Ministry of Infrastructure
Mongolia

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR
REHABILITATION OF POWER PLANTS OF
SUM CENTERS
PHASE IV
IN
MONGOLIA

OCTOBER 2000

JAPAN INTERNATIONAL COOPERATION AGENCY
PACIFIC CONSULTANTS INTERNATIONAL

October, 2000

PREFACE

In response to a request from the Government of Mongolia, the Government of Japan decided to conduct a basic design study on the Project for Rehabilitation of Power Plants in Sum Centers Phase IV and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Mongolia a study team from April 13 to June 21, 2000.

The team held discussions with the officials concerned of the Government of Mongolia, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent Mongolia in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of the Mongolia for their close cooperation extended to the teams.

Kunihiko Saito
President
Japan International Cooperation Agency

October, 2000

Letter of transmittal

We are pleased to submit to you the basic design study report on the Project for Rehabilitation of Power Plants in Sum Centers Phase IV in Mongolia.

This study was conducted by Pacific Consultants International, under a contract to JICA, during the period from March 15,2000 to November 24,2000. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Mongolia and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the Project.

Very, truly yours,

Nobuo Kuga
Project Manager
Basic Design study team on the
Project for Rehabilitation of Power Plants in Sum Centers Phase IV
Pacific Consultants International

UMUNOGOVI

1. Bayandalai
2. Bayan-Ovoo
3. Bulgan
6. Nomgon
7. Khanbogd
8. Tsogt-Ovoo
9. Khurmen
10. Tsogttsetsii

GOVI-ALTAI

11. Taishir
12. Bugat
13. Tugrug
14. Sharga
15. Khaliun
16. Bayan-Uul
17. Guulin
18. Jargalan
A1. Delger
A2. Bayantooroy

BAYANKHONGOL

B6. Guvanbulag
B7. Zag

DORNOGOVI

25. Delgerekh
30. Ulaanbadrakh

SUKHBAATAR

34. Sukhbaatar
36. Tuvshinshiree
37. Uulbayan
38. Munkhkhaan
39. Asgat

DORNOD

43. Matad
45. Chuluunkhoroot
46. Bayan-Uul
47. Sergelen
48. Sumber
50. Bayandun
B1. Dashbalbar

DUNDGOVI

A4. Adaatsag
A5. Delgerhangai

UVURKHANGAI

A6. Tugrug

KHUVSGUL

74. Tumurbulag
75. Burentogtokh
76. Tsetserleg
77. Tsagaan-Uul
78. Tunel
79. Tosontsengel
81. Alag-Erdene

ZABKHAN

86. Yaruu
87. Ikh-Uul
88. Tsagaanchuluut
89. Tsagaankhairkhan
90. Telmen
91. Otgon
92. Tosontsengel
93. Aldarkhaan
A7. Shiluustei
A8. Bayantes
B4. Bayankhairkhan
B5. Tudevtei

UVS

94. Undurkhangai
95. Baruunturuun
96. Bukhmurun
97. Davst
99. Khovd
101. Zavkhan

KHOVD

103. Altai
104. Uench
105. Mankhan
106. Durgun
107. Duut

BAYAN-ULGII

108. Tolbo
109. Tsagaannuur
110. Altai
112. Bayannuur
113. Altantsugts
115. Nogoonnuur

OBJECTIVE SUMS

Photographs showing existing conditions

Tugrug , GOVI-ALTAI

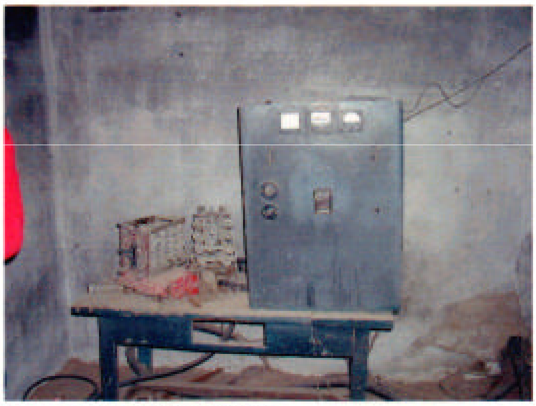
The building for a diesel engine generator set

Buulin , GOVI-ALTAI

A diesel engine generator set (60kW) made in Russia

Sharga, GOVI-ALTAI

A diesel engine generator set (60kW) made in Russia

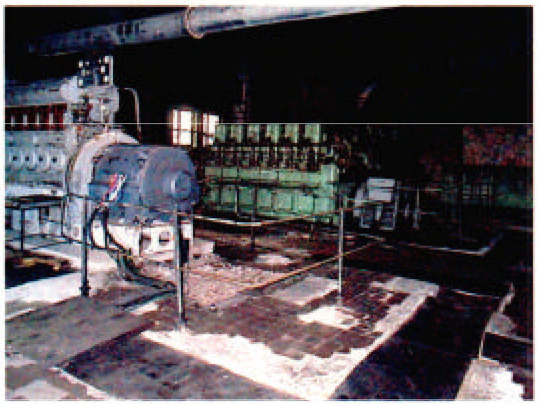


Bugat, GOVI-ALTAI

A switchboard made in Russia

Tosontsengel , ZABKHAN

The power plant in operation



Tosontsengel , ZABKHAN

A diesel engine generator set (315kW) made in Russia

Abbreviations

JICA	:	Japan International Cooperation Agency
GOM	:	Government of Mongolia
MOI	:	Ministry of Infrastructure
MOER	:	Ministry of External Relations
MOF	:	Ministry of Finance
GOJ	:	Government of Japan
ODA	:	Official Development Assistance
ADB	:	Asian Development Bank
WB	:	World Bank
KfW	:	Kreditanstalt für Wiederaufbau (Germany)
USAID	:	U. S. Agency for International Development
MR	:	Mongolian Railway
EIA	:	Environmental Impact Assessment
M/D	:	Minutes of Discussions
JIS	:	Japanese Industrial Standards
JEC	:	Japanese Electrical Committee
JEM	:	Japan Electrical Manufacturers Association
JCS	:	Japanese Cable Standard
IEC	:	International Electrotechnical Committee
DG	:	Diesel Engine Generator
GDP	:	Gross Domestic Product
BHN	:	Basic Human Needs
O & M	:	Operation and Maintenance

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CHAPTER 1

BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

1-1 Background of the Project

Mongolia is located in the center of the Asian continent, and it is landlocked between Russia to the north and China to the east, west, and south. Its total land area (1.5 million km^2) is about four times larger than Japan. Mongolia has a total population estimated at 2.4 million as of 1997, of which 30 percent lives in the capital city of Ulaanbaatar. The per capita gross domestic product ("GDP") in 1997 was $ 1,310 in comparison with $ 1,640 in 1990. About one fourth of the GDP depends on foreign aid.

In the aftermath of the collapse of the former Soviet Union in the early1990s and due to its transition from a centrally planned economy to a market-oriented one, Mongolia is still in the economic and social disruption. This is especially true in the power sector, where the country faces formidable problems because of the fact that, like the CIS countries, electricity hasn't been regarded as a "commodity" and that electric equipment and facilities haven't been maintained and repaired properly for a long time. The former is reflected in insufficient tariff levels which can not recover even the operation and maintenance costs, the low collection rate of the electric charges and low energy efficiency at factories as the largest consumer of electricity. On the other hand, the consequence of the latter is clearly seen in the poor condition of existing power generating equipment and facilities, and transmission/distribution facilities. The restriction of the power supply and unscheduled blackouts, mainly due to accidents, are common.

In view of this situation, international donors, primarily the World Bank and the U.S., have recognized that large-scale sector reform is vital, and it is being put into action. The present electric power supply system of Mongolia consists of the following four components: (1) the Central Power Supply System (including the capital city of Ulaanbaatar, Darkhan and Erdenet) which is based chiefly upon coal-fired power plants; (2) the Western Power Supply System which is serviced by several diesel-fueled power generation sets and is interconnected with the Russian grid; (3) the Eastern Power Supply System which is powered mainly by a power plant in Choibalsan; and (4) decenteralized rural systems which are not interconnected with any of the above three systems and serviced by small diesel generation sets. For the central system which has a total generating capacity of 800MW, accounting for 80% of the country's total capacity, a reform is being put in place by donors headed by U.S. Agency for International Development ("USAID") under the framework that power generation, transmission, load-dispatching, distribution (sales) sectors are to be separated, and they are operated and managed by private enterprises and organizations which get a license from the regulation committee which will be newly established. A draft of the "Electric Power Law", which was formulated based upon a concept of electricity being a "commodity" and incorporated the above reform program, has been already submitted to the assembly. Needless to say, the final objective of this reform is to induce foreign investment into power generating and distribution (sales) sectors. With these ample funds and high technology, the Government of Mongolia ("GOM") expect the old and deteriorated equipment and facilities to be renewed. (The power transmission and load-dispatching sectors are not planned to be privatized.) As for Eastern and Western Power Supply Systems, installation of new diesel engine generators and improvement of a thermal power plant in Choibalsan are being implemented through US Grant Aid arranged by USAID.

