIA will be conducted.

Table 6.2-1 Table of Current Environmental Legislation

Official Title of the Law	Date Adopted	Revision	English Translation Status
Mongolian Law on Environmental Protection	1995	2008	Official
Mongolian Law on Special Protected Areas	1995		Official
Mongolian Law on Buffer Zones of Protected Areas	1995		N/A
Mongolian Law on Air	1995	2010	Official
Mongolian Law on Water	1995		Official
Mongolian Law on Land	1995		Unofficial
Mongolian Law on Forest	1995		Official
Mongolian Law on Natural Plants Including List of Very Rare Plants	1995		Official
Mongolian Law on Hunting	1995	2000	Official
Mongolian Law on Wildlife	2000		N/A
Mongolian Law on Protection of Livestock Genetic Fund and Health	1994		N/A
Mongolian Law on Protection from Toxic Chemicals	1995		Official
Mongolian Law on Hydrology, Meteorology, and Environmental Monitoring	1997		N/A
Mongolian Law on the Protection of Forests and Grasslands from Wildfires	1996		N/A
Law of Mongolia for Forest Harvesting, and Wood Procurement and Use	1995		Unofficial
Mongolian Law on Underground Resources	1994		Unofficial
Mongolian Law on Mineral Resources	1994	1997	Unofficial
Mongolian Law for Water and Mineral Use	1995		Unofficial
Mongolian Law on Land Use Fees	1997		N/A
Mongolian Law on Fees for Use of Water and Mineral Water	1995		N/A
Mongolian Law on Forest Use Fees	1995	2000	N/A
Mongolian Law on Natural Plant Use Fees	1995		Unofficial
Mongolian Law on Fees for Hunting and Trapping and Licenses	1995		Unofficial
Mongolian Law on Use of Natural Resource Utilization Fees for Environmental Protection and Rehabilitation of Resources	2000		N/A

(Source The Asia Foundation (2009). A Mongolia Citizens Reference Book)

(2) International Environmental Guidelines

According to the JICA environmental guideline, the project needs to comply not only with the host country's laws but also with international legal systems and environmental standards. The systems related to environmental consideration of the Asian Development Bank are summarized below.

The major applicable ADB policies, regulations, requirements, and procedures for the EIA are (i) Environmental Assessment Guidelines of ADB (2003) and (ii) Safeguard Policy Statement (SPS, June 2009). The SPS provides the basis for EIA process and contents. With respect to the environment, these policies are accompanied by ADB Operations Manual, Bank Policy (OM F1, 2010). The purpose of the SPS is to establish an environmental review process to ensure that projects undertaken as part of programs funded under ADB loans are environmentally sound, are designed to operate in compliance with applicable regulatory requirements, and are not likely to cause significant environmental, health, or safety hazards. The SPS is generally understood to be operational policies that seek to avoid, minimize, or mitigate adverse environmental and social impacts, including the protection of the rights of those likely to be affected or marginalized by the development process.

The World Bank Group's Environmental, Health, and Safety Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice. The Guidelines are provided in four major categories, supplemented by relevant industry sector-specific guidelines. The General Environmental, Health, and Safety Guidelines apply as follows:

1) Air Emissions and Ambient Air Quality
2) Energy Conservation
3) Wastewater and Ambient Water Quality
4) Water Conservation
5) Hazardous Materials Management
6) Waste Management
7) Noise
8) Contaminated Land
9) Occupational Health and Safety
10) General Facility Design and Operation
11) Communication and Training
12) Physical Hazards
13) Chemical Hazards
14) Biological Hazards
15) Radiological Hazards
16) Personal Protective Equipment
17) Special Hazard Environments
18) Monitoring
19) Community Health and Safety
20) Structural Safety of Project Infrastructure
21) Life and Fire Safety
22) Traffic Safety
23) Transport of Hazardous Materials
24) Disease Prevention
25) Emergency Preparedness and Response

6.2.2 Environmental Standards

The environmental standards for ambient air quality in Mongolia exist only for urban areas. They include standards for NOx, SO_2, CO and dust; however, no standards are set for photochemical oxidants, benzene, etc. (Table 6.2-2). The emission standard for thermal power plants that is applicable to the existing thermal plants, i.e. this rehabilitation project, is MNS 5919 of 2008, which includes the standard for dust; on the other hand, the new emission standard, MNS 6298, was introduced in 2011 and will be applied when new power plants are constructed or the existing power plants undergo the modification of boilers (Table 6.2-3).

Water quality standards of Mongolia are presented in Table 6.2-4. The water quality is worsening in both urban and suburban districts of Ulaanbaatar City. With the shift to a market-based economy, many small businesses are springing up and are discharging wastewater directly into the Tuul River and its tributaries. These new industries are difficult to supervise and have resulted in enforcement problems. In addition, some ger districts have been built on low-lying land, resulting in groundwater contamination from latrines. At present, surface water pollution is an environmental issue which might need to be considered in the EIA process.

The current domestic standard of radioactive materials for building and construction is shown in Table 6.2-5. The Mongolian construction and building material sectors have a desire to utilize ash generated from the power/TPP plants. However, only a small quantity of ash has been utilized in Ulaanbaatar City, because the existing TPP plants in Ulaanbaatar City employ wet methods to handle ash, which makes it difficult to utilize ash.

The noise standards of Mongolia are shown in Table 6.2-6.

Table 6.2-2 Ambient Air Quality Standards

Item	Maximum allowable concentration of air pollutants in urban areas, adopted by the Ministry of Health of Mongolia (MNS4585, 1998)	Environmental, Health, and Safety Guidelines (World Bank, 2007)*
NO_x	0.085 mg/m^3 @day	0.2 mg/m^3 @hour
	0.085 mg/m^3 (absolute limit)	
SO_2	0.15 mg/m^3 @day	0.125 mg/m^3 @day
	0.5 mg/m^3 @20minutes	0.5 mg/m^3 @10minutes
CO	1.0 mg/m^3 @day	
	3.0 mg/m^3 (absolute limit)	
Dust (SPM)	0.15 mg/m^3 @day	0.15 mg/m^3 @day
	0.5 mg/m^3 (absolute limit)	

*World Bank (2007) Environmental, Health, and Safety Guidelines for Thermal Power Plants.

Table 6.2-3 Emission Standards

Item	Maximum allowable level of air pollutants from TTP and Thermal stations adopted by the Ministry of Health, and MNET of Mongolia (MNS 5919, 2008)	Maximum allowable level in flue gas of new thermal power plant and thermal plant adopted by the Ministry of Health, and MNET of Mongolia (MNS 6298, 2011)	Environmental, Health, and Safety Guidelines (World Bank, 2007)*
NOx	715 mg/ m^3	20% ≤Vdaf : 450 mg/m^3 10% ≤Vdaf<20% : 650 mg/m^3 Vdaf<10% : 1,100 mg/m^3	650 mg/m^3
SO_2	1,200 mg/ m^3	Population density > 10/km^2 : 600 mg/m^3 Population density ≤ 10/km^2 : 400 mg/m^3	2000 mg/m^3
CO	180 mg/ m^3	Population density > 10/km^2 : 300 mg/m^3 Population density ≤ 10/km^2 : 180 mg/m^3	
Dust (SPM)	200 mg/ m^3	50 mg/m^3–	50 mg/m^3

N.B. Excess O_2 content is 6 % for solid fuel plants.
MNS 5919 is applied to TPP4 in its present state. However, MNS 6298 will be applied when a boiler is modified.
Conditions applied to TPP4 in case of boiler modification are underlined.
Vdaf : Volatile matter (dry ash free)

*World Bank (2007) Environmental, Health, and Safety Guidelines for Thermal Power Plants.

Table 6.2-4 Surface Water Quality Standards of Mongolia (MNS 4586, 1998)

Sl.No	Chemical elements	Tolerance	Sl. No	Chemical elements	Tolerance
1	pH	6.5–8.5	15	Mo	0.25 mg/l
2	Dissolved oxygen (O_2)	6 > 4 mg/l	16	Cd	0.005 mg/l
3	Biological Oxygen Demand	3 mg/l	17	Co	0.01 mg/l
4	Chemical Oxygen Demand	10 mg/l	18	Pb	0.01 mg/l
5	NH_4-N	0.5 mg/l	19	As	0.01 mg/l
6	NO_2-N	0.02 mg/l	20	Cr	0.05 mg/l
7	NO_3-N	9.0 μg/l	21	Cr^{6+}	0.01 mg/l
8	PO_2-P	0.1 μg/l	22	Zn	0.01 mg/l
9	Cl	300 mg/l	23	Hg	0.1 mg/l
10	F	1.5 mg/l	24	Mineral oil	0.05 mg/l
11	SO_4	100 mg/l	25	Phenol	0.001 mg/l
12	Mn	0.1 mg/l	26	GINB	0.1 mg/l
13	Ni	0.01 mg/l	27	Benzo [a] pyren	0.005 mg/l
14	Cu	0.01 mg/l			

Table 6.2-5 Mongolian Standard of Limit of Radioactive Materials for Building and Construction (MNS 5072, 2001)

No.	Radium equivalent (Bq/kg)	Gamma ray dose (moP/h)	Type of building/ construction
I.	≦ 370	≦ 20	Living house, all kind of public buildings
II.	≦ 740	≦ 40	Only for industrial building and road construction
III.	≦ 2220	≦ 120	Road, building far from populated area and underground construction with 0.5m depth
IV.	≦ 3700	≦ 200	Only road and underground construction with 0.5m depth far from populated area
V.	> 3700	> 200	Shall not be used for any kind of buildings

