JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF ENERGY, GEOLOGY AND MINING (MEGM)
MONGOLIA

STUDY
ON
COMPREHENSIVE COAL DEVELOPMENT
AND UTILIZATION
IN
MONGOLIA

FINAL REPORT

(PART II : MASTER PLAN STUDY)

MAIN REPORT

NOVEMBER 1995

THE INSTITUTE OF ENERGY ECONOMICS, JAPAN (IEEJ)

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PREFACE

In response to a request from the Government of the Mongolia, the Government of Japan decided to conduct the Study on Comprehensive Coal Development and Utilization in Mongolia and entrusted the study to the Japan International Cooperation Agency (JICA).

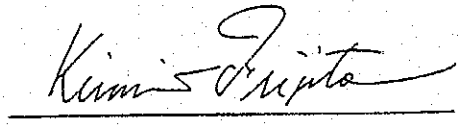
JICA sent a study team led by Mr. Takehiko Sato of the Institute of Energy Economics, Japan (IEEJ) and organized by IEEJ to Mongolia seven times from November 1993 to September 1995.

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

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

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

November 1995



Kimio Fujita
President
Japan International Cooperation Agency

November 1995

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Mr. Fujita,

Letter of Transmittal

We are pleased to submit to you the study report on Comprehensive Coal Development and Utilization in Mongolia. The report contains the advice and suggestions of authorities concerned of the Government of Japan and your Agency as well as the formulation of the above mentioned project. Also included are comments made by the Ministry of Energy, Geology, and Mining of Mongolia during technical discussions on the draft report which were held in Ulaanbaatar. The study is divided into two Parts:

Part I : Feasibility study for the renovation of two coal mines
Part II: Master plan study for the coal development and utilization and preliminary action plan

Baganuur coal mine and Shivee Ovoo coal mine were selected as "two coal mines" to be studied in Part I by both study teams in accordance with the procedure of Scope of Work.

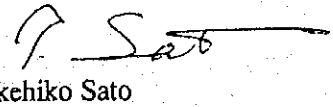
This report presents the results of the Study, which has been implemented since November 1993 in cooperation with the Ministry of Energy, Geology and Mining as the Counterpart, and consists of three separate volumes, the summary (110 pages), Part I (the renovation plans:650 pages) and Part II(the master plan:430 pages) of the main texts.

Part I reports the renovation plan of Baganuur coal mine (Chapter I) and Shivee Ovoo coal mine (Chapter II). Each Chapter includes;coal resources; present mining status; renovation plan; capital and operating costs;financial and economic analysis; and conclusion.
Part II reports the master plan and the preliminary action plans, and includes: coal demand and supply forecast; coal development and utilization plan; conceptual study of the selected plans; and conceptual "Action Plan"

In view of the urgency of renovation of coal mines in Mongolia, we recommend that Mongolian government implements the renovation plans of Baganuur coal mine and Shivee ovoo coal mine in accordance with the coal development master plan.

We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs, and the Ministry of International Trade and Industry. We also wish to express our deep gratitude to the Ministry of Energy, Geology, and Mining of Mongolia, the JOCV Ulaanbaatar office, and the Embassy of Japan in Ulaanbaatar for the close cooperation and assistance extended to us during our investigation and study.

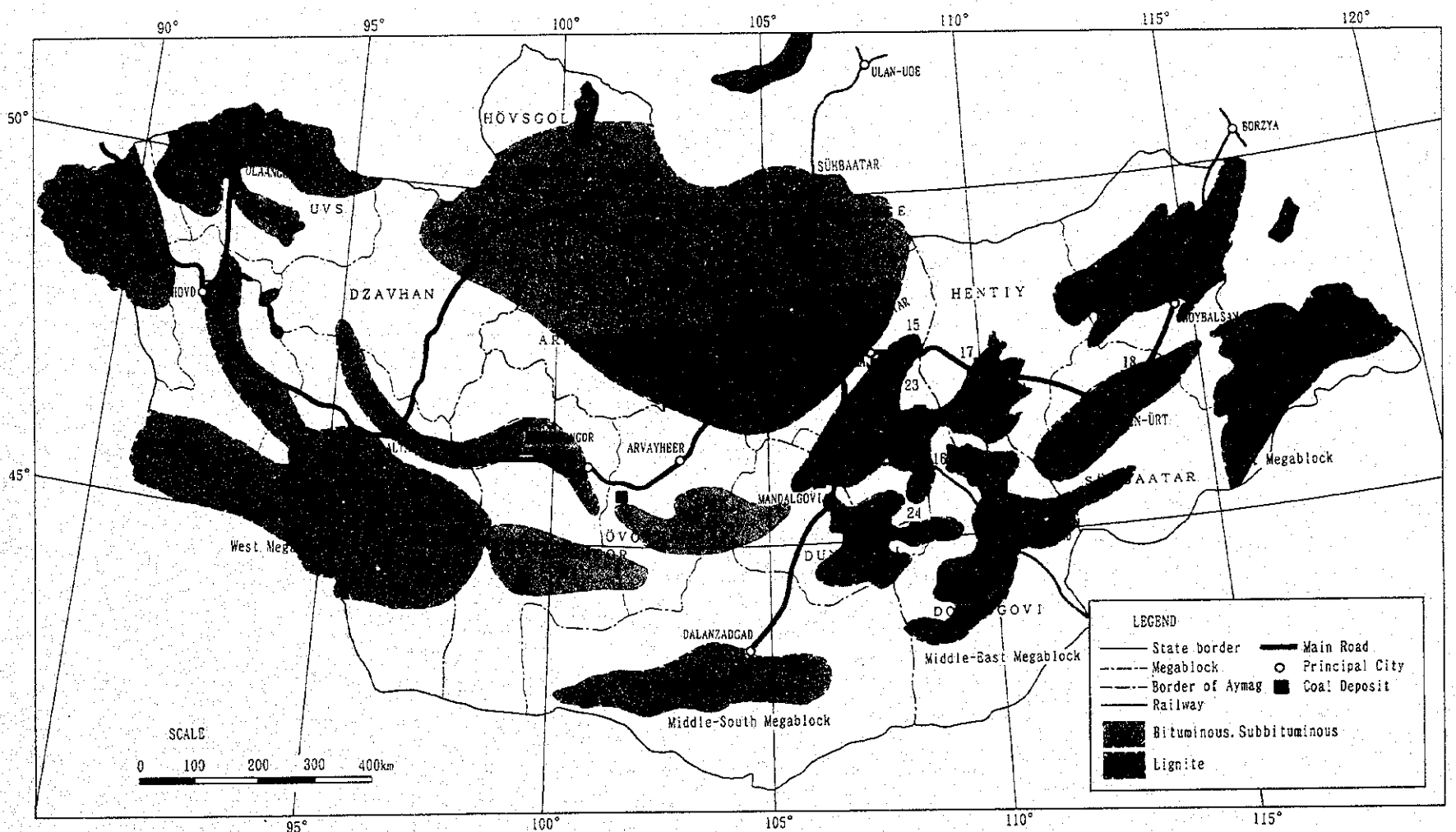
Very truly yours,



Takehiko Sato

Team Leader
The Study on Comprehensive Coal
Development and Utilization in Mongolia