In this present status in Mongolia, no concrete reform policy for the remote/isolated systems has been determined to date, in spite of the fact that they will be the biggest financial burden. Mongolia has 314 village communities called Sum Centers (hereinafter referred to as Sums), of which around 125 Sums are provided with relatively stable power supply from the Central System. Most of other Sums suffer from extreme power supply restriction or even lack of power supply because of frequent blackouts due to old diesel generators and insufficient supply of spare parts.

Problems like power shortage and unstable power supply in the above Sums cause serious problems: (1) they hamper the economic/social development of Sums; (2) therefore people looking for jobs flow into urban areas like Ulaanbaatar and form the slums; (3) nomadic people living in mobile tents called Ger, which exist 50 to 100 km around the Sums, can not enjoy sufficient public services in Sums. For these reasons, GOM recognize that rehabilitation and expansion of power equipment/facilities in Sums is an urgent need.

In consideration of the urgency of establishing adequate power supply system in the rural community, Mongolia requested the Government of Japan ("GOJ") in November, 1996 to modernize power generator facilities for the most urgently needed communities out of 189 villages, which have independent power supply systems.

1-2 Outline of the Request

As described in the preceding section, in order to solve power shortage in the rural communities, of which system is not connected with the major power grids, GOM requested GOJ in1996 the renewal of power generating facilities through Japanese Grant Aid. GOJ has responded by implementing grass-roots grants: 25 villages with the First Diesel Power Plants Rehabilitation Project in 1997 and 45 villages with the Second Power Generator

Rehabilitation Project in 1998. Furthermore, Mongolia requested GOJ to modernize power generator systems of the remaining 115 villages in 1999 and GOJ responded to the request by executing “the Project for Rehabilitation of Power Plants in Sum Centers Phase III” in the same year. Mongolia further requested GOJ to implement a similar renewal project for the remaining villages on two occasions (Phase IV).

For “the Project for Rehabilitation of Power Plants in Sum Centers Phase IV (hereinafter referred to as the Project), 83 villages other than 24 villages for Phase III and 7 villages that are planned to be connected with the major power grids are targeted. The GOM’s request is summarized as follows;

- Procurement and installation of new diesel engine generating equipment (with the rated output of 60 kW or 100 kW) for target Sums.
- Provision of training for persons who will be in charge of operation and maintenance of the power generating facilities (hereinafter referred to as “Soft Component”).

GOM requested the Government of Japan to change the target Sums twice (March 8 and April 10, 2000) and finally the target Sums have become 81 in total. The content of the revision of target Sums is exhibited in Table 1-1. Moreover, it was decided to survey the actual condition of the Sums which have been supplied with power generating facilities in Phases I and II, in order to incorporate the survey result into the Project. Two sums for Phase I and four Sums for Phase II were selected to be surveyed. (Refer to Table 1-2)

The member list of the Study team, the schedule of the study, the list of persons met, the minutes of meetings, etc. are shown in Appendix 1 to 5.

Table 1-1 Target Sums for Phase IV (1/2)

AIMAG	Initial target Sums based on GOM's request (83)	Target Sums revised based on the first request of GOM (10 Sums added, 18 Sum eliminated)	Target Sums revised based on the second request of GOM (7 Sums added, 1 Sum eliminated)	Final target Sums (81)
BAYAN-ULGII	Altai			Altai
	Altantsugts			Altantsugts
	Bayannuur			Bayannuur
	Buyant			Buyant
		Khotgor		Khotgor
	Nogoonnuur			Nogoonnuur
	Tolbo			Tolbo
	Tsenget	~~Tsenget~~		
	Tsagaannuur			Tsagaannuur
BAYANICHONGOR	Shargaljuut	~~Shargaljuut~~		
			Gurvanbulag	Gurvanbulag
			Zag	Zag
DORNOD	Bayan-Uul			Bayan-Uul
	Bayandun			Bayandun
	Chuluunkhoroot			Chuluunkhoroot
	Dashhalbar	~~Dashhalbar~~	Dashhalbar	Dashhalbar
	Khalkhgol	~~Khalkhgol~~	Khalkhgol	Khalkhgol
	Matad			Matad
	Sergelen			Sergelen
	Sumber			Sumber
DORNOGOVI	Delgerekh			Delgerekh
	Urgun	~~Urgun~~		
	Atanshiree	~~Atanshiree~~		
	Ulaanbadrakh			Ulaanbadrakh
			Zamiin-Uud	Zamiin-Uud
DUNDGOVI	Elendalai	~~Elendalai~~		
	Khuld	~~Khuld~~		
	Saikhan Ovoo	~~Saikhan Ovoo~~		
		Adaatsag		Adaatsag
		Delgerkhangai		Delgerkhangai
GOVI-ALTAI	Bayan-Uul			Bayan-Uul
		Bayantooroy		Bayantooroy
	Bugat			Bugat
		Delger		Delger
	Guulin			Guulin
	Jargalan			Jargalan
	Khaliun			Khaliun
	Sharga			Sharga
	Taishir			Taishir
	Tugrug			Tugrug
KHENTI	Gurvanbayan	~~Gurvanbayan~~		
	Burenkhaan	~~Burenkhaan~~		
KHOVD	Erdeneburen	Erdeneburen		
	Altai			Altai
	Durgun			Durgun
	Duut			Duut
	Mankhan			Mankhan
	Uench			Uench

Table 1-1 Target Sums for Phase IV (2/2)

KHUBSGUL	Alag-Erdene			Alag-Erdene
	Burentogtokh			Burentogtokh
	Tosontsengel			Tosontsengel
	Khankh	~~Khankh~~		
	Tsagaan-Uul			Tsagaan-Uul
	Tsetserleg			Tsetserleg
	Tumurbulag			Tumurbulag
	Tunel			Tunel
SUKHBAATAR	Burrentsogt			Burrentsogt
	Asgat			Asgat
	Bayantorem	~~Bayantorem~~		
	Khalzan	~~Khalzan~~		
	Munkhkhaan			Munkhkhaan
	Sukhbaatar			Sukhbaatar
	Tuvshinshiree			Tuvshinshiree
	Ulbayan			Ulbayan
TOV	Delgerkhaan	~~Delgerkhaan~~		
		Bayan Unjuul		Bayan Unjuul
UMUNUGOVI	Bayan Ovoo			Bayan Ovoo
	Bayandalai			Bayandalai
	Bulgan			Bulgan
	Khanbogd			Khanbogd
	Khurmen			Khurmen
	Nomgon			Nomgon
	Tsogt Ovoo			Tsogt Ovoo
	Tsogttsetsii			Tsogttsetsii
UVS	Baruunturuun			Baruunturuun
	Bukhmurun			Bukhmurun
	Davst			Davst
		Khartarbagatai		Khartarbagatai
	Khovd			Khovd
	Sagil	~~Sagil~~		
	Naranbulag			Naranbulag
	Undurkhangai			Undurkhangai
	Zavkhan			Zavkhan
UVURKHANGAI	Sant	Sant		
	Bayanteeg			Bayanteeg
		Tugrug		Tugrug
ZABKHAN	Aldarkhaan			Aldarkhaan
			Bayankhairkhan	Bayankhairkhan
		Bayantes		Bayantes
	Tosontsengel			Tosontsengel
	Ikh-Uul			Ikh-Uul
	Otgon			Otgon
		Shiluustei		Shiluustei
	Telmen			Telmen
	Tsagaanchuluut			Tsagaanchuluut
	Tsagaankhairkhan			Tsagaankhairkhan
			Tudevtei	Tudevtei
	Yaruu			Yaruu

Table 1-2 Sums for Phase I and II to be surveyed in the Project (Phase IV)

Time	Aimag	Target Sums (6)
First stage	KHOVD	Zereg
First stage	UMUNOGOVI	Mandal Ovoo
Second stage	BAYAN-ULGII	Deluun
Second stage	DORNOD	Tsagaan-Ovoo
Second stage	GOVI-ALTAI	Dariv
Second stage	UVS	Malchin

CHAPTER 2

CONTENTS OF THE PROJECT

CHAPTER 2　CONTENTS OF THE PROJECT

2-1　Objectives of the Project

Approximately 120 out of 310 villages in Mongolia are provided with relatively stable supply of electrical power by the Central Power Supply System and others; however, the rest of villages are suffering from frequent power stoppage and power supply shortage due to overage diesel generators, insufficient supply of spare parts, lack of funds for fuel purchase. Such power shortages are causing serious impacts on daily village life as well as socio-economic structure of the villages and furthermore causing population decrease in rural communities.