Table 6.2-6 Noise Standard

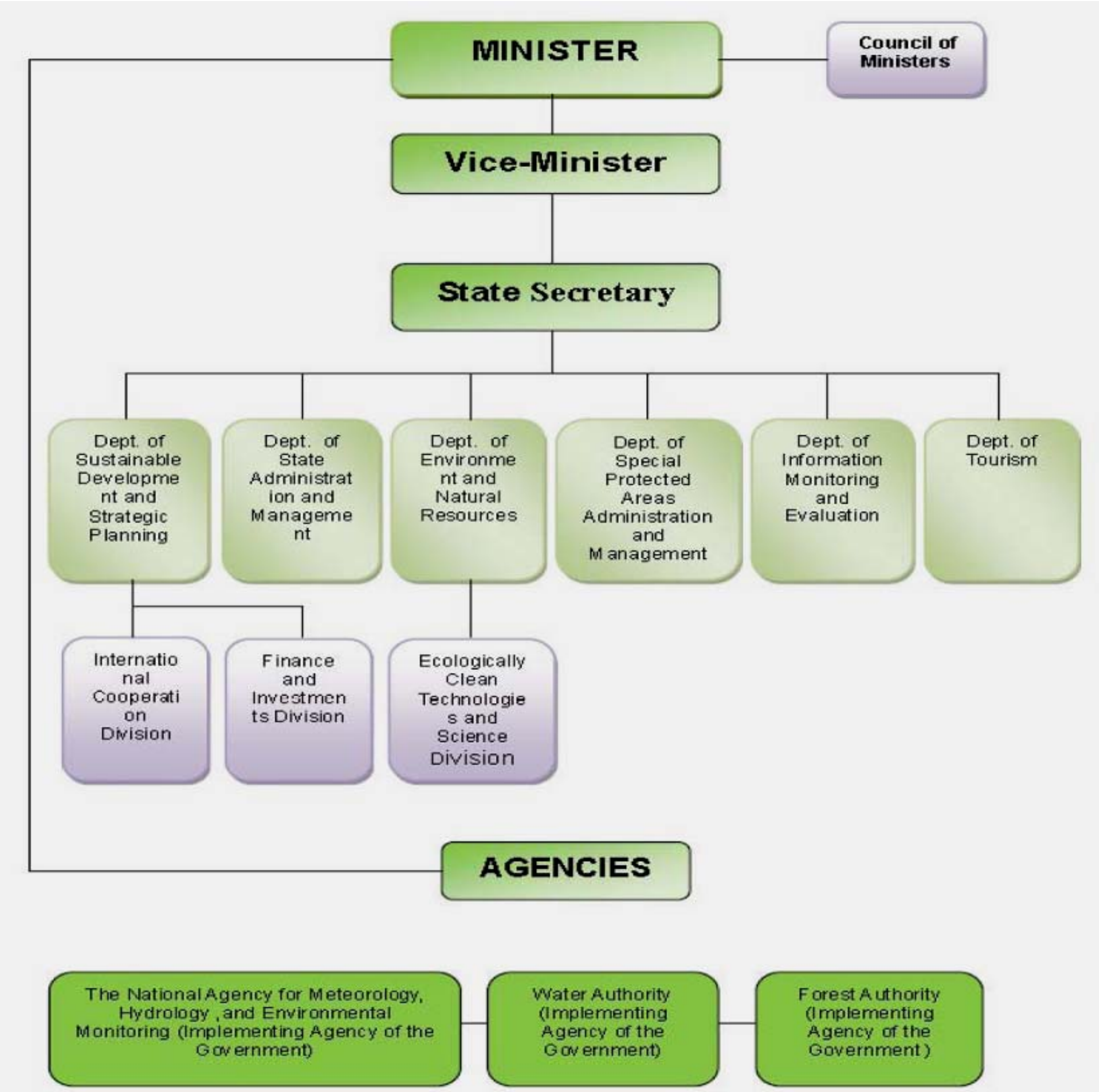
Item		Maximum allowable level of noise adopted by the Minister of Health, and MNET of Mongolia (MNS5003, 2007)	Environmental, Health, and Safety Guidelines(World Bank,2007)*
Industrial Area	Daytime (7:00-22:00)	60dB	70dB
	Nighttime (22:00-7:00)	45dB	70dB
Residential Area	Daytime (7:00-22:00)	60dB	55dB
	Nighttime (22:00-7:00)	45dB	45dB

*World Bank (2007) Environmental, Health, and Safety Guidelines for Thermal Power Plants.

6.2.3 Rolls of Relevant Properties

The MNET is the agency primarily responsible for the implementation of environmental policies in Mongolia, such as EIA process described in Fig.6.2-1. The organization chart of the MNET is shown in Fig.6.2-1. Under the MNET, there are several government agencies involved in the protection of the environment in Mongolia. The vice minister has the authority over the business projects, and the Department of Sustainable Development and Strategic Planning is responsible for the elaboration of strategic and sustainable development policies, plans, programs, and projects in areas within the mandate of the MNET. The department's functions include developing principles and policies and creating a positive legal environment for the preservation of ecological balance, in accordance with sustainable development objectives, by conducting policy research and developing policy options, designing projects and programs, offering policy leadership, and planning and initiating Mongolia's participation and actions with regard to major ecological issues at regional and international levels.

Moreover, from 2011, business owners need to monitor air quality once a month and report the results to the MNET, complying with the Law on Air, as revised in 2010. TPP4 is the largest user of water in Ulaanbaatar City, and might have a great influence on water usage in Mongolia. Although there are no means to measure the impacts (direct or otherwise) that the water usage by TPP4 has on the surrounding environment, the Water Supply and Sewerage Authority of Ulaanbaatar City, responsible for water supply in Ulaanbaatar, qualifies the amount of ground water intake by TPP4 every year.



(Source: ADB (2011). Mongolia: Ulaanbaatar Low Carbon Energy Supply Project Using a Public-Private Partnership Model)

Fig.6.2-1 Organization Chart of the MNET

6.3 Prediction of the Environmental Impact Assessment

6.3.1 Summary of the Latest EIA

Currently, this rehabilitation project is under preparation, which makes it impossible to proceed with an EIA process. Therefore, the content of EIA (period, items, mitigation measures, etc.) for this project is postulated here based on the review of the latest EIA report that was conducted for a turbine output improvement project in 2008 at TPP4 and in consideration of additional notes from interviews with TPP4 engineers in this survey. Although this latest EIA report was released four years ago, it is deemed appropriate to describe the EIA concerning this project by referring to this latest EIA report, as no major changes have been made since the time of its compilation.

A domestic environmental surveying company called EKOS conducted the EIA for the TPP4 during the period from January through December 2007 in accordance with the Environmental Impact Assessment Law described in 6.2.1. They submitted the draft version of the Detailed EIA report to the MNET after the survey and the Vice Minister of MNET authorized the TPP4 to continue its operation. In the EIA report, the overall picture of the environmental impacts of the power plant's activities is presented in a simple manner.

TPP4 is considered to be a power plant of 1 MW or larger in scale, as specified in the EIA Law, placing this project in the category of those that must be subjected to EIA though the screening process when this project will be implemented. The content of the EIA for this project will be determined after the details of the TPP4 rehabilitation plan are submitted to the MNET. However, it is presumed that the EIA for this project will be conducted along the same line as the 2008 EIA, which was done for a turbine output improvement for TPP4.The overview of the 2008 EIA report is given below.

(1) Air Pollution

The only measures for air pollution abatement in place are 250 m-high smokestacks and electrostatic precipitators. Neither flue gas desulfurization facility for SOx removal nor flue gas de-NOx facility for NOx removal, which are standard facilities for environmental measures used in Japan, is installed.

(2) Water Quality

In Ulaanbaatar City, there are no rivers that can supply water for use in a coal-fired power plant. Therefore, the generation of electric power is mostly dependent on underground water. This underground water comes from a pump house located 14.5 km from TPP4. In this pump house, a total of 12 pumps are installed. Underground water supplied by this pump house is used for power generation, heating, and general use for personnel in TPP4. About 99% of the water supplied and used in TPP4 is reused for ash treatment and 1% is discharged to the public sewer system.

Water used for cooling the steam and other purposes is pooled in a slurry pit, mixed with ash until it reaches the slurry form, and transported in a pressurized state through a steel pipe to the ash disposal site. There is a system for monitoring the amount of heavy metals and organic substances for wastewater. Since approximately 99% of wastewater is reused for ash treatment, this waste water does not affect the surrounding environment, as there are no residential houses in the surrounding areas of the ash disposal site. However, if land development activities such as housing or factory construction are conducted in areas near the ash disposal site, it will be necessary to take practical environment conservation measures and introduce a continuous monitoring system.

(3) Noises and Vibrations

The power plant is at a sufficient distance from the urban district of Ulaanbaatar City. Because there are no residential houses or business buildings nearby, the impact on the surrounding environment is thought to be minimal. Noises and vibrations, however, have an impact on employees of this power plant. A periodic medical checkup is held in June every year. If a recheck is necessary, another medical checkup is held in March. The major source of noise is the steam safety valve. Conditions of this valve are checked on a daily basis to prevent the occurrence of leaks and to reduce the level of noises. Although there are cases in which irregular noise exceeding the environmental standards occurs, no fundamental countermeasures have not been developed for it yet.

(4) Dust

Dust occurs in the fuel coal storage yard, except closed conveyors, because the yard is an open-air facility. The only countermeasure taken to prevent dust from scattering is water-spraying. Ashes collected by the electrostatic precipitator are pooled in a settling basin, mixed with used water, and transported to the ash disposal yard. Although ashes are covered by the soil, which is planted with trees and plants to prevent the ash and soil from being blown away, the effect of these measures are not observed.

(5) Management of the Ash Disposal Site and Recycle of Coal Ashes

Almost the total amount of coal ash was buried in the ash disposal site, while only a small amount of coal ash is recycled as cement materials; the reason that the vast majority of ash is simply dumped without being put to good use is: (i) it is difficult to satisfy the standards of radioactive materials for building and construction, shown in Table 6.2-5 with the wet method, which TPP4 currently adopts as the ash handling method, and (ii) there is no mature market for cement materials in Mongolia. With regard to (i), since the dry method is planning to be adopted from 2012, radioactive materials within ashes will be reduced. However, future prospects for the market are still unclear.

(6) Soil Contamination

In light of the use of heavy oil, the falling of soot and dust, and the existing conditions of the ash disposal site, concerns over possible soil contamination were mentioned. However, because problems have not occurred in the surrounding environment yet, there were no descriptions of countermeasures.

(7) Waste Management (including PCB)

Transformers and the PCB used in them, as well as those used in TPP2 and TPP3, are stored in TPP4. Under these circumstances, there is no other choice but to store them because the technology for making

PCB harmless is not yet established in Mongolia and, as a result, there is no market related to the disposal of equipment and materials containing PCB.

(8) Impacts on the Ecosystem

A survey of the animals, plants, etc., which inhabit the surrounding areas of TPP4 was conducted, and the results are summarized as follows: Only birds of urban areas, such as those of Columbiformes and Passeriformes were detected in the animal survey. Around the ash pond, no plants were recorded. Rare species included in the Red Data Book or on the Red List were not found.

(9) Asbestos

In Mongolia, Government Decision #192, which prohibits the import and use of asbestos, was released on 14 July 2010 but was later cancelled on 8 June 2011. Currently, there are no legal regulations concerning the use and disposal of asbestos in Mongolia.