Coal Resouces in Mongolia



Names of basins

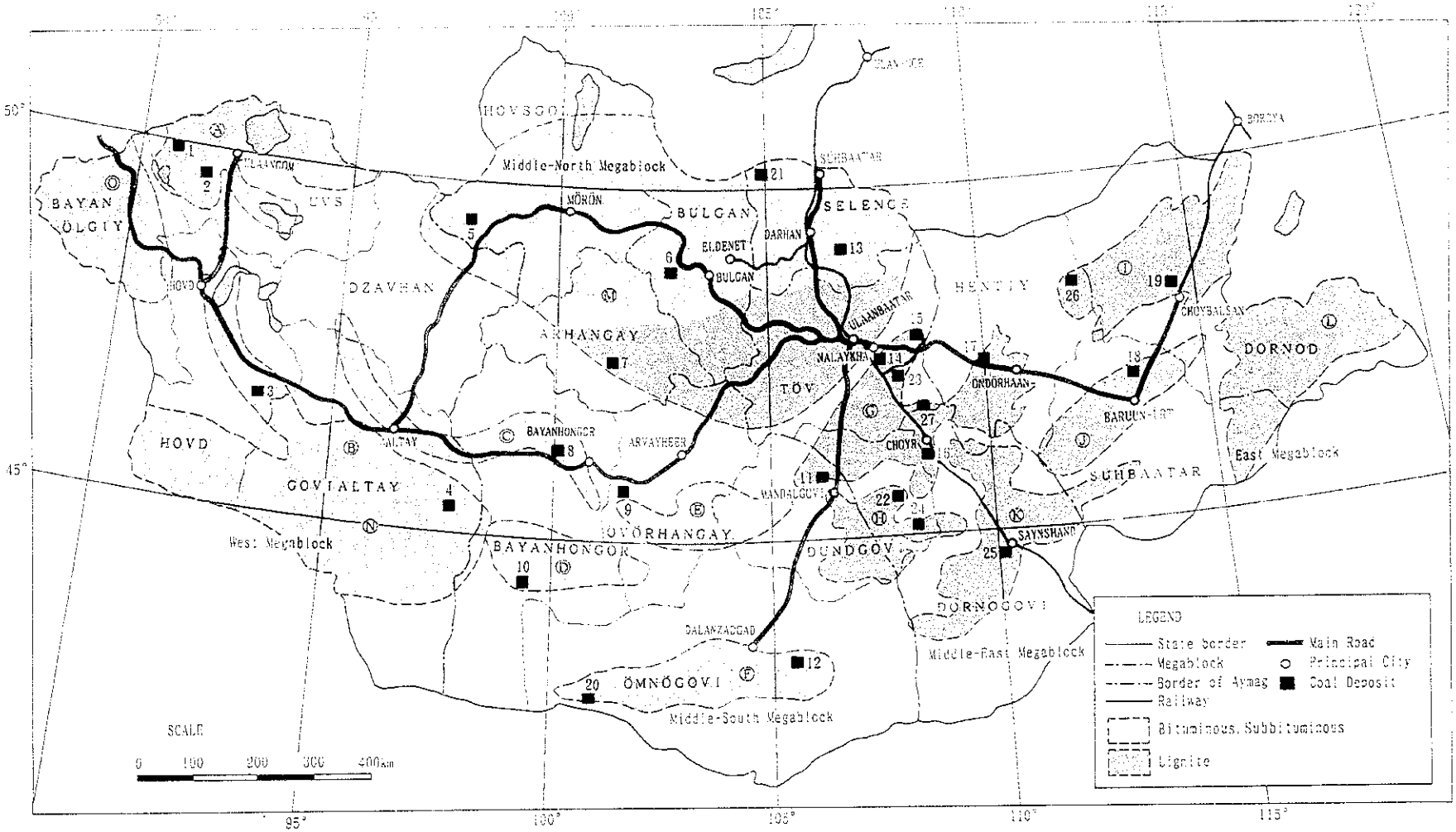
- Ⓐ:Kharkhiraa (C)
- Ⓑ:Mongol Altay (C)
- Ⓒ:South Khangay (P)
- Ⓓ:Big Bogdyn (J)
- Ⓔ:Ongiyngol (J)
- Ⓕ:South Govi (P)
- Ⓖ:Choir-Niarga (K)
- Ⓗ:Middle Govi (K)
- Ⓘ:Choybalsan (K)
- Ⓙ:Sukhe Bator (K)
- Ⓚ:East Govi (K)
- Ⓛ:Tamtsak (K)
- Ⓜ:Orkhon-Selenge (J)
- Ⓝ:Altay-Chandmani (C)
- Ⓞ:Bayan-Ulegei (C)

* C-Carboniferous, P-Permian, J-Jurassic, K-Cretaceous

Names of deposits

1 Nuursthotgor Deposit
2 Khartarvagatai Deposit
3 Khusheet Deposit
4 Zeegt Deposit
5 Mogoingol Deposit
6 Saihan-Ovoo Deposit
7 Bayantsagaan Deposit
8 Uburchuluut Deposit
9 Bayanteeg Deposit
10 Shinjinst Deposit
11 Tevshiingovi Deposit
12 Tavantologoi Deposit
13 Sharyngol Deposit
14 Nalaykha Deposit
15 Baganuur Deposit
16 Shivee-Ovoo Deposit
17 Chandagantal Deposit
18 Talbulag Deposit
19 Aduunchuluun Deposit
20 Narynsohait Deposit
21 Ulaan-Ovoo Deposit
22 Khoot Deposit
23 Tsaidamnuur Deposit
24 Ovdok-Huduk Deposit
25 Sainshand Deposit
26 Hulstnuur Deposit
27 Tugrugnuur Deposit

Coal Resources in Mongolia



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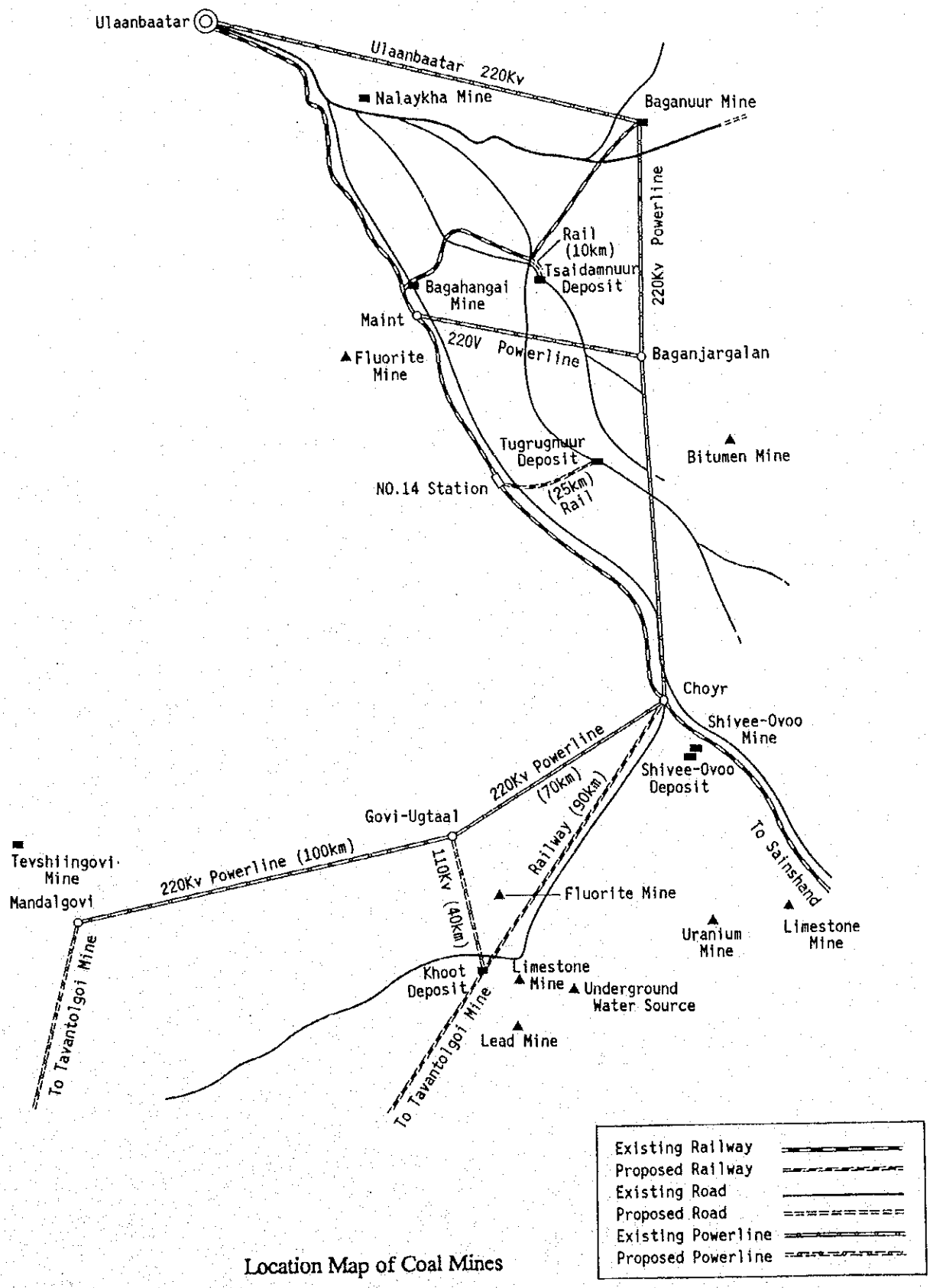
25 Sainshand Deposit
26 Halstnuur Deposit
27 Tugrugnuur Deposit



Location Map of Coal Mines

STUDY ON COMPREHENSIVE COAL DEVELOPMENT AND UTILIZATION IN MONGOLIA

FINAL REPORT

Table of Contents

PART II Master Plan Study

Table of Contents

List of Table

2 Coal Supply Demand Forecast

3 Coal Development Plan

4 Coal Utilization Plan

6 Air Quality Protection in Relation to Coal Combustion

7 Preliminary Study on Selected Plans

8 Conceptual Study of Action Plan

List of Figures

2 Coal Supply and Demand Forecast

3 Coal Development Plan

Abbreviations

AD,ad	: Air Dried Basis
ADB	: Asian Development Bank
AR,ar	: As Received Basis
ASTM	: American Society for Testing and Materials
atm.	: Atmosphere(s)
bbl	: Barrel
BCM	: Bank Cubic Meter
BWE	: Bucket Wheel Excavator
CES	: Central Energy System
CIF	: Cost, Insurance and Freight
COMECON	: Communist Economic Conference
D/L	: Dragline
D/T	: Dump Truck
DB,db	: Dry Basis
DAF,daf	: Dry Ash Free
dB(A)	: Decibel in Scale A
DCF	: Discounted Cash Flow
E.C.	: Electric Conductivity
EIRR	: Economic Internal Rate of Return
F/S	: Feasibility Study
FBC	: Fluidized Bed Combustion
FEL	: Front End Loader
FIRR	: Financial Internal Rate of Return
FLIR	: Foreign Loan Interested Rate
FOB	: Free on Board
Gcal	: Giga-calorie
GDP	: Gross Domestic Product
GHV	: Gross Heating Value
GWh	: Giga-watt-hour(s)
ha	: Hectare(s)
HCV	: Higher Calorific Value
HHV	: Higher Heating Value
HP	: Horsepower
HV	: Heating Value
HVDC	: High Voltage Direct Current