In consideration of urgency of establishing adequate power supply system in the rural community, Mongolia requested GOJ in November, 1996 to modernize power generator facilities for most urgently needed communities out of 189 villages, which have independent power supply system. GOJ has responded by implementing 4 villages by grass-roots grants: 25 villages with the Project for Rehabilitation of Power Plants in Sum Centers Phase I in 1997 and 45 villages with the Project for Rehabilitation of Power Plants in Sum Centers Phase II in 1998. Furthermore, Mongolia requested GOJ to modernize power generator system of the remaining 115 villages in 1999 and GOJ responded to the request with executing “the Project for Rehabilitation of Power Plants in Sum Centers Phase III” in the same year. Mongolia further requested GOJ to implement a similar renewal project for the remaining 81 villages in two occasions - March 8 and April 10, 2000.

In response to the latest Mongolia’s request, this project is intended to enhance the quality of rural living by renewing the existing power generating system and thus providing stable power supply to the targeted 73 villages in Mongolia.

2-2　Basic Concept of the Project

2-2-1　Assistance Policy

(1) Project Scope and Principal Policy

The scope of the project has been discussed with Ministry of Infrastructure (“MOI”) on several occasions at the time of conducting a study for formulating basic design based on the Mongolia’s official request. The resulted record of meetings is filed in the Minutes of Discussions (“M/D”) of June 16, 2000. The following major points of the discussions are mutually confirmed.

1) The subject villages for the project are determined as illustrated in ANNEX-1 of M/D. However, the villages marked with "*" indicate that study findings were different from the Mongolia's request. MOI concurred that treatment of those marked villages requires GOJ's final decision.

2) Scope of the project (tentatively referred as "Equipment Supply Project") for the villages is based on 5 year demand projection as shown in ANNEX-3 of M/D.

3) Mobile maintenance units are vital for successful operation and maintenance of the project. Based on the Mongolia's request to include new 5 Aimag appropriate service area of each mobile maintenance unit will be determined in accordance with the number of villages.

4) Soft Component will be conducted similar to the Second and Third Power Plants Rehabilitation Project. As to training facility, Sume training may be conducted by Aimag unit as a substitute for the facility in Ulaanbaatar in consideration of mitigating economic burden of villages. In case of providing a medium size power generator in Tosontsengel, training will be conducted as counterpart training, separating from training for small power generators.

5) The project will be implemented in two (2) phases due to a large number of the subject villages (i.e., 73 villages.) Refer to Table 2-2-2 (3). The phasing plan will be determined based on the practicable number of installations per phase, meteorological conditions, and accessibility to each subject village. For Tosontsengel, the installation work will be implemented in two equal phases (50/50 installation) in order to minimize transmission interruption during the installation period.

2-2-2 Analysis of the Request

(1) Issues of the Request

Among the eighty-one (81) subject villages, five (5) villages are excluded from the project as a result of the study and discussion with MOI. In addtion, the following ten (10) sites described in following items 2), 3) and 4) were carefuly examined in accordance with the grant aid scheme.

1) Villages Excluded from the Project

Village	Reasons
① Buyaant (Bayan-Ulgii province) ② Naranbulaguni (UVS province) ③ Bayan-Unjuul (Tov province)	These villages wish to connect to the Central Electricity Supply System (“CESS”) and wish to be excluded from the project. If generators are installed, connection to CESS becomes impossible in these villages.
④ Hotgor Bag (Uvs province)	This village declined the study team’s access to the site due to new Russian generator installed in 1999.
⑤ Khalhagol (Dornod province)	This is Bag, a smaller unit political subdivision than village. There are numerous Bags without electricity in Mongolia. For fairness to other Bags, inclusion of this Bag may establish unfair selection standards.

2) Villages which are not “Sum Centers” administratively

Village	Status
① Bayanteeg (Uvurhangai province)	This is a Bag. MOI requested to investigate due to its large community size and proximity to a coal mining facility. At present, the privately owned mining company supplies power.
② Hartarbagati (Uvsp province)	Ditto
③ Bayantooroy (Govi-Altai province)	This is an industrialized Tosogon administrated by Aimag, equivalent in size with Sums. Only two Tosogons, Bayantooroy and Guulin, are not sufficiently electrified. This is the reason that MOI requested to include this Tosogon in the project. Private electric company is presently supplying power.

④ Guulin (Govi-Altai province)	Ditto

3) Villages Incompatible with Capacity of Small Generators

⑤ Tosontsengel (Zabkhan province)	Small generator is not sufficient for needs of this relatively large village. MOI strongly requested a generator to accommodate the needs rather than selecting a standard generator. This request has been recorded in the minutes.
⑥ Zamiin-Und (Dornogovi province)	Small power generator is not compatible with the population size and the existing power supply system. Optimum power supply solution for the Sum Center will be studied. Its adoptability to the project ("Fourth Renewal Project") will be examined later.

4) Villages with Privately Owned and/or Operated Power Supply System

⑦ Tsagaanchuluut (Zabhan province)	Since this year the village is practically operating power plant but generators are privately owned.
⑧ Delgerekhangai (Dornogovi province)	ditto
⑨ Shilunstei (Zabhan province)	The existing facility is owned and operated by an individual.
⑩ Taishir (Govi-Altai province)	Both existing power supply facility and heating facility are privately owned and operated.

(2) Analysis of the Mongolia's Request

The analysis of the request by MR is described below based on the preceding issues, objectives of Fourth Renewal Project, and intent of GOJ's grant aids.

1) Analysis of the Decision Pended

① Sites other than Sum Center

It is recommended to exclude Bayanteeg and Hartarbagati from the project on the following grounds.

- Both communities are Bag, lower subdivision than village;
- Both communities are receiving power supply from adjacent mining company though its supply is not stable; and
- Reasons shown in Table 2-3.

On the other hand, it is recommended to include Bayantooroy and Guulinin the project since these communities are Tosogon directly under Aimag and equivalent to Sum Center in size due to industrial development. Only these communities receive no stable power supply amongst other comparable Tosogons. For further industrial developments of these communities, there are needs for stable power supply. They are also qualified for the objective criteria of this project as shown in Table 2-1.

② Villages Incompatible with Capacity of Small Generators

a) Tosontsengel (Zabkhan) Village

- The existing power generation facility and distribution network are shown in Fig. 2-1. Currently operable equipment is 2 x 315kW generator; however, generators are 10 years old and not in good working condition.
- Projection of Electricity Demand

  Since Sume generators are not operable, it is not possible to estimate the maximum power demand based on the current operations. However, it is approximated to be 1200 kW of the maximum demand based on distribution equipment capacity (i.e., main transformer capacity of 2000KVA with probable generation capability of 1800kW) and interview with Plant Manager.,

  The maximum demand for electricity for the next five years is estimated to be approximately 1300 kW (i.e., 1200kW x 1.062   1300kW) by applying 6.2 % population and household increase in five years to the current estimated demand of 1200kW since 1.2% per annum increase of households and population is recorded in Tosontsengel village, Zabkhan province (refer to 1998Year Book containing census data.) Therefore, 3 x standard 500kW generators will satisfy the maximum demand for the next five years.