However, MNET has been in dialogue with the Ministry of the Environment of Japan for cooperation in a range of environmental policies including the management of asbestos. The meetings of Japan-Mongolia Environmental Policy Dialogue has been held between the Ministry of the Environment in Japan and MNET since 2007 and the management of asbestos was clearly stated as an area of cooperation in which assistance was needed from Japan in the memorandum signed on 8 December 2011. It is expected that, with the assistance from Japan and other countries or organizations, Mongolia will work in the coming years to establish the necessary law, train people for the adequate handling of waste asbestos, and build a waste disposal site that can safety deal with waste asbestos.

6.3.2 Scoping of Environmental Impacts

The scope of the Detailed EIA is to be decided by the MNET in accordance with the Law on Environmental Impact Assessment. Since the scoping for this rehabilitation project under the Mongolian law will not be available after the submission of the technical details of the rehabilitation project, this section juxtaposes the environmental items selected in the latest EIA for reference purposes: Ecosystems, plants, underground resources, water recharge, geology, soil, water quality, climate, social hygiene and working environment (directly affected), geology, animals, forest, food production (indirectly affected) were selected as the EIA items based on the General EIA from the MNET. Considering that the similarity between this project and the project assessed in 2008, the EIA items which will be required for this project will be similar to those descried above.

6.3.3 Prediction of Environmental Impacts and Analysis of Alternatives

The Detailed EIA report must be produced by an authorized Mongolian company in accordance with the Law on Environmental Impact Assessment of Mongolia. Therefore, the official detailed prediction of environmental impacts based on the Mongolian law is not available and cannot be provided yet in this report. Instead, the methodology of Detailed EIA is given here for reference purposes. While qualitative predictions of environmental impacts on meteorology, geology, hydrology, water quality, soil, fauna, and flora were conducted, qualitative predictions and assessments were conducted on air quality, underground water, and radiation materials, which were judged to cause significant impact in the screening process. Qualitative predictions were conducted, using the Battelle system, an environmental monitoring system developed in the U.S. This method is one of the many environmental impact assessment techniques; however, it is not a standard EIA technique that is used in Japan. The 2008 EIA report introduces this method as an EIA technique that can provide a highly objective analysis of environmental impacts by calculating and comparing "environmental impact units" before and after the project, and also of the effectiveness of mitigation measures based on how much they can reduce the loss of the environmental impact units.

As an initial environmental examination, the indicative, qualitative prediction of the anticipated environmental impacts for the items selected by the scoping process in the latest EIA is given below in Table 6.3-1.

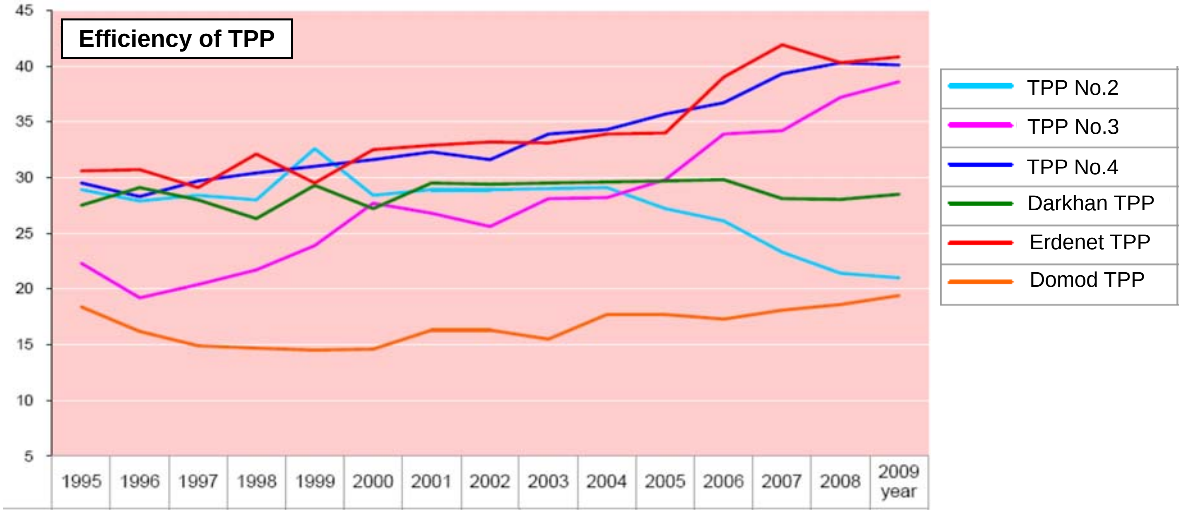
Table 6.3-1 The Prediction of Environmental Impacts

Category	Environmental Items	Evaluation		Description
		Const-ruction Phase	Opera-tion Phase	
Pollution Control	Air Quality	C-	D	**Construction Phase:** Generally, air quality degradation is possible in association with the operation of construction machines. The dispersion of asbestos is a matter of concern anticipated in the dismantling of the existing facilities. **Operation Phase:** Judging form the project characteristics, there is likely to be little impact air quality.
	Climate	D	D	There is likely to be little impact on the climate.
	Water Quality	D	D	No water contamination that would affect the surrounding environment is likely to occur.
	Soil	D	D	No work or operation that would cause soil contamination is not foreseen.
Natural Environ-ment	Fauna, Flora, and Ecosystem	D	D	Little impact on the fauna, flora, and/or ecosystem is anticipated, since the project is carried out within the existing power plant site and no rare species inhabits the site or the surrounding area.
	Forest	D	D	Little impact on forests is anticipated since the project is carried out within the existing power plant site.
	Water Recharge	D	D	No work or operation that would cause alternation to the flow regime or river bed of rivers near the site is foreseen.
	Geology	D	D	Little impact on the geology is anticipated since the project is carried out within the existing power plant site and no significant land cutting or filling is planned.
	Underground Resources	D	D	No work or operation that would affect underground resources is foreseen.
Social Environ-ment	Social Hygiene	C-	D	No work or operation that would affect the social hygiene is anticipated. However, health hazards in association with waste asbestos remains to be a matter of concern.

Category	Environmental Items	Evaluation		Description
		Const-ruction Phase	Opera-tion Phase	
	Working Environment	C-	D	**Construction Phase:** There is a possibility of noise-related problems in association with the operation of construction machines and/or vehicles. Care should be taken to prevent accidents during the construction work. Besides, health hazards in association with waste asbestos remains to be a matter of concern. **Operation Phase:** No work or operation that would affect the working environment is not foreseen.
	Food Production	D	D	Little impact on food production is likely since the project is carried out within the existing power plant site.

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown.
D: No impact is expected.

When the alternatives to this project (including no action alternative) are considered for comparative analysis, they must satisfy the demand of electricity and heat of Ulaanbaatar City sufficiently. Therefore, the use of a diesel power plant or an HOB or electricity import from other countries such as the Russian Federation or their combination will be potential alternatives to be considered in a future EIA for the TPP4 rehabilitation project. In the 2008 EIA report, environmental impacts of the proposed project were compared to the case in which energy demands were covered by other thermal power plants for the analysis of alternatives and it was concluded that the rehabilitation of TPP4 was superior to increasing the utilization of TPP2 or TPP3 based on the comparison of environmental loads from each plant. The rehabilitation of TPP4 will be the best plan among alternatives from the environmental perspective, since the efficiency of TPP4 is still higher than those of TPP2 and TPP3 (Fig. 6.3-1). Moreover, the rehabilitation of TPP4 will be beneficial from the environmental aspect of Ulaanbaatar City, since it is expected that the increased power and heat would contribute to the reduction of pollution from the ger area. Currently the construction of TPP5 at existing TPP3 site has been planned, but it is estimated that it will take longer time than the rehabilitation of TPP4.

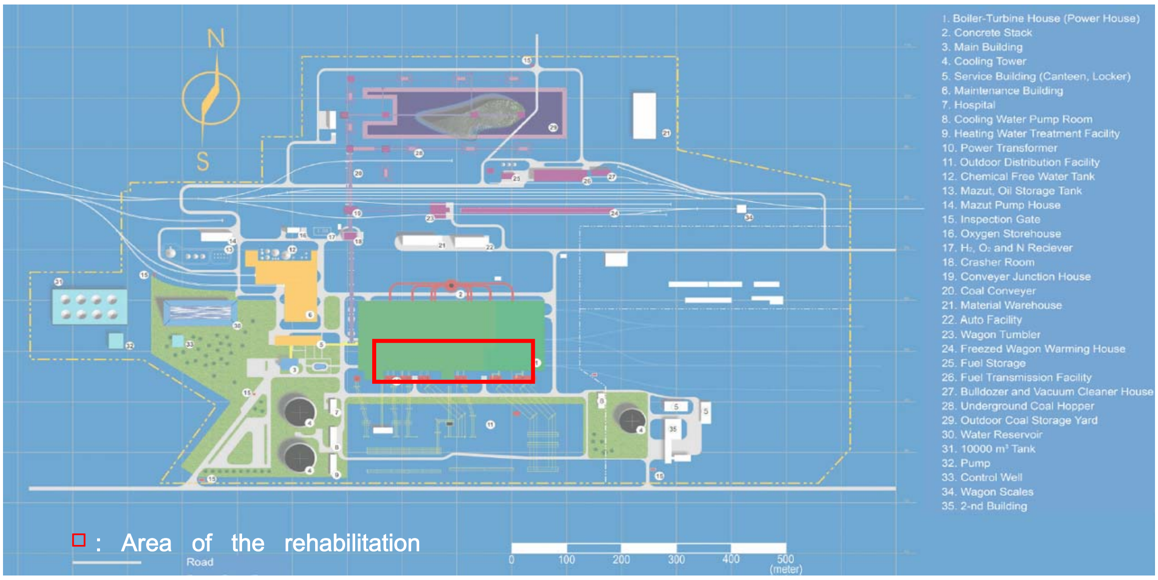


(Source: Adiyasuren and Tseyen-Oidov (2011). National Process to Establish New SO_2 Emission Standards in Mongolia. Presentation for Workshop of Trans-boundary Air Pollution in North East Asia)

Fig.6.3-1 Efficiency of Thermal Power Plants in Mongolia

6.3.4 Necessity of Land Acquisition or Involuntary Resettlement

The location of the rehabilitation project is shown in Fig. 6.3-2. No land acquisition will be required for the project as the rehabilitation of the power plant is to be conducted within the existing TPP4 plant site.



(Source of the layout of TPP4: JICA & Nippon Koei Co., Ltd. 2010. Survey for Promoting Aid Effectiveness in Energy Sector of Mongolia Final Report.)