Hz.	: Hertz
IEEJ	: The Institute of Energy Economics, Japan
INPS	: Institute of National Project for the former Soviet Union
IRR	: Internal Rate of Return
JCI	: Japan Consultant Institute
JICA	: Japan International Cooperation Agency
JIS	: Japanese Industrial Standards
KV,kV	: Kilo-volt
KVA,kVA	: Kilo-volt-ampere
kW	: Kilo-watt(s)
kWh	: Kilo-watt-hour(s)
LCV	: Lower Calorific Value
LHV	: Lower Heating Value
m.,mil.	: Million
MCR	: Maximum Continuous Rating
MEGM	: Ministry of Energy, Geology and Mining of Mongolia
MJ	: Mega-joule
MTI	: Ministry of Trade and Industry of Mongolia
MW	: Mega-watt(s)
NDB	: The National Development Board
NEDO	: New Energy and Industrial Technology Development Organization
NMP	: Net Material Product
NPV	: Net Present Value
ODA	: Official Development Assistance
OECD	: Organization for Economic Co-operation and Development
PCF	: Pulverized Coal Fired
ppb.	: Parts per Billion
rpm	: Revolutions per Minute
S.L.	: Sea Level
SNG	: Substitute Natural Gas
SPM	: Suspended Particulate Matter
SS	: Suspended Solid
TBCM	: Total Bank Cubic Meter
TCE,tce	: Ton Coal Equivalent
Tg, tg	: Tugrug(s)
TSP	: Total Suspended Particulates
UNCED	: U. N. Conference on Environment and Development

1 Introduction

1.1 History of study

Mongolia faces a serious economic crisis owing to the halt in barter trade under COMECON, and the Mongolian government intends to overcome this crisis by developing and utilizing its abundant coal resources. Coal deposits in Mongolia are said to amount to as much as 150 billion tons; there are supposedly 24 billion tons for which surveys have been carried out in some manner and deposits confirmed. However, annual coal production in Mongolia peaked at 8.6 million tons in 1988, and has since declined yearly, falling to 6.2 million tons in 1992.

For this reason Mongolia is in recent years verging on an energy crisis, and finds itself in especially acute circumstances during its bitterly cold winters. This, it would seem, finds its cause in the deterioration of facilities, the shortage of spare parts, and limited economic vitality. The Mongolian government sees the development of its abundant coal resources as a top-priority task, and in view of this situation it urgently needs to formulate a comprehensive program for development and utilization that includes renovating its main coal mines and developing new coal fields.

1.2 Objectives and scope of study

The two main objectives of this study are:

- To formulate a program for the renovation of two existing coal mines that is technically, economically, and financially optimum, and to prepare a feasibility study report; and
- To forecast a long-term coal supply and demand, formulate a coal development and utilization program and a conceptual action plan, and prepare a master plan report.

Another important objective is to transfer technology to our Mongolian counterparts through the study.

This study consists of Part I (Renovation study of Baganuur coal mine and Shivee Ovoo coal mine) and Part II (Master plan study for coal development and utilization).

Scope and approach of Part I are:

(1) Collecting information for a study on the coal mine renovation program
(2) Selecting two coal mines to be studied
(3) Developing effective renovation programs including environmental study
(4) Study of investment and operating costs
(5) Financial and economic analyses

Scope and approach of Part II are:

(1) Collecting information for the coal development and utilization program's master plan
(2) Coal supply and demand projections
(3) Coal development program
(4) Coal utilization program
(5) Energy conservation program and environmental measures for coal-related facilities
(6) Preliminary studies for selected plans
(7) Conceptual action plan

The text consists of two volumes. Volume II includes the formulations of Part II, while volume I is separated and includes Part I.

2 Coal Supply and Demand Forecast

2.1 Present status of energy supply and demand

2.1.1 Economic activities at present and in the past

After its formal independence in 1921, Mongolia where is rich, particularly, in raw agricultural materials of wool, leather and cashmere had imported virtually manufactured products from the former U.S.S.R. and other communistic countries on a barter basis until 1989, when Mongolia decided to shift its traditional centrally planned economy to a market economy. Along with the parallel developments in the U.S.S.R., the decision caused radical changes in Mongolia. The most immediate was the affective breaking of economic links with the U.S.S.R., and the withdrawal of all subsidies.

In 1992, democratic election was held and a new constitution was adopted. A broad range of reforms have been instituted to promote a market economy and a privatization program has been introduced. However, the economic situation remained difficult. The inflation rate was high and the exchange rate declined. Today, Mongolia is still in the process of transition of the market.

(1) Economic growth until the end of 1980s

Mongolia had enjoyed a relatively high economic growth until 1989, when aid from the former U.S.S.R. was abruptly withdrawn as mentioned above. The average annual growth rates (%) of Net Material Products (NMP) from 1940 to 1990 are as follows:

Note: NMP was used as an indicator of economic activities in the Socialists countries.

	(Total)	(Industry)	(Agriculture)
1940-1960	6.9	8.6	3.5
1960-1970	2.7	10.3	0.7
1970-1980	6.1	11.4	1.1
1980-1990	5.1	6.3	4.3

As can be seen in these figures, the high rate of economic growth had been accomplished by the industry sector while the agriculture sector recorded much lower growth rates for the last two decades. The share of the industry sector in NMP increased from 20% in 1970 to 36% in 1990, which can be compared to the trends of the agriculture sector's share from 33% in 1970

to 19% in 1990 (Table 2.1).

(2) Economic growth after the withdrawal of Soviet aid

Mongolia received substantial aid from the former U.S.S.R. It used this assistance to build an industrial / mineral base. The Soviets helped Mongolian build a transport system, provide oil products, supplied and operated the power plants, and financed fellowships for several hundreds of students.

A sudden shortage of spare parts and machinery provided from the former U.S.S.R. caused serious problems to Mongolian industry which had heavily relied on the Soviet technology. Trade with other members of the Socialist bloc was also disrupted, forcing Mongolia to find new trading partners and markets to export. To make matters worse, the terms of trade turned against Mongolia when the price of key exports, notably copper and cashmere, declined in the world markets. As a result, economic growth was obliged to record " minus " for four years,between 1990 and 1993, during of which period cumulative decrease in economy amounted to 34% in NMP (Table 2.2).

To attain economic stability, fiscal and monetary policies were tightened by using a wide variety of measures. To restore economic growth, the government introduced fundamental reforms to liberalize domestic and international trades, free domestic markets, and privatize public assets.

After the sharp commutative contraction of 34% in real NMP in 1990 - 93, the growth rate for 1994 is predicted to end the worst of the economic adjustment.

(3) Characteristics of Mongolian economy

The main characteristics of Mongolian economy can be summarized in the following five categories;

1) Large land space and small population

In an area of 1.6 million km^2 (four times of Japan) with a population of only 2.2 million people, Mongolia has one of the lowest population densities in the world. The small population means very small domestic market, and the large land space means very large investments for sufficient infrastructure.

Table 2.1 Share of Industry and Agriculture in NMP

(%)

Year	Industry	Agriculture	Others	Total
1940	7.0	76.1	16.9	100.0
1960	9.6	40.3	50.1	100.0
1970	19.6	33.1	47.3	100.0
1980	31.9	20.3	47.8	100.0
1990	35.5	18.7	45.8	100.0

(Source) N. Matsunaga, "Mongolia's Economic Revolution - Development and Aid Strategies", Forum IDC, No.12 (March, 1993).

Table 2.2 Growth Rates of NMP, Agriculture, and Industry

(%)

Year	NMP	Agriculture	Industry
1989	9.7	13.8	11.4
1990	-3.7	-1.9	-0.3
1991	-13.9	-5.1	-12.7
1992	-13.5	-3.9	-7.9
1993	-3.3	-7.0	-6.8

(Source) World Bank, "Mongolia - Country Economic Memorandum : Priorities in Macroeconomic Management", October 31, 1994.

2) Inland country surrounded by countries with large land space --- China and Russia

The exportation costs are very expensive, especially to countries other than China and Russia.

3) Strong stock raising sector

Mongolia has a semiarid continental climate, and its pastures and grasslands are home to over 24 million head of livestock, or over 10 per capita. Around 30% of employed people are working in stock raising sector, and stock farm and agricultural products account for 40 % of the total exports.

4) Abundant mineral resources

Mongolia has the abundant mineral resources including coal, copper, fluorspar, and molybdenum. Coal is the main source of energy in this country while copper is the main source to bring in foreign currencies.

5) High level education

Mongolia has a well educated population with an adult literacy rate of 96%.

2.1.2 Trend of energy supply and demand

(1) Final energy consumption

According to "Energy Balance Table" which is estimated by the study team, final energy consumption was 4.19 million tce (Hereafter 7,000 kcal/kg) in 1990 in Mongolia. The share of petroleum was the largest followed by coal, heat (hot water and steam), electricity, wood, and other biomass fuels (Table 2.3). The largest consumer of petroleum was "transportation/ communication", followed by "industry/construction", and agriculture.

57 % of wood was consumed in "public service/households", followed by "industry/ construction", "agriculture", and other branches. And also "other biomass fuels" were consumed mainly in these branches.