Table 2-1 Analysis of Decision Pended (1/2)

Subject Sum \ Criteria	Urgency	Necessity	Contribution to the Public	Operation and Maintenance	Available Area for New Equipment	Judge	Equipment Plan
1. Sites which are not Sum center 1-1 Bag (1) Bayanteeg (Uvurhangai) (2) Hartarbagati (Uvs)						Administrated below the Sum as a Bag; - Estimation of budget can not be decided independently. - Inexperienced in operation and maintenance of planned scale equipment. - From the national level, there are large numbers of Bags without supply of power, therefore, providing equipment for this Bag will be not recommendable in point of fairness. - Demand is too small for the planned equipment.	- -
1-2 Tosogon (Equal size to Sum center) (3) Bayantooroy (Govi-Altai) (4) Guulin (Govi-Altai)	60kW x 1 unit is possible to generate power. However due to overage, possibility of complete supply stop.	- Shortage of supply capacity - No possibility of connection to the national grid - No stock of spare parts	Currently more than 1,200 persons (305 households) can benefit supply of power. In 5 years number of beneficiaries will increase to 1,500 persons. Public facilities such as clinic, schools will be the additional beneficiary.	Experienced in same scale facility as the Project.	Area of existing 60kW - 2 units are sufficient and can be utilized.	Administration is not Sum center, however, the industry has developed and the demand has become nearly equal to Sum center. - Until now, these 2 Tosogons were the only Tosogon not included in the Grant Aid scope. - Stable supply of power is indispensable for the development of industry. - Experienced in operation and maintenance required for the Project. Judging from the above reasons, the 2 Tosogons are deemed to be included in the Project.	Refer Item 3 2 x 60kW
2. Sums which can not be supplied by 60kW and/or 100kW diesel engine generators 2-1 Tosontsengel (Zabkhan)	Generators installed in Sum centers are mostly malfunctioning. 3 district not included in the center do not receive power.	- Shortage of supply capacity - No possibility of connection to the national grid	Supply to 3 districts will enable 3,000 persons (670 households) to receive power.	Experienced in large scale facilities compared to the Project.	Area of existing 880kWx1 unit (not in service), 315kWx 3 units (1 unit not in service) are sufficient and can be utilized.	Deemed to be included in the Project. Current maximum demand : 1,200kW approx. Maximum demand after 5 years : calculated to be 1,300kW when population/household increase is assumed to be 1.2% per year (6.2% increase for 5 years) (1,200kW x 1,062 = 1,300kW) Equipment planned to be 500 kWx3 units.	3 x 500kW
2-2 Zamiin-Und (Dornogovi)						From the following reasons, it is judged not to include in the Project. - Judging from the scale of Sum center (pop. 6,100 / household 1,400) it is appropriate to connect to the national grid as requested to the central government by the Aimag and Sum center. - At the same time, the Sum center is requesting generators for the Ger settlement (400 households), however, this is an temporary countermeasure and the equipment will not be necessary after the Sum is connected to the national grid. - Even though blackouts occur in the winter time, basically 24 hours supply is carried out. - The current power supply system is owned, operated and maintained by the Mongolian Railway. - There is no plan to utilize the Project equipment after the connection to the national power grid.	-

Table 2-1 Analysis of Decision Pended (2/2)

Criteria / Subject Sum	Urgency	Necessity	Contribution to the Public	Operation and Maintenance	Available Area for New Equipment	Judge	Equipment Plan
3. Sums supplying power through private company						MOI will reply if to continue power supply by the private company or not by July 10, 2000. Provision of equipment for the following Sums were provided that the Sum will own, operate and maintain the facilities. The confirmation letter of the above was received by the Japanese Government on July 10, 2000 from MOI. Therefore, the following Sums excluding Shiluustei is deemed to be included in the Project.	
3-1 Bayantooroy (Govi-Altai)	60kW x 2 units are possible to generate power. However due to overage, possibility of complete supply stop.	- Shortage of supply capacity - No possibility of connection to the national grid - No stock of spare parts	680 persons (145 households), clinic, dormitory are will benefit from the supply. In addition, flourmill factory can receive stable power supply.	Operation is implemented by an private own company.	Area of existing 60kWx2 units (overage but in order), 30kWx1 unit (not in operation) is sufficient and can be utilized.		2 x 60kW
3-2 Tsagaanchuluut (Zabhan)	60kW x 1 unit is possible to generate power. However due to equipment failure, possibility of complete supply stop.	- Shortage of supply capacity - No possibility of connection to the national grid - No stock of spare parts	670 persons (148 households) and public facilities can benefit from the supply.	The owner of the facility is a private company, however, the actual operation is implemented by the Sum office.	Area of existing 60kWx3 units (2 units overage and not in operation) is sufficient and can be utilized.		2 x 60kW
3-3 Delgerkh (Dornogovi)	60kW x 1 unit is possible to generate power. However due to overage, possibility of complete supply stop.	- Shortage of supply capacity - No possibility of connection to the national grid - No stock of spare parts	Beneficiaries are 870 persons (193 households) and public facilities.	The owner of the facility is a private company, however, the actual operation is implemented by the Sum office.	Area of existing 100kWx1 unit (not in operation), 60kWx2 unit (1 unit not in operation) is sufficient and can be utilized.		2 x 60kW
3-4 Taishir (Govi-Altai)	30kW x 1 unit and 60kW x 1 are possible to generate power. However due to equipment failure, possibility of complete supply stop.	- Shortage of supply capacity - No possibility of connection to the national grid - No stock of spare parts	Beneficiaries are 540 persons (120 households) , public facilities and sawmill.	Private owned company is operating the power supply and heating system.	Area of existing 60kWx1 unit, 30kWx1 unit is sufficient and can be utilize		2 x 60kW
3-5 Shiluustei (Zabhan)	Generator provided by Japanese Grand Aid in 1999 has been moved in from different Sum.	- No possibility of connection to the national grid	Beneficiaries are 660 persons (161 households) and public facilities.	A private owns the generating facility and providing the supply.	Area of existing 60kWx1 unit, 100kWx1 unit (not in operation) is sufficient and can be utilize		-

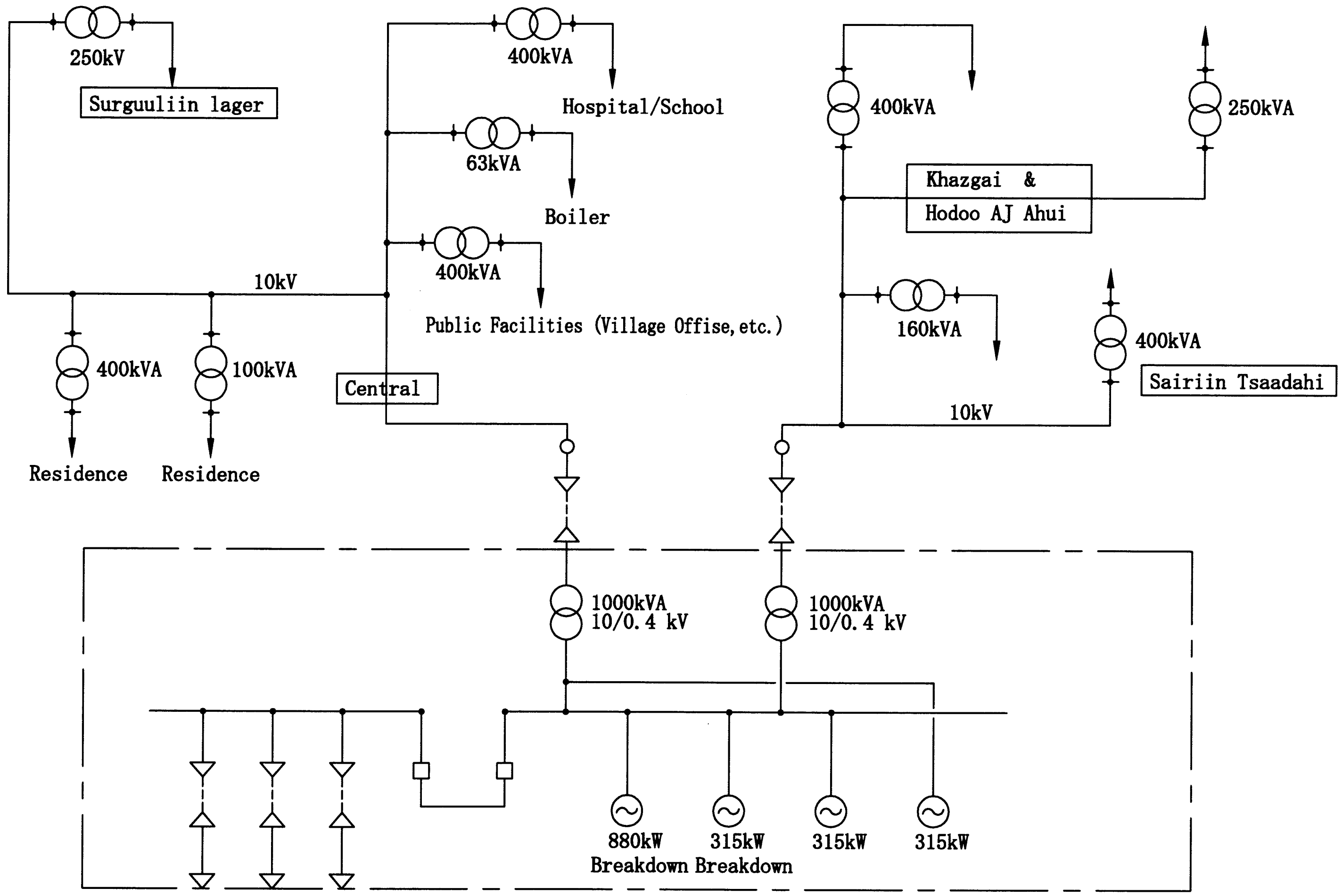


Fig. 2-1 Existing Tosontsengel Power Plant/10 KV Distribution Diagram

- Scope of Equipment Procurement

  The existing plant has sufficient space for newly procured equipment. Thus, the following items are considered.