Fig.6.3-2 Location of the Rehabilitation Project

6.4 Mitigation Measures and the Environmental Monitoring

6.4.1 Construction Phase

At the time of the preparation of this report, the legal EIA procedure under the applicable Mongolian law has not been initiated yet, as EIA is technically impossible pending the finalization of the technical specifications of the rehabilitation project. In this situation, major points of concerns that should be taken into account from the environmental point of view are described below. As is shown in 6.3.3, environmental impacts such as air pollution and poor working environment condition due to noise etc. are anticipated during the construction phase. In order to mitigate these negative impacts, the following measures are recommended based on the practice in Japan.

(1) Air Pollution

1) Measures to be taken during the construction phase

- To reduce the number of commuter vehicles by promoting the use of the public bus or the car sharing among the people coming to the site for construction work;
- To avoid the transportation of construction materials during the commuting time, if possible;
- To avoid the construction work during the night time, in principle;
- To avoid sudden accelerations and/or idling of vehicle engines;
- To use low emission machines whenever possible; and
- To educate workers about the above-mentioned mitigation measures by holding meetings periodically.

(2) Asbestos

1) Measures to be taken during the construction phase

a) Marking of the construction area

- The entry of unauthorized people to the construction area must be prevented by putting up off-limits signs and roping off the area.

b) Isolation of the construction area from neighboring area

- The workplace where thermal insulation materials containing asbestos exist must be covered by isolation materials (in Japan, special products called “grove bag” are commercially available) to prevent asbestos from scattering into the air during the working time.

c) Use of the protective equipment by workers in the construction area

- Workers must wear the protective equipment described below in the isolated workplace:

(i) Masks (self-contained breathing apparatus: equipment with an air tank that one should carry on the back, or supplied-air respirators: equipment which distributes compressed air to several workers through hoses);

(ii) Protective clothing (all-enveloping chemical-proof clothing: disposal protective clothing with distinguished dustproof ability);
(iii) Protective glasses and masks; and
(iv) Chemical-proof boots.

d) Removal of the materials containing asbestos from the construction area

- Asbestos must be removed from the workplace with special recovery bags to the temporary storage site (special recovery bags for asbestos are available in the market in Japan).
- Temporary storage sites for the isolation of asbestos must be secured by using containers and/or shelters.

2) Measures to be taken during the transportation and treatment of waste

- The transportation of asbestos from the temporary storage site to the final waste treatment site and the treatment of waste asbestos must be properly conducted by qualified industrial waste treatment companies or personnel.
- Consultation should be made with the MNET with regard to the proper disposal of asbestos, as necessary (considering the situation in Mongolia, the option of keeping waste asbestos in the temporary storage site might be the best option for the time being).

(3) Noise

1) Measures to be taken during the construction phase

- To reduce the number of commuter vehicles by promoting the use of the public bus or the car sharing among the people coming to the site for construction work;
- To avoid the transportation of construction materials during the commuting time, if possible;
- To take noise-reduction measures, such as the installation of a noise-reduction cover to industrial machines that produce noise and the establishment of noise barrier mounds; and
- To make efforts to maintain the good performance of construction machines through inspection and maintenance.

(4) Accident prevention

1) Measures to be taken during the construction phase

- To take measures to prevent traffic accidents by putting up signage, installing fences, and stationing traffic wardens etc., as necessary; and
- To educate workers thoroughly about safe driving and install warning signs and road-curve mirrors at the places where construction vehicles are prone to traffic accidents.

6.4.2 Operation Phase

No significant environmental impact is anticipated in the operation phase; however, it should be monitored for confirmation based on the results of the already on-going environmental monitoring that is conducted by TPP4. The environmental monitoring plan given in the latest EIA is show in Table 6.4-1. Natural environment protection implementation plans are additionally designed every year for mitigation measures during the power plant operation such as vegetation cover on filled ash pond (Fig.6.4-1). The recent natural environment protection implementation plans characteristically contain many items for CSR (corporate social responsibility). Results of these environmental monitoring, the progress of the annual natural environment protection implementation plan in the current year, and the natural environment protection implementation plan for the next year are reported to the MNET each year for review.

It is assumed that there is no environmental monitoring or environmental protection plan required especially for this project, because this rehabilitation project is to be conducted within the existing facility.

Table 6.4-1 Implementation Plan of the Environmental Monitoring

Item	Content	Responsible section	Frequency
1.Air Quality	Survey on SO_2, NOx, temperature, pressure, wind velocity, wind direction at the distance of 0.1, 0.5, 1, 3.5 km from the flue	Boiler parameter Section	4 times / year
	Survey on SO_2, NOx, CO_2, CO, O_2, dust at the flue, and entrance and exit of ESP of each boiler		dust: twice / month, residuals: once / week
2.Water Discharge	Survey on pH, EC, suspended solids, COD, SO_4, PO_4, crude oil at the ash pond or conjunct pipelines	Chemistry Department	4 times / year
3.Soil Contamination	Survey on pH, SO_4, heavy metal, crude oil at the distance of 0.5- 1 km from the crude oil tank	Chemistry Department	4 times / year

Table 6.4-2 Natural Environment Protection Plan for the Year 2011

No.	Content	Necessary funds (million Tg)	Period
Measures to prevent air pollution			
1	Plant 200 trees around the ash storage sites	5.0	2011-
2	Restore the original conditions of the ash disposal site, plant trees	7.5	2011-12
3	As a measure of nature preservation, plant trees along the retaining wall of the ash disposal site.	7.5	2011-12
4	Install emission and wind velocity measuring equipment.	15.0	2011-15
Countermeasures for soil contamination			
1	Conduct chemical surveys of water in pits of the wastewater treatment facility every month; publicize survey results.	Power plant research laboratory	Every month
2	Cover the floor of ash storage sites with asphalt.	20.0	2012-13
3	Conduct a survey to identify the sources of soot and dust generated by boilers and turbines. As the sources are identified, monitor the conditions of soot and dust generated.	-	Every month
4	While doing restoration work, remove soil from surrounding contaminated areas, and monitor the conditions of contamination.	0.5	Second quarter
5	Conduct audits by taking note of the amount and storage of harmful chemical substances. Do work to ensure that leaks do not occur.	-	At all times
6	The heavy oil section conducts surveys to collect data necessary for installing a system which screens heavy oil coming from the drainage hole.	1.5	Third quarter
Monitor, survey, research, and training			
1	Do research on components of flue smoke; extract materials generated from the 4th thermal Power Plant, and confirm the flue smoke standard for the plant.	0.5	Every month
2	Have a research institution do research to verify whether the quality of underground water and that of drinking water comply with the human sanitation guideline. Publicize the results of this research.	0.5	Every year
3	Conduct continuous monitoring on the electrostatic precipitators to ensure that they always operate as specified in the operation standard.	-	Every month
4	Prepare and display a poster about natural environment protection to enlighten employees on the importance of environmental protection.	3.0	Third quarter
5	Conduct monitoring to collect data on the 4th ash disposal site. Based on collected data, determine the number of years the ash disposal site can continue to be used.	-	At all times
Corporate social responsibility			
1	Produce the TV programs reviewing the cause of the air pollution around Ulaanbaatar.	With MMRE	2011-12
2	Make a brochure about the relationship between the air pollution and the human health.	With MMRE	2011-12
3	Inform the mass communication medias about the achievement of the energy conservation in TPP4	-	Every year
4	Install a new heating pump for the residents around the airport.	15.0	2011-14

(Source: Photo taken by a TPP4 engineer)

Fig.6.4-1 Vegetation Cover on Filled Ash Pond

6.5 Environmental Checklist

Environmental considerations concerning this rehabilitation project are shown in Table 6.5-1.

Table 6.5-1 Environmental Checklist

Category	Environmental Item	Main Check Items	Yes : Y No : N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) N (b) - (c) - (d) N	(a) Not yet prepared. (b) (c) (d) Not required.
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a) N (b) N	(a) Explanation is not given yet, but will be conducted when the project plan is fixed and ready. (b) -
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) Y	(a) Alternative plans were examined in the latest EIA and will be further examined in the future, since the Mongolian Law on Environmental Impact Assessment requires it.
2 Pollution Control	(1) Air Quality	(a) Do air pollutants, such as sulfur oxides (SOx), nitrogen oxides (NOx), and soot and dust emitted by the power plant operations comply with the country's emission standards? Is there a possibility that air pollutants emitted from the project will cause areas that do not comply with the country's ambient air quality standards? Are any mitigating measures taken? (b) In the case of coal-fired power plants, is there a possibility that fugitive dust from the coal piles, coal handling facilities, and dust from the coal ash disposal sites will cause air pollution? Are adequate measures taken to prevent the air pollution?	(a) Y (b) Y	(a) Monitoring of emission and ambient air quality is conducted once to four times a month to confirm that the power plant operations comply with the country's emission standards (refer to Fig. 6.5-1 and Fig. 6.5-2). (b) Water spraying, hardening treatment on coals, covering to transporter, and vegetation covering are conducted as anti-pollution measures.
	(2) Water Quality	(a) Do effluents including thermal effluents from the power plant comply with the country's effluent standards? Is there a possibility that the effluents from the project will cause areas that do not comply with the country's ambient water quality standards or cause any significant temperature rise in the receiving waters? (b) In the case of coal-fired power plants, do effluent from the coal piles and coal ash disposal sites comply with the country's effluent standards? (c) Are adequate measures taken to prevent contamination of surface water, soil, groundwater, and seawater by the effluents?	(a) Y (b) Y (c) Y	(a) It was confirmed that effluents from the power plant complied with the country's effluent standards by the preliminary survey conducted in 2011. (b) ditto (c) The bottom of the ash and wastewater disposal site is covered with the vinyl sheet.
	(3) Wastes	(a) Are wastes, (such as waste oils, and waste chemical agents), coal ash, and by-product gypsum from flue gas desulfurization facility generated by the power plant operations properly treated and disposed of in accordance with the country's regulations?	(a) Y	(a) There is no leakage from used oil tank observed.
	(4) Noise and Vibration	(a) Do noise and vibrations comply with the country's standards?	(a) Y	(a) It generally complies with the standards by noise reduction measures such as steam vent silencers, but irregular noise exceeding the environmental standards can occur. However, there are no significant impacts on the citizens, since there is no residential area around the projected site.