68 % of electricity was consumed in "industry/construction" in 1990. "Public service/ households", the second largest consumer of electricity, accounted for only 13 % in 1990.

Table 2.3 Estimate of Energy Balance in Mongolia (1990)

(1,000 tce) *

	Coal	Wood	Other Biomass	Petroleum Products	Coke	Electricity	Heat	Total
<Primary Energy Supply>								
Production	3,632.5	186.5	50.9	-	-	-	-	3,869.9
Import	41.6	-	-	1,120.0	4.7	28.0	-	1,194.3
Total Supply	3,674.1	186.5	50.9	1,120.0	4.7	28.0	-	5,064.2
Export	(-)235.2	-0.2	-	-	-	(-)9.3	-	(-)244.7
Stork change	(-)59.8	46.4	(-)31.6	748.4	(-)0.2	-	-	703.2
Domestic Supply	3,379.1	232.7	19.3	1,868.4	4.5	18.7	-	5,522.70
<Energy Conversion, Own Consumption and Losses>								
Electricity and heat generation	(-)2,194.6	-	-	(-)146.0	-	411.3	721.1	(-)1,208.2
Own Consumption and losses	(-)4.3	(-)0.3	-	(-)12.5	-	(-)105.3	-	(-)122.4
<Final Energy Consumption>								
Industry/construction	505.0	29.8	5.4	505.1	4.1	221.5	n.a.	n.a.
Transportation/communication	57.9	2.4	0.4	796.7	0.4	21.5	n.a.	n.a.
Agriculture	80.7	27.8	2.5	239.0	-	14.4	n.a.	n.a.
Public service/household	340.1	133.5	5.6	18.2	-	42.9	n.a.	n.a.
Others	196.4	38.5	4.0	150.8	-	24.6	n.a.	n.a.
Sub-Total	1,180.1	232.0	17.4	1,709.8	4.5	324.7	721.1	4,190.1
Other Uses	0.1	0.4	1.4	0.1	-	-	-	2.0
Total	1,180.2	232.4	19.3	1,709.9	4.5	324.7	721.1	4,192.1

(Note) * --- 7,000 kcal/kg

(Source) Estimated from Statistics of MEGM

The final consumption of heat means the amount of heat which is supplied to plants, factories, households, etc. from outside power plants, and it is consumed by them. 720,000 tons of heat in the Table 2.3 means the amount of hot water and steam supplied by the Central Energy System (CES). Although the amount of heat supplied by other suppliers than five power stations belonging to the CES is not included,the figures of final consumption of coal, petroleum, and others are included in this table.

(2) Primary energy requirements

Primary energy which was input for meeting the final energy consumption above was 5.52 million tce (Table 2.3). Coal has the largest share in the total, which was 61% in 1990. According to Table 2.4, coal has accounted for around two-thirds of the total primary energy requirements since 1970.

Coal was followed by petroleum, which accounted for 34 % in 1990. Thus, 95 % of the total primary energy requirement was occupied by coal and petroleum Wood, other biomass fuels and imported electricity sum up barely 5 % of the total even in all.

Almost all of the coal consumed in Mongolia is produced domestically and only 166 thousand tons per year of coal is imported by Erdenet copper mine, while all of petroleum is imported. Among petroleum products, gasoline and gas oil (diesel fuel oil) have much larger shares, both of which are mainly used as fuels for automobile, bus, and truck (Table 2.5). Oil is also used as fuel for diesel fired power plants situated outside of the CES.

(3) Economic growth and energy consumption

Energy consumption generally increases with the higher Gross Domestic Product. The energy dependence of the economy can be determined by the ratio of the growth rate of energy consumption and the growth rate of the Gross Domestic Product. This relationship is known as energy GDP elasticity. Alternatively, the energy intensity in the GDP is indicative of the relationship between energy consumption and GDP. It is calculated simply as the ratio between energy consumption and GDP.

In Mongolia, Net Material Product (NMP) is used in stead of GDP, however, the correlation between energy consumption and NMP is unknown after 1990 because energy consumption

Table 2.4 Estimate of Primary Energy Requirements in Mongolia

(1,000 tce)*

	1970	1975	1980	1985	1990
Coal	1,059	1,454	2,381	2,949	3,370
	(66.1)	(64.5)	(69.8)	(67.0)	(63.0)
Coke	1	2	--	5	5
	(0.1)	(0.1)	(--)	(0.1)	(0.1)
Petroleum	355	517	740	1,078	1,710
	(22.2)	(22.9)	(21.7)	(24.5)	(31.9)
Wood	151	252	226	341	232
	(9.4)	(11.2)	(6.6)	(7.7)	(4.3)
Other Biomass	36	31	30	16	17
	(2.2)	(1.4)	(0.9)	(0.4)	(0.3)
Net import of	-	-	32	12	19
Electric Power	(-)	(-)	(0.9)	(0.3)	(0.4)
Total	1,602	2,256	3,409	4,401	5,353
	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)

(Note) -- means negligible small and - zero.

* --- 7,000 kcal/kg

(Source) Estimated from Statistics of MEGM

Table 2.5 Petroleum Products Consumption in Mongolia

(1,000 tce) *

	1970	1975	1980	1985	1990
Gasoline	206.7	293.0	398.2	484.2	806.5
	(57.9)	(56.7)	(52.9)	(44.9)	(47.2)
Kerosine	7.0	5.2	9.6	7.3	7.0
	(2.0)	(1.0)	(1.3)	(0.7)	(0.4)
Gas oil	132.2	204.4	292.0	503.4	793.2
	(37.0)	(39.5)	(38.8)	(46.6)	(46.4)
Heavy fuel oil	11.1	14.5	53.4	84.3	103.1
	(3.1)	(2.8)	(7.1)	(7.8)	(6.0)
Total	357.0	517.1	753.2	1,079.2	1,709.8
	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)

* :---7,000kcal/kg

(Source) Estimated from Statistics of MEGM

data is collected every five year. Figure 2.1 shows the relationship between energy consumption and NMP in Mongolia. According to this figure, it seems that these two indicators have a clear correlation until economic disruption. In this study, future demand will be forecasted based on the correlation analysis.

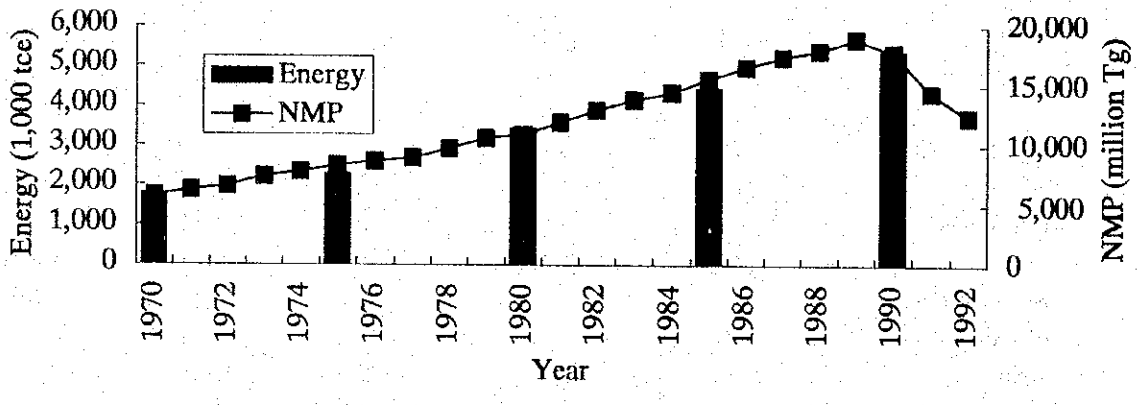


Figure 2.1 Relationship between Primary Energy and NMP

2.1.3 Trend of coal demand and supply

(1) Demand for coal

Coal demand was 5.26 million tons in 1993 (the calorific value is estimated 3,000 - 3,500 kcal/kg). Coal demand recorded its peak (7.60 million tons) in 1988, and has decreased by two million tons within the following five years (Table 2.6).

The biggest consumer of coal is electricity generation and heating plants in which 4.05 million tons of coal was consumed in 1993. Coal demand in this sector also recorded its peak in 1988, compare to the sharp drop in coal demand during 1989 and 1993, the total demand decrease with electricity generation and heating plants was not so damaging with loss of 500,000 tons. It proves how important coal is to this sector. It is to say, on the other hand, the coal demand with the other sectors was rather disastrous. The CES area accounted for 88 % of the total coal demand in 1990. And in the CES area Ulaanbaatar had the largest share as shown in the table below.