  • Improvement work for generator foundation,
  • Installation and commissioning of 3 x 500kW generators (including spareparts for three years of operation,
  • Control panel for generators,
  • Auxiliary engine,
  • Panel board and cabinet for servicing the plant,
  • DC supply panel
  • Existing Main transformer - cabling and connection between the main transformer and other control panels.

It is recommended to include this village as part of this project shown in Table 2-1.

b) Zamiin-Uud Sum

The governor of this province explained to the study team at the meeting in Sainshand (provincial capital) that provincial policy towards Zamiin-Uud is as follows.

- Increase transmission capacity by raising transmission voltage originating from China to 35 KV from the existing 10KV,

- Connect to the Central Grid System at Sainshand or Zuunbayan (total transmission extension of approximately 240 km),

- Installation of independent and stand-alone generator plant (diesel operated power plant, etc.)

The provincial government is requesting realization of the above three alternatives to the central government but in reality the provincial government wants connection to the Central Grid System. A similar view was repeatedly mentioned by the village mayor and vice village mayor at the time of interview in Sum Center. However, at this Sum Center level stable power supply to Ger residents in the surrounding areas appeared to be a serious issue because such residents complain about frequent power stoppage during winter.

It is recommended to exclude this village from the project for the following reasons.

- In consideration of the Sum Center size, connection to the Central Grid System is the best alternative solution for the village;

- Despite of winter power stoppage, electricity is currently supplied 24 hours a day;

- The existing power supply facility is owned, operated, and maintained by MR. Village government has no experience in operation and maintenance of power supply facility.

- It is unclear whether or not province and Sum Center has an effective operation/maintenance plan after installation of their desired facility.

c) Villages with Privately Owned and/or Operated Power Supply System

Villages in this category are eight villages as shown below. However, two villages are excluded from the project because of non-Sum Center sites. Thus, six villages are qualified for the project.

Bayanteeg	Excluded (not-in-project)
Hartarbagati	Excluded (not-in-project)
Bayantooroy	
Guulin	
Tsagaanchuluut	
Delgerekhangai	
Shiluustei	
Taishir	

It was explained to Mongolia that Japanese grant aids cannot be categorically applied to private facility as principles of grant and that any facility installed or constructed by use of such grants must be operated and maintained by public entity such as village. MOI responded that they would inform GOJ of whether or not villages would continue private ownership and/or operation of plant by July 10, 2000.

MOI issued an official letter to GOJ stating that six villages above are entrusted to operate and maintain power plants. As shown in Table 2-1, six villages are qualified for the project.

d) Other Villages

Villages classified other than “Decision Pended” is evaluated on the basis of predetermined evaluation criteria as shown in Table2-2. All other villages are found to be qualified for the project.

Table 2-2 Result of the Study (1/2)

○ : No problem, △ : Require modification, × : Problem

AIMAG	SUM	It is not possible to connect to central grid system within 5 years	Existing power plant is not enough for present demand	Space for new generating facility is available	Ground and floor conditions are sufficient for the new generator	Wall & Roof of Power house is sufficient to protect the new generating facility	No problem for inland transport / installation of the new generator	Method of tariff calculation is reasonable and clear	Fee collection ratio is more than 90%	People in the Sum has enough capability for operation and maintenance of the new generator	fuel oil supply is sufficient for the operation of the new generator	No problem in existing power distribution	No problem for public benefit	No problem for fairness	They wish to receive the new generator	**Result**	Remarks
BAYAN-ULGII	Altai	○	○	○	○	△	○	○	○	△	△	○	○	○	○	○	
	Altantsugts	○	○	○	○	△	○	△	○	△	△	○	○	○	○	○	
	Bayannuur	○	○	○	○	△	○	△	○	△	△	○	○	○	○	○	
	~~Buyant~~	○	○	○	○	△	○	△	○	△	△	○	○	○	×	×	They wishes to connect to central grid system [Deleted by MOI]
	~~Khotgor~~	-	-	-	-	-	-	-	-	-	-	-	-	×	×	×	Bag, they refused to accept the survey team.[deleted by MOI]
	Nogoonnuur	○	○	△	△	△	○	△	○	△	△	○	○	○	○	○	
	Tolbo	○	○	○	○	△	○	○	○	△	△	○	○	○	○	○	
	Tsagaannuur	○	○	△	△	△	○	△	○	△	○	○	○	○	○	○	
BAYANKHONGOR	Gurvanbulag	○	○	○	△	△	△	○	○	△	△	○	○	○	○	○	
	Zag	○	○	○	△	△	○	△	○	△	△	△	○	○	○	○	
DORNOD	Bayan-Uul	○	○	○	△	△	△	△	△	△	△	○	○	○	○	○	
	Bayandun	○	○	○	△	△	△	△	△	△	○	○	○	○	○	○	
	Chuluunkhoroot	○	○	○	○	○	○	△	○	△	○	○	○	○	○	○	
	Dashbalbar	○	○	○	△	△	△	△	○	△	△	△	○	○	○	○	
	~~Khalkhgol~~	○	×	○	△	△	△	△	△	×	△	○	○	×	○	×	Bag [deleted by MOI]
	Matad	○	○	○	△	△	△	△	△	△	△	○	○	○	○	○	
	Sergelen	○	○	○	△	△	△	○	△	△	△	○	○	○	○	○	
	Sumber	○	○	○	△	△	△	△	△	△	○	○	○	○	○	○	
DORNOGOVI	Delgerekh	○	○	○	△	△	△	△	△	△	△	○	△	○	○	○	Operation of new generator by Sum is confirmed by MOI's letter issued July 10, 2000.
	Ulaanbadrakh	○	○	○	△	○	△	○	○	△	△	○	○	○	○	○	
	Zamiin-Uud	○	○	×	×	×	○	×	×	×	△	△	○	○	△	×	Small diesel generator cannot be applied
DUNDGOVI	Adaatsag	○	○	○	△	△	○	○	△	△	○	△	○	○	○	○	
	Delgerkhangai	○	○	○	△	△	△	○	△	○	○	○	○	○	○	○	
GOVI-ALTAI	Bayan-Uul	○	○	△	△	△	△	△	△	○	△	○	○	○	○	○	
	Bayantooroy	○	○	○	△	○	○	△	○	○	○	○	△	○	○	○	Tosogon、 operation of new generator by Sum is confirmed by MOI's letter issued July 10, 2000.
	Bugat	○	○	○	△	△	○	△	△	△	○	○	○	○	○	○	
	Delger	○	○	○	△	△	○	△	△	△	○	○	○	○	○	○	
	Guulin	○	○	○	△	△	○	△	○	△	○	○	○	○	○	○	Tosogon
	Jargalan	○	○	○	△	△	○	△	△	△	○	○	○	○	○	○	
	Khaliun	○	○	○	△	△	○	△	△	△	○	○	○	○	○	○	
	Sharga	○	○	○	△	△	△	△	△	○	○	○	○	○	○	○	
	Taishir	○	○	○	△	△	○	○	○	△	○	○	△	○	○	○	Operation of new generator by Sum is confirmed by MOI's letter issued July 10, 2000.
	Tugrug	○	○	○	△	△	○	△	△	△	○	○	○	○	○	○	
KHOVD	Altai	○	○	○	△	△	○	△	○	△	○	○	○	○	○	○	
	Durgun	○	○	○	△	△	○	△	△	△	○	○	○	○	○	○	
	Duut	○	○	○	△	△	○	△	○	△	○	○	○	○	○	○	
	Mankhan	○	○	○	△	△	△	△	△	○	△	△	○	○	○	○	
	Uench	○	○	○	△	△	△	△	○	△	○	○	○	○	○	○	