Category	Environmental Item	Main Check Items	Yes : Y No : N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
2 Pollution Control	(5) Subsidence	(a) In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence?	(a) N	(a) Extraction of groundwater is strictly controlled by the Water Supply and Sewerage Authority of Ulaanbaatar City.
	(6) Odor	(a) Are there any odor sources? Are adequate odor control measures taken?	(a) N	(a) Extraction of groundwater is strictly controlled by the Water Supply and Sewerage Authority of Ulaanbaatar City.
3 Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) There is no protected area within or around the project area.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Is there a possibility that the amount of water (e.g., surface water, groundwater) used by the project will adversely affect aquatic environments, such as rivers? Are adequate measures taken to reduce the impacts on aquatic environments, such as aquatic organisms? (e) Is there a possibility that discharge of thermal effluents, intake of a large volume of cooling water or discharge of leachates will adversely affect the ecosystem of surrounding water areas?	(a) N (b) N (c) - (d) N (e) N	(a) There is no ecologically valuable habitat within or around the project area. (b) There is no the protected habitat of endangered species within or around the project area. (c) Significant ecological impacts are not anticipated. (d) There has not been any adverse effect on the aquatic ecosystem observed by the relevant power plant (e) Discharge of thermal effluent will not occur.
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Are the compensations going to be paid prior to the resettlement? (e) Are the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(a) N (b) - (c) N (d) - (e) - (f) - (g) - (h) - (i) - (j) -	(a) This project is conducted within the existing power plant site. (b) - (c) - (d) - (e) - (f) - (g) - (h) - (i) - (j) -

Category	Environmental Item	Main Check Items	Yes : Y No : N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
4 Social Environment	(2) Living and Livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? (b) Is sufficient infrastructure (e.g., hospitals, schools, and roads) available for the project implementation? If the existing infrastructure is insufficient, are any plans developed to construct new infrastructure or improve the existing infrastructure? (c) Is there a possibility that large vehicles traffic for transportation of materials, such as raw materials and products will have impacts on traffic in the surrounding areas, impede the movement of inhabitants, and any cause risks to pedestrians? (d) Is there a possibility that diseases, including infectious diseases, such as HIV, will be brought due to the immigration of workers associated with the project? Are adequate considerations given to public health, if necessary? (e) Is there a possibility that the amount of water used (e.g., surface water, groundwater) and discharge of thermal effluents by the project will adversely affect existing water uses and uses of water areas (especially fishery)?	(a) N (b) Y (c) N (d) N (e) N	(a) - (b) There are paved roads within and around the project area and elementary school, kindergarten, and hospitals within 2 km of the project site. (c) - (d) - (e) -
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	(a) There is no archeological, historical, cultural, and religious heritage within or around the projected area.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N	(a) There is no significant landscape within or around the project area.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	(a) - (b) -	(a) There is no place inhabited by ethnic minorities and indigenous peoples within or around the project area. (b)
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not violate safety of other individuals involved, or local residents?	(a) Y (b) Y (c) Y (d) Y	(a) (b) (c) A "PDCA cycle" has been developed in which individual workers report dangerous or damaged sites and in response the repair work is done as soon as possible. (d) There have never been any cases of security guards violating the safety of other individuals or local residents in the projected site.
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce the impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce the impacts?	(a) Y (b) N (c) N	(a) Measures currently conducted in TPP4, such as water spraying and proper waste management, will be conducted during construction. (b) - (c) -
	(2) Accident Prevention Measures	(a) In the case of coal-fired power plants, are adequate measures planned to prevent spontaneous combustion at the coal piles (e.g., sprinkler systems)?	(a) Y	(a) Water spraying, coal-hardening treatment and periodical monitoring are conducted.

Category	Environmental Item	Main Check Items	Yes : Y No : N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
5 Others	(3) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) Y (b) - (c) Y (d) Y	(a) The current environmental monitoring will be continued. (b) Contents of current monitoring were decided by the EIA process, and the MNET confirms the results every year. Items of environmental monitoring are shown in Table 6.4-1. (c) The proponent secures the allocation of the necessary budget for monitoring every year at the time of budget preparation for the next year. (d) The results of environmental monitoring, and natural environment conservation plan, and the natural environment conservation plan for the next year are reported to the MNET every year.
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Power Transmission and Distribution Lines checklist should also be checked (e.g., projects including installation of electric transmission lines and/or electric distribution facilities). (b) Where necessary, pertinent items described in the Ports and Harbors checklist should also be checked (e.g., projects including construction of port and harbor facilities).	(a) N (b) N	(a) Installation of electric transmission lines and/or electric distribution facilities is not conducted in this project. (b) Construction of port and harbor facilities is not conducted in this project.
	Note on Using Environmental Checklist	(a) If necessary, the impacts to trans boundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as trans boundary waste treatment, acid rain, destruction of the ozone layer, and global warming).	(a) N	(a) There is no trans-boundary or global issue within or around the project area and this project will not cause significant effects on the global environment.

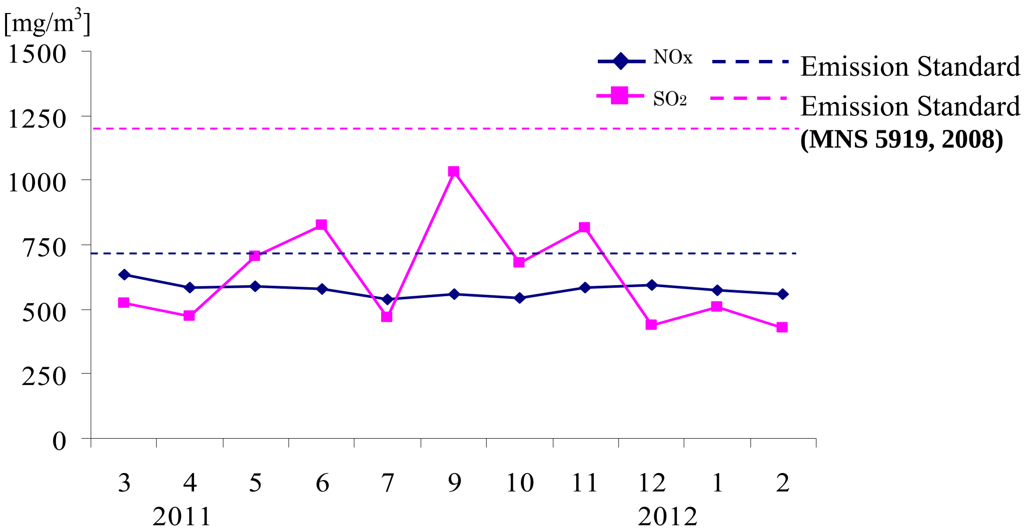


Fig.6.5-1 Results of SO_2, and NOx Monitoring by TPP4

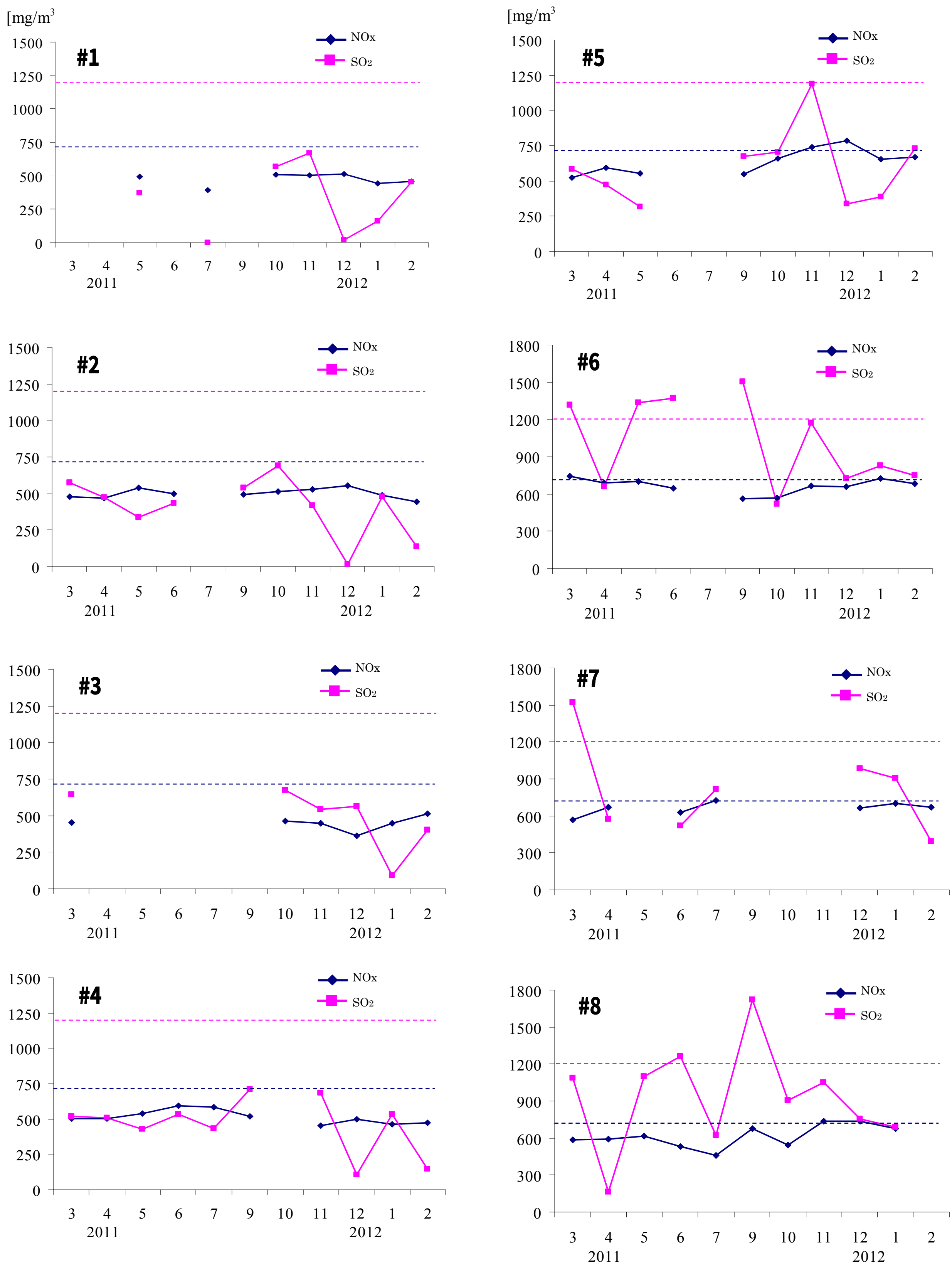


Fig.6.5-2 Results of SO_2, and NOx Monitoring of Boilers in TPP4

*Dashed lines indicate the emission standards (MNS 5919, 2008)

Chapter 7

Planning for Project Implementation Method

TABLE OF CONTENTS

Chapter 7 Planning for Project Implementation Method

LIST OF TABLES

LIST OF FIGURES

Chapter 7 Planning for Project Implementation Method

7.1 Procurement Method

JICA-ST organized the project implementation method and procurement method in order to carry out Japanese ODA loan project smoothly, which includes equipment procurement and consulting service, and studied about points to consider which affect smooth implementation of the project. Specifically, bidding method, contract conditions, selection of EPC contractor and considerations about contract management of executing agency during implementation of project.