Table 2.6 Coal Consumpion in Main Branches of Economy of Mongolia

(unit: 1000 ton)

Years	Total Consumption	Electricity generation & Heating plants	Industry & construction	Transportaion & commnication	Agriculture	Public Services & Household	Others
1980	4,315.6	2,184.0	711.7	41.7	321.9	426.6	629.7
1981	4,581.2	2,211.3	810.5	44.3	347.7	774.9	392.5
1982	4,720.5	2,352.8	793.0	45.6	348.6	772.1	408.4
1983	4,910.4	2,520.0	816.0	47.4	353.0	740.0	434.0
1984	5,470.1	3,468.0	766.0	52.9	381.0	666.0	136.2
1985	6,166.8	3,678.6	1,232.4	60.9	400.5	702.4	92.0
1986	6,816.8	3,904.0	911.0	67.3	465.0	784.0	685.5
1987	7,212.3	4,243.0	1,329.0	71.2	517.0	439.0	613.1
1988	7,596.8	4,542.0	1,137.0	75.0	429.0	737.0	676.8
1989	7,251.5	4,311.0	1,066.0	71.6	202.0	668.0	932.9
1990	6,649.0	4,324.0	995.0	114.0	159.0	670.0	387.0
1991	6,991.8	4,497.0	1,099.0	56.0	101.0	611.0	627.8
1992	6,014.0	4,438.0	877.0	66.0	69.0	452.0	112.0
1993	5,261.9	4,049.0	734.6	86.8	61.5	209.0	121.0

(Source) Ministry of Energy, Geology and Mining of Mongolia

	(%)
Ulaanbaatar	79
(Three power plants)	(71)
Nalaikh	1
Darkhan	7
Erdenet	7
Others	6
Total	100

(2) Coal supply

Three main coal mines - Baganuur, Shivee Ovoo, and Sharyngol - supply almost all coal consumed in the CES area. Coal supplies from these mines were 2.85 million, 600 thousand, and 1.18 million tons respectively in 1993. Additionally, 300,000 - 400,000 tons of coal from stocks was consumed to meet demand in 1993. Shivee Ovoo is the newest coal mine, which started production in 1992 while Baganuur has been producing coal since 1978. Sharyngol started its production in 1965, the level of which has decreased to the half of its peak.

Aduunchuluun coal mine with the production of 350 thousand tons per year, the fourth largest in Mongolia, is situated in Dornod province and supplies its coal to a provincial coal-fired power plants outside the CES. 90 % of the coal production is from these four coal mines in Mongolia. Other 22 coal mines are small ones, even the largest production among which is less than 100,000 tons. They merely meet coal demand in rural areas outside the CES (except for Nalaikh coal mine).

Total coal production has decreased by two million tons since its recorded peak in 1988. Table 2.7 shows coal consumption and supply in 1993 estimated by MEGM. Some figures in which are a little different in their trends from those mentioned above.

2.2 Potential demand on coal

2.2.1 Electric power sector

Electric power generation and supply in Mongolia are divided into two system, one of them is the Central Energy System (CES) and the other is outside the CES. The CES was established in 1967 with the connection of 110 kV transmission lines. As regards to the present status of the CES, it is reported in section 4.1.1 in detail. On the other hand, in the eleven province centers outside the CES, there are 160 diesel generators with the capacity of 630 - 1,800 kW and 300 counties have about 600 small diesel generators with the capacity of 60 - 100 kW. Total installed capacity of the

Table 2.7 Coal Consumption and Supply in 1993

(1,000 ton)

Consumers	Nalaikh	Sharyngol	Baganuur	Shivee-ovoo	Local mines	Total
Ulaanbaatar						
Power plant No.2		57.3	82.2	1.4		140.9
Power plant No.3		554.9	362.0	14.0		930.9
Power plant No.4			1,750.0	300.0		2,050.0
Biol. plant		8.6	9.4	1.4		19.4
Railway		5.2	81.3			86.5
Other		1.9	250.6	65.0	5.0	322.5
Nalaikh aimag	31.6		8.8		8.4	48.8
Sub-total	31.6	627.9	2,544.3	381.8	13.4	3,599.0
Darkhan						
Power plant		214.1				214.1
Cement plant		8.4				8.4
Hotol plant		24.2				24.2
White Brick Co.		3.7				3.7
Sovinvest		7.1				7.1
Other		4.2	22.4	3.5		30.1
Sub-total		261.7	22.4	3.5		287.6
Erdenet						
Power plant		130.0	76.3	5.9		212.2
Erdenet copper		84.3				84.3
Other					10.0	10.0
Sub-total		214.3	76.3	5.9	10.0	306.5
Selenge						
Erchim		10.4	25.2	3.0		38.6
SBBK		8.6	20.8			29.4
Other		2.3	7.6	2.2		12.1
Sub-total		21.3	53.6	5.2		80.1
Aimags						
Tov			58.0	10.0		68.0
Bulgan			18.6	12.4	7.8	38.8
Uvs					42.5	42.5
Hovd					50.6	50.6
Bayanolgiy					95.1	95.1
Zavhan					11.0	11.0
Govialtai					24.1	24.1
Bayanhongor					27.1	27.1
Ovorhangay					58.2	58.2
Dundgovi					22.7	22.7
Omnogovi					35.4	35.4
Dornogovi			4.6	20.0	7.3	31.9
Hovsgol			14.0	3.0	7.3	24.3
Suhbaatar					49.6	49.6
Dornod					351.0	351.0
Arhangay					23.0	23.0
Mongolsov					10.0	10.0
Mine use	10.0	59.2	78.7	8.3	51.9	208.1
Total	41.6	1,184.4	2,870.5	450.1	898.0	5,444.6

(Source) MEGM

power stations in Mongolia accounted for 984 MW and the installed capacities of five power plants in the CES are as follows:

Name of power plant	Installed capacity(MW)	Boiler capacity(t/h)
Ulaanbaatar No.2	24	220
Ulaanbaatar No.3	148	1,950
Ulaanbaatar No.4	540	2,940
Darkhan	48	750
Erdenet	36	450
Total	796	6,240

Figures 2.2 and 2.3 show historical electric power generation in Mongolia and electricity consumption by sectors. Most of the electricity is generated by the CES and outside the CES accounted for 11% of total electric power generation of Mongolia in 1992. As electricity demand of the CES in the future is reported in section 2.4, it will show 5 - 6%/year of the growth rate after the recovery from the present recession. On the other hand, the demand outside the CES area in the future will be depended greatly on the rural electrification policy of the government. The existing CES grid has no hydro power plant, however, there are some hydro-potential in the northern areas as well as the north-west area both of which are located outside the CES. Due to lack of hydro power plant in the CES grid, power at peaks has been imported from Russia through 220 kV transmission line. In order to solve a weak point of the CES grid with only coal fired power plants, Egiin hydro power plant of 220 MW (55 MW x 4), located near the CES grid, is planned to put into the CES around in 2000. The hydro power plant project will expect favorable impact on the economic activities such as indigenous construction material manufactures and construction firms as well as the employment of workers.

As a future project, in order to get foreign currencies, possibility of electricity export to China, Korea, Japan, and etc by HVDC transmission line should be pursued as one of the options of effective coal use. In China, according to the eighth 5 year plan from 1991 and 10 year development plan of social and economy until 2000, it foresaw 6% of GNP growth rate, 1.1 trillion kWh of power generation, and 240 million kW of install capacity in 2000. However, in 1992, the target of GNP growth rate until 2000 was modified to 8-9%. According to this growth rate, required install capacity of power plants in 2000 was about 300 million kW(1.5 trillion kWh

of power generation). In order to reach 300 million kW, China has to construct 17 million kW of power plants every year, however, it is difficult to construct because of lack of coal production, infrastructure, and funds. Under such as situation of Chinese power sector, technical and economical possibility of power export to China will be expected for effective coal use and acquisition of foreign currency. In this report, possibility of this project is described in the section 4.1.2 (5).

Electric power and heat generation in the CES will keep the position of the biggest consumer of coal in the future, even if indigenous oil is produced. As indigenous oil is expected to take the place for imported petroleum products. Moreover, surplus oil production will be exported in order to get foreign currency.

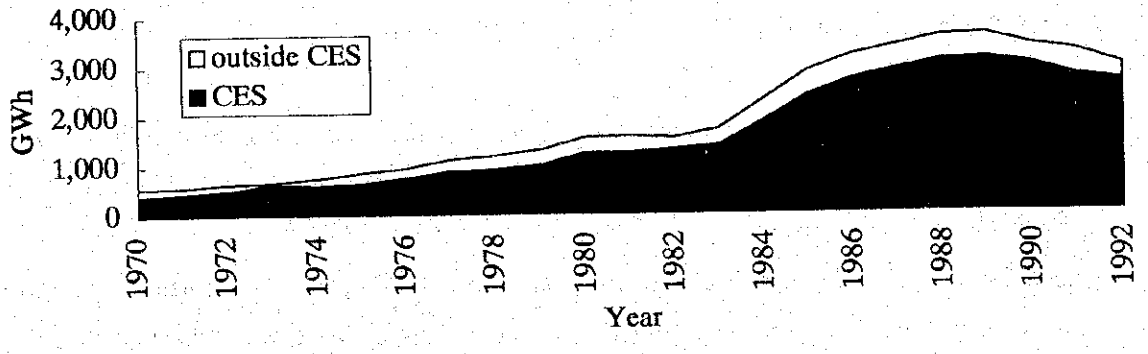


Figure 2.2 Historical Electric Power Generation in Mongolia

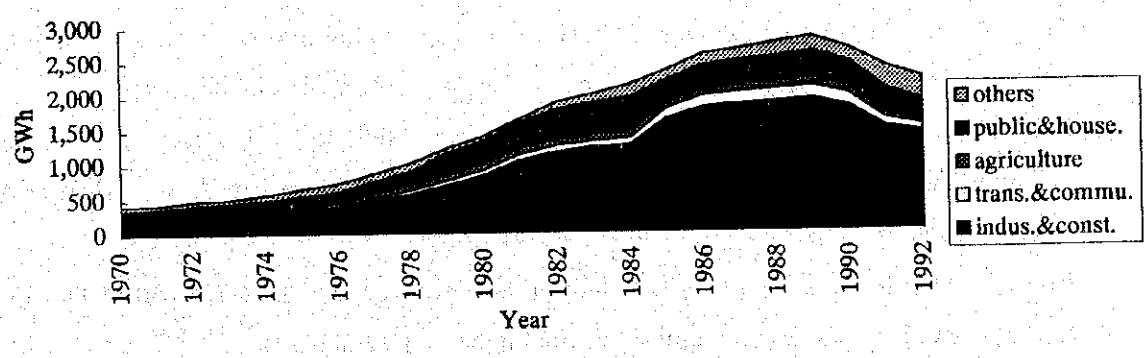


Figure 2.3 Trend of Electricity Consumption by Sector

2.2.2 Industry and construction sector

Mongolia is a country which has the abundant resources of minerals, and mining has been expected to play an important role in her development plans as one of leading industries in the country. Since a large scale geological surveys have started in the middle of 1920s, many kinds of mineral resources including copper, molybdenum, lead, zinc, tin, tungsten, gold, silver, fluorspar, phosphates, petroleum, coal, and iron have been found.