Table 2-2 Result of the Study (2/2)

○ : No problem, △ : Require modification, × : Problem

AIMAG	SUM	It is not possible to connect to central grid system within 5 years	Existing power plant is not enough for present demand	Space for new generating facility is available	Ground and floor conditions are sufficient for the new generator	Wall & Roof of Power house is sufficient to protect the new generating facility	No problem for inland transport / installation of the new generator	Method of tariff calculation is reasonable and clear	Fee collection ratio is more than 90%	People in the Sum has enough capability for operation and maintenance of the new generator	fuel oil supply is sufficient for the operation of the new generator	No problem in existing power distribution	No problem for public benefit	No problem for fairness	They wish to receive the new generator	**Result**	Remarks
KHUBSGUL	Alag-Erdene	○	○	○	○	△	△	○	○	△	△	○	○	○	○	○	
	Burentogtokh	○	○	○	○	△	△	△	○	△	△	○	○	○	○	○	
	Tosontsengel	○	○	○	○	△	○	○	○	△	△	○	○	○	○	○	
	Tsagaan-Uul	○	○	○	△	△	△	△	○	△	△	○	○	○	○	○	
	Tsetserleg	○	○	○	△	△	△	△	○	△	△	○	○	○	○	○	
	Tumurbulag	○	○	○	△	△	△	○	○	△	△	○	○	○	○	○	
	Tunel	○	○	○	△	△	○	△	△	○	○	△	○	○	○	○	
SUKHBAATAR	Asgat	○	○	○	△	△	△	○	○	△	△	○	○	○	○	○	
	Munkhkhaan	○	○	○	△	△	△	○	○	○	△	○	○	○	○	○	
	Sukhbaatar	○	○	○	○	△	△	△	○	△	△	○	○	○	○	○	
	Tuvshinshiree	○	○	○	△	△	△	△	○	△	△	○	○	○	○	○	
	Uulbayan	○	○	○	○	△	△		○	△	△	○	○	○	○	○	
TOV	~~Bayan Unjuul~~	-	-	-	-	-	-	-	-	-	-	-	-	○	×	×	They wishes to connect to central grid system [Deleted by MOI]
UMUNOGOVI	Bayan Ovoo	○	○	○	○	△	○	△	○	○	○	○	○	○	○	○	
	Bayandalai	○	○	○	○	△	○	○	○	○	△	○	○	○	○	○	
	Bulgan	○	○	○	△	○	○	△	○	○	△	○	○	○	○	○	
	Khanbogd	○	○	○	○	△	○	○	○	○	△	○	○	○	○	○	
	Khurmen	○	○	○	○	△	○	○	○	○	△	○	○	○	○	○	
	Nomgon	○	○	○	△	○	△	△	○	○	△	○	○	○	○	○	
	Tsogt Ovoo	○	○	△	△	△	○	△	○	○	△	○	○	○	○	○	
	Tsogt Tsetsgii	○	○	○	○	△	○	○	○	○	△	○	○	○	○	○	
UVS	Baruunturuun	○	○	○	△	△	○	○	○	○	△	○	○	○	○	○	
	Bukhmurun	○	○	○	○	△	○	○	○	○	△	○	○	○	○	○	
	Davst	○	○	○	○	△	○	△	○	○	△	○	○	○	○	○	
	Khartarbagatai	○	○	○	○	△	○	○	○	○	△	○	×	×	○	×	Bag
	Khovd	○	○	○	○	△	○	△	○	○	△	○	○	○	○	○	
	~~Naranbulag~~	-	-	-	-	-	-	-	-	-	-	-	-	○	×	×	They wishes to connect to central grid system [Deleted by MOI]
	Undurkhangai	○	○	○	○	△	○	△	○	○	△	○	○	○	○	○	
	Zavkhan	○	○	○	○	△	○	○	○	○	△	○	○	○	○	○	
UVURKHANGAI	Bayanteeg	○	△	×	×	×	○	×	×	×	○	△	×	×	○	×	Bag
	Tugrug	○	△	○	△	△	△	○	○	○	○	○	○	○	○	○	
ZABKHAN	Aldarkhaan	○	○	○	△	△	△	△	○	△	△	○	○	○	○	○	
	Bayankhairkhan	○	○	○	○	○	△	○	○	△	△	○	○	○	○	○	
	Bayantes	○	○	○	△	○	△	△	○	△	△	○	○	○	○	○	
	Tosontsengel	○	○	○	△	○	○	△	○	○	○	○	○	○	○	○	Small diesel generator cannot be applied
	Ikh-Uul	○	○	○	△	△	△	○	○	△	△	○	○	○	○	○	
	Otgon	○	○	○	△	△	△	○	○	△	△	○	○	○	○	○	
	Shiluustei	○	△	○	△	△	△	×	△	×	△	△	△	○	○	○	
	Telmen	○	○	○	△	△	△	○	○	△	△	○	○	○	○	○	
	Tsagaanchuluut	○	○	○	△	△	△	○	○	△	△	○	△	○	○	○	Operation of new generator by Sum is confirmed by MOI's letter issued July 10, 2000.
	Tsagaankhairkhan	○	○	○	△	△	△	○	○	△	△	○	○	○	○	○	
	Tudevtei	○	○	○	△	△	△	○	○	△	△	○	○	○	○	○	
	Yaruu	○	○	○	△	△	△	○	○	△	△	○	○	○	○	○	

2) Villages Qualified for the Project

As afore-mentioned, five villages out of 81 villages originally requested by Mongolia were excluded from the Project during the course of discussions with MOI. Furthermore, three villages such as Bayanteeg, Hartarhagati and Zamiin-Uud are excluded from the project amongst villages of "Decision Pended." In all 73 villages are qualified as part of the project.

Basic design and basic implementation plan are targeted for seventy-three (73) villages specified above.

2-3 Basic Design

2-3-1 Design Concept

On the basis of discussions with MOI and the field survey, the following design policies are formulated in consideration of natural and economic conditions, constructability and logistics conditions, operation/maintenance ability of implementing agency, and construction period of grant projects.

(1) Natural Conditions

1) Elevation

Equipment selection for villages situated at higher elevation shall be made on the basis of adequacy of power output at the elevation. In another word, higher output equipment may be specified if necessary to attain a design output.

2) Lightening

Many incidents of seasonal lightening were recorded in the mountainous regions. Power to villages is supplied by low voltage aerial aluminum transmission wires, which may damage power generator system by inducing lightning. The system shall be designed to counter such lightning incidents.

3) Temperature

Temperature difference of the minimum -50°C and the maximum 45°C was recorded at one of the subject villages. The system shall be designed to withstand such a temperature difference.

4) Precipitation

The total annual precipitation of the subject villages is limited to approximately 245 mm for the past five (5) years. Since the proposed equipment will be housed, no special considerations for extraordinary precipitation are considered.

5) Winds and Sand Dusts

Sume villages have a recorded maximum wind velocity of 40m/sec. Although the equipment will be housed, preventive measure for sand dust intrusion to the housing will be required in the southern desert region.

6) Generator Foundation

Generator foundation requires more concrete mass rather concrete strength for serving its purpose. An optimum construction method of in-situ concrete casting will be adopted for its apparent economic reason.

(1) Environmental Mitigation Measures

Environmental mitigation policy will be described to counter the following potential environmentally detrimental elements. During the field study, Mongolia has requested GOJ to adopt mitigation measures for the same elements.

- Exhaust gas,
- Waste oil treatment, and
- Used batteries

1) Exhaust Gas

Although no pollution regulations on exhaust gas of 60/100kW diesel generators are adopted in Mongolia and Japan, low emission type generators, whose emission level is lower than the regulated technical guidelines set forth by the Ministry of Construction of Japan, will be adopted for the project. For 500kW diesel generators, generator type emitting less exhaust level than the Japanese standards will be adopted.

2) Waste Oil Treatment

Waste oil may be treated in the following ways.

- Recycling of waste oil,
- Incineration treatment at a small incinerator, and
- Incineration treatment at a thermal power plant.

Recycling of waste oil is the most preferable method; however, cost/benefit of treatment plant and marketability of the recycled products is not favorable to adopt this method. As a matter of fact, Mongolia has constructed such recycle plant but the plant was ultimately shut down due to non-existent economic viability in Mongolia. Larger recycling plants are operating in Japan but similarly their economic viability is questionable.