7.1.1 Procurement Situation of Similar Project in Mongolia

(1) General Situation of Tender and Contract of Civil Construction Work

JICA-ST interviewed local civil contractor. This result is shown in Table 7.1-1.

Recently civil constructions in Mongolia are concerning to infrastructure development such as road, hotel, and bridge and mining construction. JICA-ST interviewed local civil contractor. This result is shown in Table 7.1-1. As for civil construction of power plant, they had experience of foundation construction relating to boiler modification work in Japanese ODA loan project in TPP4 Phase1(1995-2002) and Phase2 (2001-2008), and they attended tender and contracted as local contractor. Further, JICA-ST confirmed about situation of tender of new cooling tower construction in TPP4, as follows.

a) Advertising
The bid was announced in Mongolian daily newspapers which are "Daily news" and "Today", and by Mongolian Financial Ministry procurement’s website (“e-procurement.mn").

b) Qualification of bidders
There was a qualification.

c) Limitation of contractor’s country
They did not have limitation.

d) Employment of consultants
They did not employ consultants.

e) Evaluator of bidding
Proposal was evaluated by TPP4 tender committee.

f) Other
Construction supervision is implemented by TPP4 engineers

(2) General Situation of Local Consultant

JICA-ST interviewed local consultant. This result is shown in Table 7.1-1. There is a local consultant who has experience of local consultant in rehabilitation project in TPP3 and TPP4 including renovation of mechanical, electrical and control system, they have capability of local consultant of this project.

(3) General Situation of Local Erection Contractor

JICA-ST interviewed local erection contractor, and investigated procurement situation of construction material and equipment. This result is shown in Table 7.1-1. According to the result of interview, work experience, own erection machine, etc. of three major erection contractors in Mongolia are organized. They have experience of major overhaul and repair work in TPP2, TPP3 and TPP4, especially in boiler rehabilitation work in Japanese ODA loan project of TPP4 (Phase1 and Phase2). That contractor has experience to have received training about erection technique, schedule control and safety management education; therefore, it will be no problem about selection of contractor by LCB or ICB, and employment as EPC's sub contractor during implementation period.

(4) Procurement Situation of Construction Material and Equipment

JICA-ST investigated procurement situation of construction material and equipment necessary for construction work. This result is shown in Table 7.1-1.

Steel material can be procured form Darkhan steel mill in Mongolia and cement can be also procured in Mongolia. It is possible to procure steel, cement and wood from Russia and China. Regarding heavy erection machine, they do not have large crane (100 ton, 200 ton class） but they can arrange it from China.

Therefore as for procurement of materials for this project, procurement in Mongolia or import from Russia and China is possible.

Table 7.1-1 General Situation of Local Contractor and Consultant

Item / Company	Kind	Organization and Business outline		Completed works	Procurement of goods	Note
1.HASU MEGAWATT Interview with GANSUKH (Vice director)	・Mechanical construction ・Electrical construction ・Civil construction	・Material division ・Construction division ・Operation division Number of employees ; 500	1) Material division ・Number of employees ; 50 ・Procurement and material processing of steel (including boiler tube) 2) Construction division ・Number of employees ; 250 , (engineer ; 28) ・Mechanical Boiler maintenance, installation of auxiliary equipment of TPP, construction of piping of heating system, welding (including pressure parts),scaffolding, lagging, foundation construction ・Electrical cabling, installation and maintenance of motor 3) Operation division ・Number of employees ; 200 ・Operation of TPP (boiler, coal handling) ・Operation of heating system ・Operation of mining equipment	1) TPP4 Japanese ODA loan project (Phase1, Phase2) Modification of mill system (foundation construction) 2) Replacement of TPP4 boiler tube 3) Operation of TPP (boiler, coal handling) 4) TPP2,3,4 periodical inspection of boiler 5) Replacement of TPP3 high pressure steam piping (φ273x30mm) 6) Renovation of main piping of central heating system of UB 7) World Bank project Construction of sanitary water piping at the Ger district	1) Steel (steel frame, iron rod etc) From Russia, China	1) They have no experience about major foundation construction of TTP, (such as Turbine foundation cnstruction) but they can do foundation construction if detail drawings areprovided. 2) Bidder requested to cooperate for the South Gobi TPP 450MW project and the TPP5. 3) They have cranes. (10ton, 30ton) 4) English capability of Engineer Engineer can read drawing and specification in English, and they also can prepare report in English. 5) They have many machines (rolling, cutting, boring and bending) in their shop.
2.MEZ Interview with TSEELEESUREN (Project business investigation director)	・Mechanical construction ・Electrical construction	・Management division ・Construction division ・Project business investigation division Number of employees ; 200	1) Construction division ・Number of employees ; 150 ・Mechanical Boiler maintenance, installation of auxiliary equipment of TPP, Construction of pipelines of heating system, welding (including pressure parts) ,scaffolding, lagging ・Electrical cabling, installation and maintenance of motor 2) Project business investigation division ・Number of engineer ; 28 (electric ;3, mechanic ; 22 , financial ; 3) ・Design engineering	1) TPP4 Japanese ODA loan project (Phase1, Phase2) Modification of mill system 2) Modification of TPP2,3,4 boiler 3) Rehabilitation and modernization for increasing capacity of TPP4 turbine 4) Extension and modernization of piping of central heating system of UB 5) Construction of transmission line (35kV) 6) Construction of equipment of coal supply, compressor and cooling tower of TPP (18MW)	1) Steel (steel frame, iron rod etc) From Darkhan (steel factory), Russia, China 2) Cement From domestic cement factory 3) Chemical (ammonia, LP-gas, etc) From Russia, China (oxygen and nitrogen can be procured by domestic factories)	1) They have no experience about major foundation construction of TTP, (such as turbine foundation cnstruction) but they can major foundation construction when these detail drawings are provided to them. 2) English capability of engineer Engineer can read drawing and specification in English, and they also can prepare report in English. 3) Licence Operation licence (registration number ; 036/09) ・Erection and installation, repair & maintenance, testing & adjustment of boilers and piping with pressure of over 80kg/cm^2. ・Erection and installation, repair & maintenance, testing & adjustment of equipment with pressure less than 80kg/cm^2. ・Erection and construction, testing & adjustment of TPP with capacity of 0.1 - 100MW. 4) In the past two years they received all of the TTP4's construction. 5) They do not have large crane.（100ton, 200ton） but they arrange from China. other heavy machine (such as bulldozer, truck, crane (30ton class), backhoe) can procure in UB.
3.TEDMENT Interview with BYAMBADORJ	・Civil construction ・Building construction	・Civil and building division ・Management division (including realty business) Number of employees ; 180	1) Number of employees ; 30 (electric ;1, water supply ; 1 , civil and building ; 28) 2) Building construction, equipment foundation construction, completion test, consultant, real estate agent	1) Building construction of TPP4 2) Foundation and structure construction of coal conveyor 3) Construction of turbine, boiler, office building and reinforcing bar steel of stack of Tavan Tolgoi Uhaa Hu TPP	1) Wood, steel frame, iron rod From Darkhan (steel factory), Russia, China 2) Cement From Domestic cement factory	1) English capability of engineer Engineer can read drawing and specification in English, and they also can prepare report in English. 2) They have logistics company in China (Neimenggu) They established a joint venture together with China company in 2001. Number of employees ;1600
4.ENERGY INTERNATIONAL Interview with BADRAL（President） （Former MMRE）	・Consulting service ・Operation & Maintenance	Number of engineer ; 45		1) Feasibility study of construction of Tavan Tolgoi TPP (600MW) 2) Operation and maintenance of Oyu Tolgoi TPP 3) Consultant of construction of power supply and water supply system		1) English capability of engineer Engineer can prepare the drawing and report in English.
5. MON ENERGY Interview with ERDENE DALAI (President)	Consulting service	Number of engineer ; 25 (mechanical and electrical engineer) Plus 10 engineer / every project		1) Local consultant TPP4 Japanese ODA loan project (Phase2) 2) Feasibility study ・Aduunchuluun coal mine mouth TPP 300MW under coal liquefaction technology project ・Booroljuut coal mine mouth TPP 600MW ・Tsaidamnuur coal mine mouth TPP 300MW 3) Detail engineering and design drawing ・Single wire earth return (SWER) electricity distribution lines ・Heat station and district heating system in Ulaangom town		1) English capability of engineer Engineer can prepare the drawing and report in English.
6.NPC (National Power Consultant) Interview with BATTSEND (President)	Consulting service	Number of engineer ; 5-6 (mechanical and electrical engineer) C & I ; not permanent engineer		1) Local consultant GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit) gratis fund aid project 2) Feasibility study ・Mogoingol coal mine mouth TPP24MW ・Expansion of South Gobi TPP 600MW ・Central heating system (preliminàrily feasibility study) 3) Proposal for revision of energy low and saving energy		1) English capability of engineer Engineer can prepare the drawing and report in English.
7.IPC (International Power Company) Interview with ALTANGADAS (President) (Former TPP4 PIU project manager)	Consulting service	Number of engineer ; 5 (permanent engineer ; 2 (electrical engineer))		1) Feasibility study, detail engineering and design drawing of heating system 2) Consultant of transmission line ・6kV-10kV ・220kV (from China to Tavan Tolgoi (600km), from Tavan Tolgoi to Oyu Tolgoi (50km), from Tavan Tolgoi to Ulaanbaatar (550km))		1) English capability of engineer Engineer can prepare the drawing and report in English.

7.1.2 Procurement Procedure

(1) Basic Plan of Contract Clause and Contract Conditions

In implementation of this project, it is necessary to consider requirement of Japanese ODA loan project. Therefore, the employment of the overseas consultant having enough experience for similar supervising service is required. In addition, it is necessary to take pre-qualification procedure, preparation of bid document, bidding and evaluation, and contract in accordance with JICA's guidelines for procurement, and items relating to these procedure are organized below. Furthermore, about points to consider for smooth implementation during project period, JICA-ST confirmed the lessons in past Japanese ODA loan project and considering example of the project by other donors, the points to consider that the contract management (executing agency during a project period) should take are mentioned.

1) Procurement of services and construction material and contract scheme

   As mentioned above, this project is implemented in accordance with the scheme of Japanese ODA loans. Therefore, necessary employment of consultants and procurement of material should follow the guidelines for procurement and employment of consultant under Japanese ODA loans, published in April 2012.

2) Procurement method

   Procurement method will be implemented by above mentioned guideline.