Socialists countries' companies. The majority of companies in Mongolia are operating to produce copper, molybdenum, tin, tungsten, and fluorspar under the joint ventures with russian and other former. Most of the minerals are exported after being processed but their quality are poor.

Mongolian reserves of copper is among the fifth largest in the world, and copper accounts for about 35% of total exports in the country. Main deposits are Erdenetiin - Ovoo and Tsagaansu - varga. Other main mineral deposits and signs are as follows:

- Molybdenum ..... Most molybdenum reserves are also situated at Erdenetiin - Ovoo and Tsagaansu - Varga deposits. Small reserves have been discovered at Aryn Nuur, Undertsagaan, and Eguzer.
- Lead and zinc ..... Polymetal deposits are situated mainly in the central Mongolia. To date, about 30 lead and zinc signs have been discovered at Tumurtein - Ovoo, Ulaan and Tsaviin.
- Gold and silver ..... Several placers gold and ore deposits have been discovered at north Khentei and at west Bayanhongor Zediin in the west. And silver resources are in Asgat in the northern part of Mongolian Altai mountains and in Mungun Unduriin 170 km from Baganuur railway station.
- Tungsten ..... Tungsten deposits and signs are widespread throughout Mongolia with principal concentrations in the eastern and central part of the Mongolian Altai in the west.
- Fluorspar..... More than 60 fluorspar deposits and about 300 signs have been discovered mainly in the central and eastern provinces. Most of the resources are at the Berh, Har Airag, and Bor-Undur ore districts.
- Iron ..... Ore deposits are situated mainly in the south-east and northern part of the country. Surveys have been made in Tumurtolgoi, Bayangol, and Tumurtei.

As mentioned above, mineral resources are mostly situated at sites several hundred km from the

capital city, and infrastructures including roads, railways, electric power, and water have not been prepared around the sites.

The National Development Board (NDB) projects that the sub-sectors of metal processing, building materials, and light industry will increase their shares of production in industry and construction sector in Mongolia (Table 2.8). The former two industries -- metal processing and building materials -- include such coal consuming industries as iron and steel, and cement, brick, and lime, respectively.

NDB also shows main projects in the industry sector (Table 2.9).

Table 2.8 Forecast of Production in Mining/Industry Sector in Mongolia

(Billion Tug.)

	1993	1994	2000	2005	2010
Electricity / Heat	32.8	48.3	73.9	90.9	127.3
	(19.0)	(18.1)	(14.2)	(12.6)	(14.0)
Coal	11.9	17.7	20.9	22.6	37.9
	(6.9)	(6.6)	(4.0)	(3.1)	(4.2)
Mining	70.4	72.1	119.1	160.6	166.9
	(40.8)	(27.0)	(22.8)	(22.2)	(18.4)
Metal Processing	0.3	4.2	23.5	57.2	135.9
	(0.2)	(1.6)	(4.5)	(7.9)	(15.0)
Building Materials	3.2	3.2	39.8	61.6	77.6
	(1.9)	(1.2)	(7.6)	(8.5)	(8.6)
Food Processing	28.5	52.3	92.2	103.8	114.6
	(16.5)	(19.6)	(17.6)	(14.4)	(12.6)
Light	20	43.7	134	199.3	208.3
	(11.6)	(16.3)	(25.6)	(27.6)	(23.0)
Others	5.4	25.9	19.4	26.9	38.0
	(3.1)	(9.7)	(3.7)	(3.7)	(4.2)
Total	172.5	267.4	522.8	722.9	906.5
	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)

(Source) NDB

Table 2.9 List of Main Mining and Industry Projects in Mongolia

Project name	Year of Commissioning	Planned Capacity (Thousand tons per year)
<Mining>		
Modernization of Erdenet copper mine	1995-2009	20,000-25,000
Ulaan deposit	1998-2000	2,000 (*)
Tsav deposit	2000-2003	100 (*)
Undur Tsagaan deposit	2005-2008	5,000 (**)
Tavantolgoi coal deposit	2005-2010	7,000
<Building materials>		
Shivee-govi cement	1997-2000	1,200
small cement plant	2000-2010	10-15 (each)
<Metal processing>		
Copper wire rolling	2000-2003	20
Ferro-molybdenum	2005-2006	5
Tungsten alloy	2004-2006	0.05
<Textile>		
Synthetic fiber	2005	1
Cotton spinning	2010	0.5
<Leather processing>		
Leather processing	2005	n.a.
Leather dying	2010	0.5

(*) lead and / or zinc
(**) tungsten
(Source) NDB

(1) Mining projects

1) Erdenet copper mine project

As shown in Table 2.10, the production of copper concentrate increased from 44 thousand tons in 1980 to 354 thousand tons in 1990. All of them was produced by the Erdenet Ore-Dressing Company, the giant Mongolian / Russian joint venture, which accounts for 40 -50 % of the value of total Mongolia's exports and is the largest business corporation in the country. The capacity of producing the copper concentrate is 350 thousand tons per annum.

Table 2.10 Production and Export of Copper Concentrate in Mongolia

(1,000 tons)

Year	Production	Export
1980	44.0	128.9
1985	342.7	342.7
1990	354.0	347.5
1991	257.4	243.6
1992	300.2	346.0
1993	334.3	394.5

(Source) Statistical Office of Mongolia, Mongolian Economy and Society in 1993,1994

It is estimated that around 250 thousand tons of coal was used for generating steam in six boilers in the plant in 1993, of which around 160 thousand tons were imported from Russia. The plant consumes a lot of electric power supplied by the CES, while it planned to install turbines and generators for generating power in the plant in the future. Two sets of turbines and generators, each with a generating capacity of 30 MW, will be installed and utilize the existing boilers. After their commissioning in around 1997-98, about 300 thousand tons of coal will be consumed additionally in the plant.

2) Other mining projects

Though the coal consumption of each projects is not clarified, coal will be fired for steam generation and other uses in planned projects:

(a) Ulaan lead and zinc deposit

The deposit is situated 120 km to the north of Choibalsan city in Dornod province. According to NDB, if a mine is developed by around 1998 - 2000, production capacity will be 2 million tons per annum.

(b) Tsav lead and zinc deposit

The deposit is also situated in Dornod province, and if a mine is developed by around 2000 - 2003, its production capacity will be 100 thousand tons per annum, according to NDB.

(c) Undur Tsagaan tungsten deposit

The deposit is located 170 km from the Baganuur railway station to the east in Henti province. According to NDB, 5 million tons per annum of tungsten will be produced by around 2005 - 2008.

Although some development plans have been considered, the schedule of these three projects may be postponed mainly due to the difficulty to find out the users in the international market.

(2) Manufacturing projects

1) Cement

Cement production increased from 178 thousand tons in 1980 to the peak of 541 thousand tons in 1987, and then declined to only 82 thousand tons in 1993. There are two cement plants in Mongolia, one in Darkhan and the other in Khutul (60 km from Darkhan). Wet-type rotary kilns are installed in both of the plants, and the capacity of producing cement is 200 thousand tons per annum in Darkhan and 500 thousand tons per annum in Khutul.

In 1993 the Darkhan plant consumed 8,400 tons of coal and the Khutul plant consumed 48,400 tons, and half of the amount was imported from Russia. Coal consumption at their full capacity production is estimated to be 130 thousand tons per annum in Darkhan and 325 thousand tons per annum in Khutul, although current production is only around one-tenth of their capacities.

One new cement plant is being built and will start its operation in 1995. It is located in Hovd city in Hovd province and has the capacity of producing 10 thousand ton per annum of cement.

Additionally, the construction of some small plants similar to the Hovd cement plant is planned in Henti, Omnogovi, and Suhbaatar provinces. Other plants in Bayanhongor and Hovsgol provinces are expected to be larger than those in the three provinces above (It is said that a 100-thousand-ton-plant will be built in Moron city in Hovsgol province and that a 50- 200-thousand-ton-plant in Bayanhongor).

The largest plant now being considered is a 1.2 million-ton-plant at Shivee-Govi (near Shivee Ovoo) in Dornogovi province, which will be completed by around 2000-2005 according to NDB. Upon completion, the plant is estimated to use 700 thousand tons of coal in a year.