There is a solution to provide a small incinerator installed at all 73 subject villages to incinerate waste oil. At present, home stove is used to burn waste oil in villages. There are no regulations to control use of small incinerators in Mongolia and Japan. However, such small incinerators are intended for perfect combustion and they appear to be less polluting than ordinary home stoves. On the other hand, there is another solution that mobile maintenance crue can be utilized to collect waste oil at the time of regular maintenance check, and incinerate at a small incinerator in Aimag. This solution inevitably increases burden on mobile maintenance crue and deteriorate environments of Aimag more so than each village incinerating its own waste oil. For this reasoning, installment of a small incinerator for each village is a better solution.

In case of treating waste oil at thermal power plant, mitigation measures for exhaust gas are taken at such plant. It is acceptable to mix waste oil with the fuel in such case. However, it is unrealistic to consider this mitigation measure for the project since only thermal plants in Mongolia is limited to Choibarsan And Ulaanbaatar. Transportation of waste oil to these plants itself appears infeasible from operation and maintenance point of view.

Thus, it is recommended to adopt a mitigation measure of utilizing small incinerators for waste oil treatment.

3) Used Battery

In the past projects (upto Third Power Supply Project), 262 generators have installed and additional 147 generators are planned to be installed, totaling 409 generators at the end of this project. This means that 1,636 car batteries must be treated every 3 to 4 years. In Japan manufacturers of battery are responsible for collection, recycling, dismantling, and treatment. Investment for such treatment facility is considerable. It is desirable for Mongolia at national level to develop permanent mitigation measures as environmental policy; however, in consideration of large investments in this regard, it is recommended for Mongolia to store used batteries safely.

4) Other potential environmental pollutions such as noise and vibration are considered nil since power plants are located or to be located fairly distant from residential areas.

(3) Design Policy for Generator Foundation

For generator foundation design, there are two methods: in-situ concrete and precast concrete panel (cast at plant in Ulaanbaatar) In this project, concrete mass is more important than its strength; thus, in-situ concrete is recommended for its cost effectiveness.

(4) Policy for Mobile Maintenance Unit

A comparison table indicating locations of mobile maintenance unit (from grass-root grant to Fourth Power Supply Project) is shown in Table 2-3 below.

Table 2-3 Tentative Locations of Mobile Maintenance Unit

Aimag Mobile Maintenance Unit Location		Mobile Maintenance Unit Aimag Jurisdiction Territory	Number of Villages Administered by Mobile Maintenance Unit	Tentative Locations of Mobile Maintenance Unit
1	Govi-Altai	Govi-Altai	19	●
2	Bayanhongol	Bayanhongol	17	●
3	Khuvsgul	Khuvsgul	19	●
		Bulgan	1	
4	Zabkhan	Zabkhan	23	●
5	Khenti	Khenti	7	
6	Khovd	Khovd	12	
7	Sukhbaatar	Sukhbaatar	11	
8	Uvurkhangai	Uvurkhangai	7	
		Arkhangai	3	
9	Dundgovi	Dundgovi	5	
10	Dornod*	Dornod	9	●
11	Uvs*	Uvs	12	●
12	Bayan-Ulgii*	Bayan-Ulgii	8	●
13	Dornogovi*	Dornogovi	6	●
14	Umnogovi*	Umnogovi	13	●
Total			172	9

After analyzing service area per mobile maintenance unit and the number of villages needed for service, it is concluded to install mobile units in nine (9) Aimags.

(5) Soft Component

As for the operation of electric power supply of the village that are not connected to the Central Power Supply System, the associated villages are implementing the operation and maintenance on a self-financing system. However, there are no dedicated staffs to implement the operation and maintenance of the engine generator, but only an officer who holds another post in the village. Accordingly, the operation system is far from what is called a sustainable operation of power supply.

Up to recent years, these villages have utilized generating facilities manufactured by the former Soviet Union. Therefore, they do not have adequate knowledge regarding the facilities to be supplied by this Project. The existing facilities are not maintained periodically and it was found out that repair work is executed each time after any breakdown occurs. In addition, most of the villages do not keep daily operation records/logs, therefore, the actual cause of the breakdown can not be pursued.

Most of villages adopt fixed price method which means partiality arises due to no link between the consumed power and payment amount. Each time when it is necessary to purchase spare parts caused by breakdown, the villagers are burdened by an additional payment since the existing electric charges do not include such cost.

During the mission's stay in Mongolia, the MOI requested to the study team include the "Soft Component" which was carried out during related former project.

From the above reasons, the "Soft Component" included in this Project will fundamentally follow the Phase II and III projects, but is further strengthened in the following points.

- Planning of the implementation plan of mobile maintenance team
- Complete recording of the daily logs of the village operation and works by mobile maintenance team
- Define the functions of each village, Mobile Maintenance Unit System, MOI regarding communication and clarify the communication setup.

2-3-2 Design Criteria

For determining proper design capacity of generator for each village, reliable demand projection is required for such village. Therefore, it is important to collect detailed information and data on demand characteristics and existing supply status of villages.

This study team has distribute questionnaires written in Mongolian to all villages prior to the actual survey and collected the answered questionnaires (later translated into English). At the time of collection, the study team checked consistency of data by interviewing respondents so as to enhance accuracy of data.

(1) Basic Data for Electricity Demand Projection

Demands are classified into three user types and analyzed based on the collected basic data.

1) General demand (household demand),
2) Public demand, and
3) Industrial demand (Industrial and commercial demand.)

The maximum demand for each village is estimated by plotting daily load curve for the five year projection, assuming that the daily peak of 1) General demand and a sum of 2) Public demand and 3) Industrial demand do not occur simultaneously.

The following data and information were used for the five-year demand projection.

① 1999 Mongol Statistics (Year Book)
② 2000 Mongol Census Data (a copy received from Statistics Bureau)
③ Questionnaires conducted by the Study Team

Learning from the actual demands of Phase I and II of the Project for Rehabilitation of Power Plants of Sum Centers (actual demands less than projected), demand projections are made based on actual population and household indices of subject villages rather than applying national averages.

(2) Demand Projection

1) General Demand

Approximately 70 % of the total demand is this demand type. As shown in the study data, demand projection is based on the peak winter season between October and April.

Peak demand period occurs from 17:00 hrs. to 23:00 hrs. Generators are rarely operated in these hours in villages.

2) Public Demand

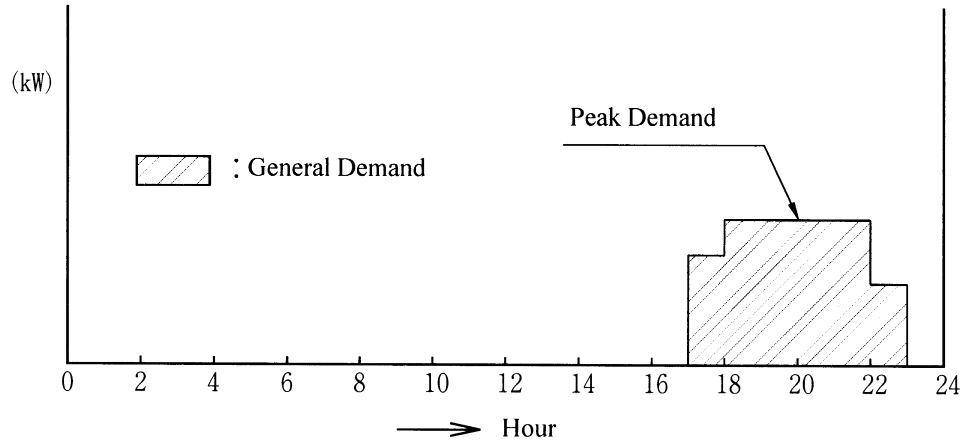
Public demand includes demands for village office, hospitals, schools, civic centers, and central heating needs. This type of demand occurs from 8 a.m. to 5 p.m. However, hospitals and central heating system require 24 hours operation in winter. Boiler loads will be based upon 24 hours operation. Since there is no plan for new facilities until year 2005, no abrupt change in public demand is anticipated. Therefore, public demand will be the same as today.