   Based on the scale of the project, P/Q is necessary, and bidding process will be as follows, from project scale.

   i) P/Q is carried out by ICB.
   ii) As for EPC bidding by ICB, only bidders who passed P/Q can bid.
   Regarding the packages, erection work is not excluded from scope of EPC, and each package includes equipment and erection work.

3) Consulting service

   Before implementation of this project, it is planned to complete contract of employment of consultant according to JICA's guidelines. In selection of consultant, conditions specified in JICA's guidelines, and ICB is applied. If local organization request, direct contracting with certain consultant who is very familiar with similar project, may be possible.

   Significance of employment of overseas consultant is as follows.

   i) In Mongolia no rehabilitation of power station like this project scale is carried out since completion of Phase 2 of TPP4. Therefore, local consultant has no experience about detail design, preparation of bid document, bid evaluation, contract negotiation, construction supervision and coordination in commissioning of similar work in Mongolia.
   ii) Overseas consultant has enough knowledge about general contract condition, know-how and fair evaluation method in contract negotiation for selection of bidder in ICB.

iii) Overseas consultant has enough technical knowledge about design and construction of overseas similar power plant.
iv) The overseas consultant learned know-how for negotiation with EPC contractor in the construction management through experience of similar overseas project.

In this project, consultant will do various work about equipment procurement, such as design, preparation of bid document, bid evaluation, EPC contract negotiation, supervising work , coordination of commissioning work, therefore it is indispensable to select consultant who has enough experience of overseas project. It is recommendable to employ local consultant in order to support overseas consultant and to carry out consultant service efficiently.

Scope of consulting service is shown below.

i) Design for preparation of bid document
ii) Preparation of bid document
iii) Evaluation of P/Q
iv) Bid evaluation
v) Negotiation with EPC contractor
vi) Supervising work of construction
vii) Coordination between executing agency and EPC contractor during construction period
viii) Coordination between executing agency and EPC contractor during commissioning period

4) Bid document

As for each package, the bid document shall include all information necessary for bidder to enable to prepare for bid about equipment and services to be provided. Also conditions of contract (both general and special); technical specifications; list of goods or bill of quantities and drawings, as well as necessary appendices, specifying required guarantees are included.

AS for technical matter for procurement, requirement should be corresponding to ICB, JIS and other International standard.

If Mongolian standards which concerning to certain equipment and material are applied, it should be mention clearly in the bid document.

Regarding the preparation of bid document

i) Since it is necessary to control and proceed with whole project efficiently step by step during project implementation period, measure when design change occurs, including clear description about responsibility and responsible party, should be incorporated into bid document. The final responsibility is EPC contractor.
ii) Risk analysis during each phase of this project will be carried out, in reference with past example, after confirmation of lessons in past Japanese ODA loan project, and deal of contractual dispute between EPC contractor and executing agency should be incorporated into general condition clause of bid document.

iii) These contract condition will be prepared, investigating not only those of past similar Japanese ODA loan projects and JICA's guidelines, but also those specified in bid documents of projects by ADB and WB, and in FIDIC. Further in order to proceed with execution work smoothly, and to secure the skill of EPC contractor's engineer, schedule control and procurement of necessary materials, requirement relating to site work, such as site training of erection skill by equipment supplier, establishment of firm site organization by EPC contractor, and preparation of suitable erection machine for purpose, should be incorporated into bid document.

5) Advertising

Advertising follows JICA's guideline, and it is in English.

(2) JICA's Review of Procurement Process

JICA's review process during procurement process and consultant selection process after L/A is shown in Fig.7.1-1, and 7.1-2 respectively.

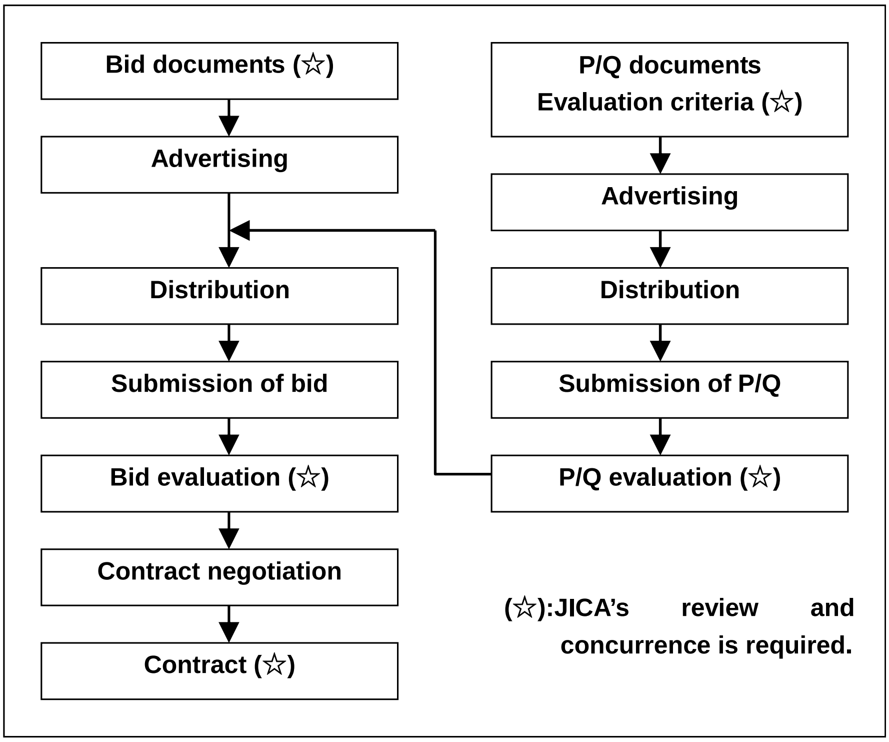


Fig.7.1-1 JICA's Review during Procurement Process

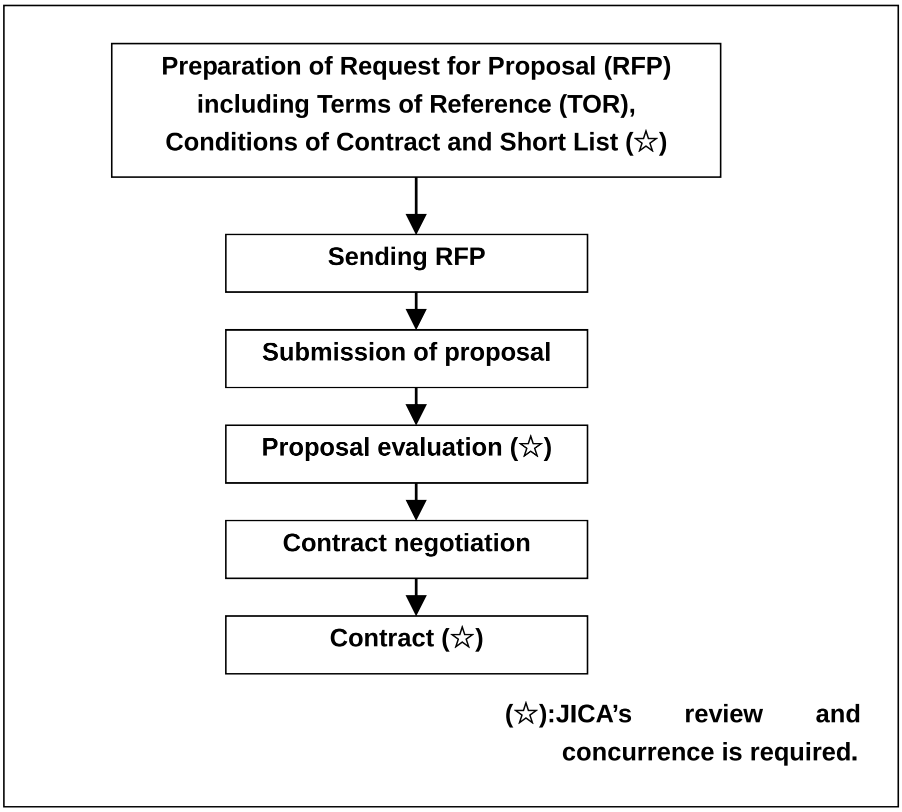


Fig.7.1-2 JICA's Review during Consultant Selection Process

7.2 Selection Plan of Construction EPC Contractor

(1) Prequalification of Bidders

Prequalification condition of bidders is in accordance with project scale and items specified in JICA's guidelines. Examples of P/Q conditions are shown below. As for financial condition, bidder is requested to submit audited financial statements, and should indicate soundness.

a) To request bidders to submit certification to prove experience of same type of equipment and good operation without trouble after several years from initial operation. (securement of reliability)

b) To have EPC function, and to be supplied by OEM supplier (including parent company and subsidiary company) which has EPC experiences. (clear responsibility of OEM. Avoiding risk of erection work)

c) When modification of existing facilities is necessary, it is necessary to include the design of modification. (avoiding completion risk)

d) To request bidders to submit certification to prove satisfaction of contract schedule, and to prove actual schedule. (avoiding schedule risk)

f) Financial soundness (avoiding completion risk)

(2) Adoption of LCB

As mentioned before (7.1.1), it is confirmed that erection contractors have capability of implementing erection work of this project, and that it will be no problem. Further, since it will help to increase job opportunities of local construction contractors, it should be planned to select contractors for boiler furnace wall modification and erection work of soot blowers (including erection material supply) by LCB.

(3) Plan for Tendering Package (Scope, order as per kind of work)

There are 2plans of tendering package, one is one package including equipment supply and erection work, the other is separate package depends on equipment , and comparison of two plans is shown in Table 7.2-1.

In case of separate package, following 2 packages may be preferable.

a) Turbine governor modification and modification of Turbine control system to DCS
b) Installation of soot blower and Renovation of mill roller

Table 7.2-1 Number of Package

Case	Case-1	Case-2
Package	Separate package (including equipment supply , erection and commissioning)	One package (including equipment supply , erection and commissioning)
Merit	1. It is easy for many bidders to participate in Tender. 2. Compared with Case-2, price may be reduced. 3. TPP 4 has experience of implementation.	1. Compared with Case-1, this case is beneficial for owner because coordination work between contractors can be decreased. 2. Owner's risk about coordination work decreases. 3. Compared with Case-1, more reliable and eligible bidders participate in Tender.
Demerit	1. More coordination works between contractors are necessary. 2. Owner has risk about coordination work. 3. As for modification work, Contractor has schedule risk if delay of shut down schedule of existing turbine will occur.	1. As for modification work, Contractor has schedule risk if delay of shut down schedule of existing turbine will occur.