2) Brick

The production of bricks increased from 111 thousand tons in 1980 to the peak of 181 thousand tons in 1988 and then declined to only 33 thousand tons in 1993.

There are more than 15 plants manufacturing red (brown) bricks which are used for constructing the main body of houses and buildings. The largest one is located in Ulaanbaatar with the capacity of producing 60 - 70 million pieces per annum of bricks. Other three plants are located in Dornogovi, Hovd, and Govialtay provinces with the capacity of 8 - 16 million pieces of bricks.

Smaller plans in the other provinces are capable to produce 2-4 million pieces of red (brown) bricks respectively, many of which are operating seasonally.

Coal consumption is estimated to be 80 thousand tons per annum at the full capacity production in the Ulaanbaatar plant.

The production of white bricks, which are used for decorating the surfaces or walls of houses and buildings, is supposed to be included in the figures shown above.

There are two white brick plants in Mongolia, one in Darkhan and the other in Dornod. The production capacity of the Darkhan plant is now being expanded from 20 - 30 million pieces to 65 - 75 million pieces.

3) Lime

The production of lime increased from 64 thousand tons in 1980 to the peak of 122 thousand tons in 1988 and then declined to 68 thousand tons in 1993. There are two large lime plants in Mongolia, one in Khutul (the same site as the cement plant) and the other in Darkhan (the same site as the white brick plant). In the Darkhan plant, the utilization rate of production capacity was about 50% in 1993 (30 % in the case of white brick), and 70 % of the products was used for manufacturing white bricks and the rest was supplied to the Erdenet Copper Mine. The Khutul lime plant has the capacity of producing 65 thousand tons per annum, and is estimated to use 30 thousand tons of coal at the full capacity production. There are also other eight lime producing plants in Mongolia.

4) Steel

There is one steel plant in Darkhan city, which started its operation in 1994, and is planning to use coal for steel making in the future. The plant is currently making steel at an electric arc furnace by using iron scrap as material, where a kiln using coal for direct reduction of iron ore will be built by 1998, according to the plan of Ministry of Trade and Industry.

In the plan, the initial capacity of producing 75 thousand tons of sponge iron will be increased to 320 thousand tons, and 320 thousand tons of Sharyngol coal will be used. An iron ore mine will be developed at Tumurtei, 100 km from Darkhan city, where coal will be also used for steam generation and other uses.

2.2.3 Agriculture sector

Agricultural production will increase as below listed, according to NDB (Billion Tug.) :

1993	91.1
1994	118.2
2000	124.9
2005	135.1
2010	140.6

Coal consumption in the agriculture sector increased from 322 thousand tons in 1980 to the peak of 517 thousand tons in 1987 and then decreased to 62 thousand tons in 1993. As the agro-industrial project is considered as one of the targeted projects especially for expanding exports from Mongolia, energy consumption (including coal) in the sector is expected to expand at the rate of more than the average in all sectors.

2.2.4 Public service and household sector

Coal consumption in the sector increased from 427 thousand tons in 1980 to the peak of 784 thousand tons in 1986, and then declined to 209 thousand tons in 1993. In the medium and long term, two factors are considered to contribute to increase in coal consumption in the sector. One is the settlement of houses by a larger number of people, which will result in a larger amount of coal consumption in addition to electric power. The other is the shortage of biomass fuels including animal dung and wood in the gels around large cities, which will urge them to use more coal for cooking and heating.

2.2.5 Transportation / communication and others

Coal consumption in the transportation / communication sector increased from 42 thousand tons in 1980 to 114 thousand tons in 1990, and coal consumption with other sectors increased from 630 thousand tons in 1980 to the peak of 686 thousand tons in 1986, and then declined to 121 thousand tons in 1993. It is estimated that they has been fired mainly in small boilers, not for moving rail cars which are motored by diesel fuel oil. However, such consumption of coal is foreseen to increase as the railway expands the transports of freight and passengers due to higher economic activities in the future.

2.2.6 Exportation

Coal production in existing coal mines is low calorific coal which is not suitable for export and a large amount of export cannot be expected in the future.

Coking coal of Tavantolgoi is one of potential coal resources for export, but development of the transportation facilities in Mongolia and China will be the bottle neck of Tavantolgoi coal development.

Tavantolgoi deposit is located 540km south of Ulaanbaatar. Coal quality is classified into bituminous coal and the several coal seams are classified into coking coal, However, large amount of investment should be required for the construction of infrastructure.

In addition, potential demand for coking coal and its transportation in neighboring countries should be studied in order to determine the development of Tavantolgoi coal.

2.3 Supply capability of coal

2.3.1 Present status of coal mining activities at existing coal mines

There are a large amount of coal reserves of low to medium quality in Mongolia. The geological reserves are about 150 billion tons which are contained in 15 coal basins. Present exploration maturity is low, and it seems that the present measured coal reserves are little when compared with the expected amount of useful resources, however, it is expected to substantially increase overall coal reserves by continuing exploration in the coal deposit areas. Coal is the only significant source of primary energy in Mongolia, therefore, coal development plan is very important subject in energy strategies. At present, there are 17 state coal mines that are controlled by the Ministry of Energy, Geology and Mining (MEGM). The coal production in Mongolia since 1980 is shown in Table 2.11. From 1980 to 1988, coal production grew double the amount, and after 1989, the production gradually decreased because of economic recession caused by the change of economic system from centralized planning system to free market system. At present, about 90 % of total coal production in state mines is produced by the main four coal mines of Sharyngol, Baganuur, Shivee Ovoo, and Aduunchuluun.

Coal mines in Mongolia are classified into two types, the large coal mines (Baganuur, Shivee Ovoo, and Sharyngol) for supplying to the power plants, heat boilers, industry sector, and so on in the CES (Central Energy System) area and the small mines for supplying to local demand. The far distance to the railway makes these small local mines unable to supply coal to the CES, and thus they produce an output of coal only to meet a local demand. Table 2.12 shows present status of coal mining activities.

Note: The CES area means the region where is connected by 110 kV and 220 kV of transmission lines between the five power plants in the cities, Ulaanbaatar, Darkhan, and Erdenet. At present, seven provinces, Selenge, Bulgan, Henti, Arhangay, Tov, Ovorhangay, and Dornogovi belong to the CES area. As regards coal mines, Baganuur, Shivee ovoo, Sharyngol, Nalaikh, Saihan Ovoo, Bayanteeg, Chandgantal, Uburchuluut, and Hangay coal mines are in the CES area (Nalaikh will be closed in 1995). See Figure 4.1.

Table 2.11 Coal Production in Mongolia by Coal Mines (1980 - 1993)

(Unit: 1,000 ton)

Coal Mine	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Nalaikh	804.6	860.0	856.6	818.0	489.5	414.0	629.8	712.6	538.7	434.5	234.9	199.4	114.0	41.6
Sharyngol	1,798.8	2,020.5	2,076.0	2,121.9	2,034.4	2,032.8	2,025.3	1,984.4	2,053.0	1,900.6	1,474.8	1,296.7	1,291.0	1,183.1
Baganuur	539.4	197.6	743.6	718.1	1,386.5	2,509.4	2,884.5	3,342.8	4,064.5	3,785.8	3,700.6	3,831.6	3,398.6	2,848.2
Shivee Ovoo													145.3	603.1
Aduunchuluun	297.2	341.2	356.6	390.5	427.2	412.0	388.5	469.3	612.9	536.1	512.2	496.5	443.5	350.8
Tevshiingovi					71.2	69.2	62.0	70.1	72.3	57.5	37.8	46.8	22.3	22.7
Saikhan Ovoo	35.0				20.0	24.0	27.0	28.1	29.0	26.0	9.2	20.5	7.7	2.8
Nuurstkhotgor	125.6	127.7	124.6	135.3	131.2	134.7	138.6	146.4	180.5	192.0	198.4	174.6	144.3	95.1
Bayanteeg	227.2	206.0	178.1	182.0	200.9	207.8	220.5	221.6	230.1	240.3	226.1	188.6	153.4	108.3
Khartarvagatai	76.2	85.0	98.1	87.5	98.5	109.9	110.5	172.5	192.0	219.7	213.0	157.4	110.0	51.9
Zeegt		47.5	42.0	48.0	55.0	60.0	72.9	78.7	86.8	91.2	72.2	87.8	52.2	24.1
Tavantolgoi	117.7	88.7	95.1	89.0	104.3	106.6	129.3	133.4	136.3	137.3	115.0	129.0	94.0	43.1
Mogoingol	61.5	62.0	65.7	74.2	89.8	102.3	108.0	122.6	124.8	127.9	103.5	108.9	64.3	35.3
Khusheet	51.4	56.6	62.0	67.0	81.5	96.8	86.0	76.0	60.7	65.0	61.5	60.0	41.2	33.6
Chandgantal	67.0	75.0	80.1	82.1	76.4	83.4	85.8	100.8	113.0	120.5	102.3	123.8	91.5	55.1
Jinst												20.0	2.9	10.0
Talbulag	81.2	85.1	77.5	91.4	87.4	91.1	95.8	106.0	111.2	110.1	95.5	94.4	71.1	55.6
Total	4,282.8	4,252.9	4,856.0	4,905.0	5,353.8	6,454.0	7,064.5	7,765.3	8,605.8	8,044.5	7,157.0	7,036.0	6,247.3	5,564.4