7.3 Contract Management

(1) Project Monitoring and Management

The project schedule will be controlled effectively by "Monitoring & Management Unit" (hereinafter called PIU) which is mainly established by TPP4, after start of this project.

PIU will obtain information about progress of design, procurement, ordering, manufacturing, inspection, delivery, construction and erection activities from EPC contractor, then prepare monthly progress report highlighting the progress of various activities, identifying the problem and suggest corrective measures to be taken to keep project schedule.

In order to coordinate schedule of various work, it is necessary to hold coordination meeting periodically, and to coordinate work schedule. All of pending items will be discussed and solved between concerned parties, in weekly and monthly meetings.

It is envisaged that all outstanding problems would be sorted out during these meetings to ensure smooth execution of the project.

In order to keep project schedule, PIU should secure guarantee of necessary payment for construction work from financial agency.

PIU should monitor procurement schedule of main equipment and other equipment which has long leading time.

(2) Management of EPC Contract

In order to ensure the efficient and proper execution of the project, PIU should discuss with consultant and contractor.

7.4 Risk Analysis during Implementation Period

In order to ensure the efficient and proper execution of the project, it is necessary for PIU to carry out risk analysis and to take countermeasures to avoid risk. Currently following three risks are considered.

a) Risk in management process during engineering stage
This risk is design defect and discrepancy risk, and this risk causes various improper issue and defect in whole design. This risk also expands “project delay risk” in the next stage of “project execution”.

b) Risk in management process during execution period
This risk causes project schedule delay, completion delay, further shortage of budget, necessity of additional investment and increase of generation cost. Finally, it may cause decrease of investment efficiency.

c) Operational Risk
This risk disturbs proper operation of power station after start of commercial operation, causes efficiency decrease. Finally, this risk also causes increase of generation cost, and aggravate financial situation.

7.5 Safety Management during Implementation Period

(1) Safety Equipment and Improvement of Working Environment

It is necessary to secure safety equipment and to improve working condition. Safety condition of TPP4 is as follows.

1) Lots of” Safety first” indications are posted in TPP4, enlightenment for safety is carried out.
2) Workers are well wearing helmets and safety shoes.
3) Safety goggles (for working area with chemicals, steam and spark), dust mask (dusty area such as inside of ESP) and safety belt (Higher level work) are not wearing.
4) Lighting facilities are not enough in the dark area.
5) Use of temporally lighting equipment in dark area work is not enough.
6) Safety meeting is not carried out.

(2) Safety Countermeasure

1) Improvement of safety awareness

   Because of above situation (1), improvement of safety awareness is necessary, and positive action to avoid accident is important.

   a) To establish safety manager
   b) To carry out safety training for all employee (prepare the safety manual) when they started working in TPP4
   c) Carry out morning meeting of prediction of dangerous activity about daily work
   d) Carry out the periodically safety patrol by TPP4 and Contractor. If unsafe work and unsafe action was found, it is necessary to identify the problem at site, to improve the situation, to disseminate and to prevent a recurrence of the accident.

2) Securing Safety goods

   Following safety goods are necessary.

   a) Safety goggles, dust mask, safety belt, earplugs, etc.
   b) Indication plate for working place, heights and an opening
   c) Safety net
   d) Lighting facilities and equipment at working area
   e) Temporally lighting
   f) Fire extinguisher

3) Others

   a) Securing emergency communication structure
   b) Preparation of safety manual

7.6 Terms of Reference of Consulting Services

7.6.1 Introduction

Because of recent rapid economic growth and higher concentration of people to Mongolian capital Ulaanbaatar city (population approx. 1.1 million), the power and heat demand supply balance is becoming very tight and construction of new power and heat generation facilities and renovation of existing facilities are considered to be urgently carried out. Thermal power plant NO.4 (TPP4), constructed in 1983, is major power and heat supply source, which has a key role to supply approx. 70% of power demand of Central electricity system around Ulaanbaatar city, and approx. 65% of heat demand in Ulaanbaatar city. However, it has some problems for reliable operation because of deterioration of several equipments, for example, turbine trips more than once a month. Therefore, in order to continue to operate TPP4 in future, as a major power and heat supply source, urgent rehabilitation is necessary.

Based on above background, TPP4, as the Execution Agency, intends to proceed with some rehabilitation work in order to improve power and heat supply capability and reliability. TPP4 wishes to engage a consulting firm to provide the necessary professional and technical services to ensure the successful implementation of the project. Japanese ODA loan will finance the consulting services of which detail requirements are described hereunder.

7.6.2 Project brief

(1) Scope of the project

a) Modification of existing mechanical hydraulic governor to electro-hydraulic type governor for six turbines
b) Modification of existing turbine control system to DCS (Distributed Control System) for six turbines
c) Replacement of existing mill rollers and tables by ceramic material for four boilers
d) Installation of soot blowers for eight boilers

(2) Project schedule

The envisaged target milestone and key-dates for this project are as follows:

	Milestone	Key-dates
a)	Issue of pre-qualification documents	7 months before the contract between TPP4 and successful bidder
b)	Issue of bid documents	6 months before the contract between TPP4 and successful bidder
c)	Completion of modification of governor and DCS	64 months after the contract between TPP4 and successful bidder
d)	Completion of installation of Mill roller and soot blower	32 months after the contract between TPP4 and successful bidder

7.6.3 Scope of the Services

(1) Basic Design and Engineering

The Consultant shall be responsible for preparation of basic plans, description, drawings, specifications and schedules for Bidders to prepare proposal document and for contract documents. The design shall include specification of equipment, layout and arrangement of components, selection of equipment and materials.

(2) Assistance to TPP4 in Pre-qualification

The Consultant shall undertake the following works:

a) Preparation of pre-qualification documents
b) Assistance to TPP4 for pre-qualification announcement
c) Evaluation of submitted documents from bidders
d) Preparation of draft evaluation report and assistance to TPP4 in preparing final evaluation report

(3) Assistance to TPP4 in Bidding

The Consultant shall undertake the following works:

a) Preparation of bid documents
b) Assistance to TPP4 in replying to Bidder's question and in issuing addenda to bid documents
c) Evaluation of bidders' proposal
d) Assistance to TPP4 in clarification meeting with bidders
e) Preparation of draft evaluation report and assistance to TPP4 in preparing final evaluation report
f) Preparation of contract documents

(4) Design Supervision

The Consultant shall undertake the following works:

a) Review and approval of drawings, documents and procedures submitted by the Contractor
b) Assistance to TPP4 in design coordination meeting with the Contractor in Mongolia

(5) Inspection, Testing and Delivery Control during Manufacturing

The Consultant with TPP4 participation shall undertake to implement the following:

a) Review and approval of proposal on quality assurance, quality control plan and delivery schedule prepared by the Contractor
b) Regular review of production and delivery schedule submitted by the Contractor

c) Review and approval of shop test procedures and shop test reports submitted by the Contractor

d) Shop test witness of major equipment

(6) Construction Supervision

The Consultant with TPP4 participation shall undertake the following:

a) Coordination, supervision and inspection of all construction and erection works

b) Review and approval of the Contractor's quality assurance and control program at site

c) Monitoring and control of work progress and initiation of corrective measures, if required

d) Submission of monthly progress reports

e) Assistance to TPP4 at site coordination meeting with the Contractor in Mongolia

f) Inspection and direction of preventive safety

(7) Commissioning and Acceptance Tests

The Consultant shall undertake the following:

a) Assistance to TPP4 during the various commissioning stages of the Project including performance guarantee test

b) Review and approval of the Contractor's test procedures including performance guarantee test

(8) Assistance in Reporting to JICA

The Consultant shall assist TPP4 in preparing progress report for the Project on a quarterly basis until the Project is completed, and in preparing project completion report.

7.6.4 Reports and Documents

The Consultant shall be prepare and submit to TPP4 as follows:

a)	Basic design report with drawings	5 copies
b)	Pre-qualification documents	5 copies
c)	Bid documents	5 copies
d)	Draft evaluation report of pre-qualification	5 copies
e)	Draft evaluation report of bidding	5 copies
f)	Monthly progress report	10 copies
g)	Quarterly progress report	10 copies
h)	Project completion report	10 copies

7.6.5 Consulting Staff Expertise Requirement

The consulting services will be provided by a composite team of foreign and local consultant which will include but not be limited to the following engineers:

1) Foreign Engineer
    a) Project Manager
    b) Mechanical Engineer
    c) Electrical Engineer
    d) Instrument & Control Engineer
2) Local Engineer
    a) Assistant Manager
    b) Mechanical Engineer
    c) Electrical Engineer
    d) Instrument & Control Engineer

7.6.6 Facilities to be Provided by TPP4

TPP4 shall provide following facilities and services to the Consultant.

a) Assistance in obtaining visa, working permit, etc. for foreign consultants, if necessary
b) Access to all area of TPP4 and other area, building and facilities relating to the Project in Mongolia
c) Supply of necessary data, documents and information, including authorization for taking photographs, and arrangement of meeting with TPP4 engineer, as required by the Consultant
d) A Project Implementation Unit (PIU) consists of engineers corresponding to above mentioned expertise, who have enough reading, speaking, hearing and writing ability in English, as a local counterpart of the Consultant
e) Tax exemption for foreign consultants
f) Provision of rooms and facilities inside TPP4 site for office work, with desks, chairs, lightings, heating facilities, etc., including reasonable internet access environment, for all of the members of the Consultant.

7.6.7 Responsibility of TPP4

TPP4 shall comply with the Guidelines for the Employment of Consultants under Japanese ODA Loans, April, 2012. Special attention shall be paid to the followings:

1) In the case of difference of opinion between TPP4 and the Consultant on any important matters involving professional judgment that might affect the proper evaluation or execution of the Project, TPP4 shall allow the Consultant to submit promptly to TPP4 a written report and simultaneously, to submit a copy to JICA. TPP4 shall forward the report to JICA with its

comments in time to allow JICA to study it and communicate with TPP4 before any irreversible steps are taken in the matter. In case of urgency, the Consultant shall have the right to request TPP4 and/or JICA that the matter be discussed immediately between TPP4 and JICA.

2) TPP4 is responsible for supervising the Consultant's performance and ensuring that the Consultant carries out the assignment in accordance with the Contract. Without assuming the responsibilities of TPP4 or the Consultant, JICA may monitor the work as necessary in order to confirm that this is being carries out in accordance with appropriate standard and based on acceptable data. As appropriate, JICA may take part in the discussions between TPP4 and the Consultant. However, JICA shall not be liable in any way for the implementation of the Project by reason of such monitoring or participation in the discussions. Neither TPP4 nor the Consultant shall be released from any responsibility for the Project by the reason of JICA's monitoring or participation in discussion.