(Source) MEGM

Table 2.12 Present Status of Coal Mining Activities

Coal Mine	Production (1,000 ton)	Present capacity (1,000 ton)	Rank of coal	Destination	Mining method
[State mine]					
CES area					
Sharyngol	1,183	800	Sub-bituminous	1,2,3	Open cut
Baganuur	2,848	3,700	Lignite	1,2,3	Open cut
Shivee ovoo	603	600	Lignite	1,2,3	Open cut
Nalaikh	42	closed in 1995	Lignite	1,2,3	Underground
Saikhan ovoo	3	n.a	Bituminous	3	Underground
Bayanteeg	108	642	Lignite	3	Open cut
Chandgantal	55	348	Lignite	3	Open cut
Non-CES area					
Aduunchuluun	350	1,356	Lignite	1,2,3	Open cut
Tevshiingovi	22	266	Lignite	3	Open cut
Nuurstkhotgor	95	266	Sub-bituminous	3	Open cut
Khartarvagatai	52	266	Sub-bituminous	3	Open cut
Zeegt	24	266	Sub-bituminous	3	Open cut
Tavantlgoi	43	75	Bituminous	3	Open cut
Mogoingol	35	90	Sub-bituminous	3	Open cut
Khusheet	34	266	Bituminous	3	Open cut
Jinst	10	150	Bituminous	3	Open cut
Talbulag	56	72	Lignite	3	Open cut
[Prefectural]					
Non-CES					
Maant	3	n.a	Sub-bituminous	3	Open cut
Hurengol	5	n.a	Sub-bituminous	3	Open cut
[Private]					
CES					
Uburchuluut	1	n.a	Lignite	3	Open cut
Hangay	20	n.a	Lignite	3	Open cut
Non-CES					
Tsahiurt	3	n.a	Sub-bituminous	3	Open cut
Dubunt	45	n.a	Sub-bituminous	3	Open cut
Olonbulag	2	n.a	Bituminous	3	Open cut
Narynsohait	n.a	n.a	Bituminous	3	Open cut
Tsagaan ovoo	n.a	n.a	Lignite	3	Open cut
Khoot	1	n.a	Lignite	3	Open cut

(Note) 1 --- power plant, 2 --- heat boiler, 3 --- local use n.a --- not available

(Source) MEGM

(1) Coal mines for the power plants

Coal demand in Mongolia since 1980 is shown in section 2.2. It seems that the most of coal is consumed by electricity and heat sector. Approx. 90 % of the total electricity in Mongolia is generated by the CES which is composed of three coal fired power plants in Ulaanbaatar and each one in Darkhan and Erdenet. At present, three big coal mines (Sharyngol, Baganuur, and Shivee Ovoo) supply coal to the CES.

1) Baganuur coal mine

Baganuur coal mine located in 110 km east from Ulaanbaatar is the largest open pit coal mine in Mongolia. Minable reserves are in excess of 500 million tons up to 200 meters in depth and geological reserves are more than 700 million tons up to 350 meters in depth. There are three minable coal seams from 2.4 to 97.8 meters of thickness. The designed production capacity is six million tons per annum, but, actual production is 3.7 million tons per annum at present. The coal production actually peaked in 1988 at 4.06 million tons and has largely decreased to a level of 2.85 million tons in 1993 due to lack of maintenance parts caused by the economic disruption. Coal quality is lignite with 3,870 kcal/kg of calorific value, 31 % of moisture content, 12.1 % of ash content, and 0.4 % of sulphur content. Coal such as lignite easily causes spontaneous combustion. In 1993, Baganuur mine supplied 69 thousand tons of coal to No.2, 325 thousand tons to No.3, 1.72 million tons to No.4 power plant in Ulaanbaatar, 147 thousand tons to the heat boilers in the CES area, and the rest 500 thousand tons of coal to factories and residential area through Nuurs Company. Coal is transported by two units of M62 type diesel locomotives with an output of 2000 PS that haul 30 wagons on railway from Baganuur to Ulaanbaatar for 201 km. Capacity of each wagon is 65 tons, and as regards transportation capacity between Baganuur and Bagahangai, about four million tons of coal per annum can be transported to Ulaanbaatar by rail.

2) Shivee Ovoo coal mine

Shivee Ovoo open pit coal mine located in 260 km southeast from Ulaanbaatar is the newest coal mine in Mongolia. The mine was commenced in 1992 and was designed to develop a capacity of 500 thousand tons per annum by the Mining Institute of Mongolia. It excavated about 600 thousand tons in 1993. Minable reserves within the present mining boundary are in excess of 500 million tons and geological reserves of the whole area are more than 2.5

billion tons in this deposit. There are four minable coal seams from 2.0 to 23.2 meters of thickness. The coal of Shivee Ovoo coal mine contains lignite of 2,690 ~ 3.610 kcal/kg of calorific value, 34.5~43.6 % of moisture, 8.7~17.3 % of ash, and 0.5~0.9 % of sulphur, but oxidization of coal seam near the surface and the delay of dewatering from the coal seam are further inferior property of the coal. Baganuur and Shivee Ovoo mines are described in detail in Part I of this study. Shivee Ovoo mainly supplies coal to No.3 and No.4 power plants in Ulaanbaatar, heat boiler in Choir, and the rest of coal is consumed locally. Coal is transported by two units of M62 type diesel locomotives with an output of 2000 PS that haul 29 wagons on railway from Shivee Ovoo to Ulaanbaatar for the distance of 250 km.

3) Sharyngol coal mine

Sharyngol open pit coal mine is located in about 200 km north from Ulaanbaatar. This mine was designed and commissioned in 1965 to develop a capacity of 2.5 million tons per annum. Since the remaining minable reserves in the area produce about only 30 million tons within 250 meters in depth, it is required to maintain the present production level of about one million tons per annum. Sharyngol coal is sub-bituminous and has the better quality of high calorific value than Baganuur and Shivee Ovoo. The possibility of blending coals from different areas can also be considered. The typical coal quality of Sharyngol coal mine is 15.0 % of moisture (as received), 17.5 % of ash (air dry), 3,900 - 4,200 kcal/kg of calorific value (as received), and 0.6 % of sulfur (air dry). In 1993, Sharyngol supplied 45 thousand tons to No.2 power plant, 517 thousand tons to No.3 plant, 845 tons to No.4 plant, 216 thousand tons to Darkhan plant, and 129 thousand tons to Erdenet plant. Such being the case, approx. 80 % of coal from Sharyngol has been consumed in power plants in the CES. Sharyngol coal is transported by two units of TE2 type diesel locomotives with an output of 1,000 PS each hauling the fleet which is composed of 25 wagons. Coal from here is transported to each demand site via Darkhan II on the trunk line. In early 1980s, this mine actually supplied two million tons of coal per annum by rail.

4) Aduunchuluun coal mine

Aduunchuluun coal mine located outside the CES also supplies the coal to a power plant in Choybalsan city that is not connected in the CES. The coal-fired power plant (24 MW) that is a few away from Aduunchuluun mine supplies electricity to Dornod and Suhbaatar. The mine developed as an underground mine in 1957 is the biggest in the local mines and shifted

to an open cut mine in 1969. In 1988, an annual output reached 600 thousand tons and exported total 415 thousand tons of coal to former Soviet Union from 1988 to 1992. In 1993, however, the export to Russia stopped because of decreasing Russian coal demand and coal production decreased to 350 thousand tons. Coal quality is lignite of the low grade with 2,400 kcal/kg of calorific value, 45.2% of moisture, 16.7% of ash, and 1.1% of sulphur.

(2) Other local coal mines

In 1960, ten coal mines outside of CES area were developed for local coal demand. Presently, all provinces have their own mine except Bayanolgiy, Zavhan, and Arhangay provinces. It is estimated that most of the local coal mines have a large production capacity in comparison with their actual production scale. The coal production scale is controlled because of the lack of infrastructure facilities to the coal market, and very small local demand as well. Some of local mines have a high quality coal, however, they can neither supply to large demanding area nor to export to foreign countries. In reality, most of the local coal mines have not only no railway system but also no other infrastructures to the user. In light of above-mentioned circumstances, the consumers have to transport it by themselves. And this eventuates costly to transport of coal by the consumers for long distance from the mine site to the market. Poor road condition in rural area reduces transportation efficiency and it reflects very high transportation cost.

In general, there is no large industries in rural area. Coal is used in the heat boiler of the province, public offices, schools, households, and so on. Since coal demand is poor, most of the local mines operate overburden removal in summer and coal mining in winter. If local coal demand increases in the future, they can supply coal by increasing the rate of operation without increasing mining equipments. Figure 2.4 shows coal flow between demand sites and mines.

2.3.2 Development capability of coal mines

There is great possibility of coal development based on open cut method in Mongolia. In reflecting future expansion of coal demand, it would be important to give a priority for coal development from nearest area of the demand sites. There are 17 coal mines that MEGM is responsible for mining operations in Mongolia. The amount of coal production has been gradually decreasing since 1989 due to the economic disruption. Moreover, Nalaikh coal mine near Ulaanbaatar is planned to close up the mining in 1995 because of deterioration of mining condition, and the coal

Figure 2.4 Coal flow between Demand Sites and Coal Mines in Mongolia

(Source) MEGM