3) Industrial Demand

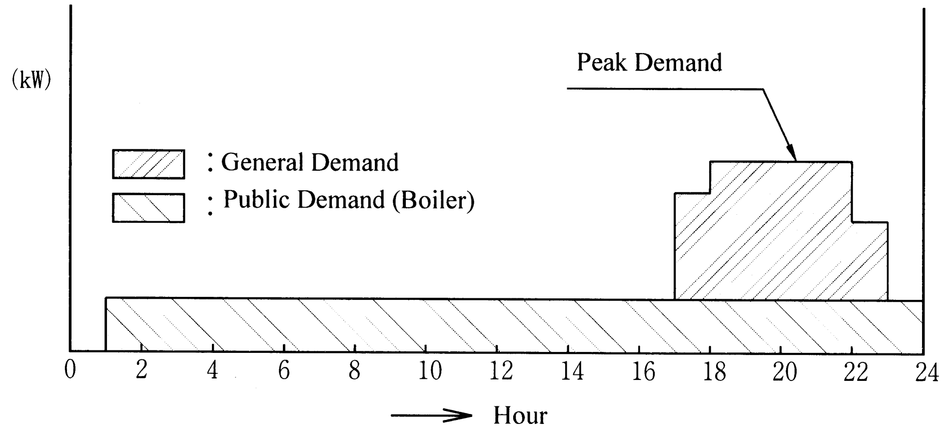
Demands from wool manufacturing, woodcraft, food processing, and hotels are classified in this category. At present, instability in power supply is causing practically suspension of business operation. Once stability in power supply is re-established, this industrial demand will be increased in the future. Thus, this type of demand will be projected as part of demand analysis.

Assuming that operating hours are constant, daily load curve in five years later will be illustrated in three patterns as shown in Fig. 2-2.

① General Demand Only



② General Demand＋Public Demand （incl. boiler）



③ Public Demand + Industrial Demand

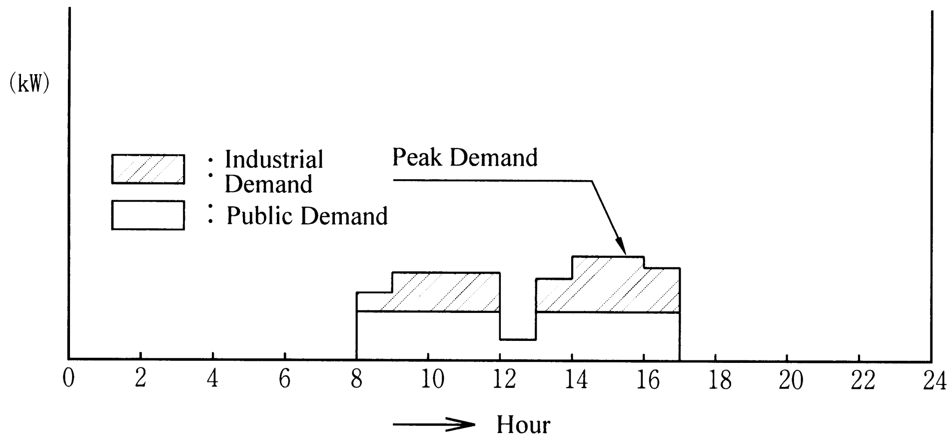


Fig. 3-2 Daily Loading Patterns by Village

(3) Design Generator Capacity

Design generator capacity (generator capacity and number of generators) was determined based on the following determinants.

1) Optimally economical operation must be feasible for the daily load condition curve of the fifth year demand. In another word, its operation must be feasible at low fuel consumption level.

2) Combined capacity of each generator and number of generators installed must be sufficient for the maximum demand load. Generator capacity should be estimated in consideration of transmission energy loss(i.e. transmission wire sizing and service distance.)

3) In order to achieve parallel operation of generators, combination of same generators is adopted. However, no connection or parallel operation with existing generators is considered.

Each resultant figure is shown in the following tables and figures.

①	Table 2-4	Maximum Demand, Energy Loss, and Design Generator Capacity
②	Table 2-5	Generator Capacity and Required Number of Generators by Villages
③	Fig. 2-3-1～2-3-18	Daily Load Curve and Design Generator Capacity by Villages

Table 2-4 Maximum Demand Projection, Estimated Energy Loss, and Design Power Generation (1/2)

Province	Village	Number of Supply Lines (cct)	Max. Demand Projection (1) (kW)	Estimated Energy Loss (2) (kW)	Design Power Generation (1) + (2) (kW)
BAYAN-ULGII	Altai	3	120.8	12.9	133.7
	Altantsugts	4	79.6	11.7	91.3
	Bayannuur	3	151.4	39.4	190.8
	Nogoonnuur	3	128.9	19.0	147.9
	Tolbo	3	128.9	42.3	171.2
	Tsagaannuur	3	161.3	26.5	187.8
BAYANKHONGOR	Gurvanbulag	3	93.7	18.0	111.7
	Zag	4	77.8	3.7	81.5
DORNOD	Bayan-Uul	3	156.8	17.0	173.8
	Bayandun	3	171.5	8.8	180.3
	Chuluunkhoroot	1	207.1	16.4	223.5
	Dashbalbar	2	103.2	4.0	107.2
	Matad	4	73.5	7.8	81.3
	Sergelen	3	100.2	13.0	113.2
	Sumber	4	232.2	43.0	275.2
DORNOGOVI	Delgerekh	5	97.3	22.2	119.5
	Ulaanbadrakh	3	89.3	23.3	112.6
DUNDGOVI	Adaatsag	2	79.7	3.8	83.5
	Delgerkhangai	3	93.0	21.0	114.0
GOVI-ALTAI	Bayan-Uul	1	122.9	24.5	147.4
	Bayantooroy	4	81.7	24.7	106.4
	Bugat	3	103.4	2.6	106.0
	Delger	4	88.0	30.0	118.0
	Guulin	3	127.1	7.5	134.6
	Jargalan	4	104.3	2.5	106.8
	Khaliun	4	104.9	4.7	109.6
	Sharga	3	91.1	12.4	103.5
	Taishir	2	68.4	0.7	69.1
	Tugrug	3	96.1	4.1	100.2
KHOVD	Altai	4	101.8	11.3	113.1
	Durgun	2	103.4	11.6	115.0
	Duut	4	95.8	4.0	99.8
	Mankhan	4	157.9	16.7	174.6
	Uench	2	89.2	20.5	109.7
KHUVSGUL	Alag-Erdene	3	116.2	17.5	133.7
	Burentogtokh	3	159.7	22.0	181.7
	Tosontsengel	5	129.7	23.0	152.7
	Tsagaan-Uul	2	145.9	17.4	163.3
	Tsetserleg	5	172.3	18.6	190.9
	Tumurbulag	3	86.4	16.8	103.2
	Tunel	4	105.1	20.0	125.1
SUKHBAATAR	Asgat	3	88.6	25.9	114.5
	Munkhkhaan	3	162.4	22.7	185.1
	Sukhbaatar	2	135.1	23.3	158.4
	Tuvshinshiree	2	90.9	18.7	109.6
	Uulbayan	3	83.2	33.5	116.7
UMUNOGOVI	Bayan Ovoo	6	91.2	9.7	100.9
	Bayandalai	4	92.4	17.3	109.7
	Bulgan	3	83.4	9.2	92.6
	Khanbogd	4	95.8	19.0	114.8
	Khurmen	3	91.8	16.9	108.7
	Nomgon	3	90.9	25.0	115.9
	Tsogt Ovoo	5	71.1	3.7	74.8
	Tsogttsetsii	3	70.0	16.5	86.5

Table 2-4 Maximum Demand Projection, Estimated Energy Loss, and Design Power Generation (2/2)

Province	Village	Number of Supply Lines (cct)	Max. Demand Projection (1) (kW)	Estimated Energy Loss (2) (kW)	Design Power Generation (1) + (2) (kW)
UVS	Baruunturuun	2	218.9	17.6	236.5
	Bukhmurun	2	92.8	14.9	107.7
	Davst	4	99.8	15.8	115.6
	Khovd	4	92.5	18.4	110.9
	Undurkhangai	3	137.6	51.4	189.0
	Zavkhan	5	98.1	7.8	105.9
UVURKHANGAI	Tugrug	3	95.4	20.0	115.4
ZABKHAN	Aldarkhaan	4	139.1	20.3	159.4
	Bayankhairkhan	2	77.5	21.5	99.0
	Shiluustei	3	101.4	10.3	111.7
	Bayantes	3	92.1	18.4	110.5
	Ikh-Uul	2	79.0	31.9	110.9
	Otgon	1	68.9	16.4	85.3
	Telmen	3	71.1	31.0	102.1
	Tsagaanchuluut	4	104.3	2.7	107.0
	Tsagaankhairkhan	4	101.1	12.9	114.0
	Yaruu	3	81.4	27.9	109.3
	Tosontsengel	2	1500.0	0.0	1500.0

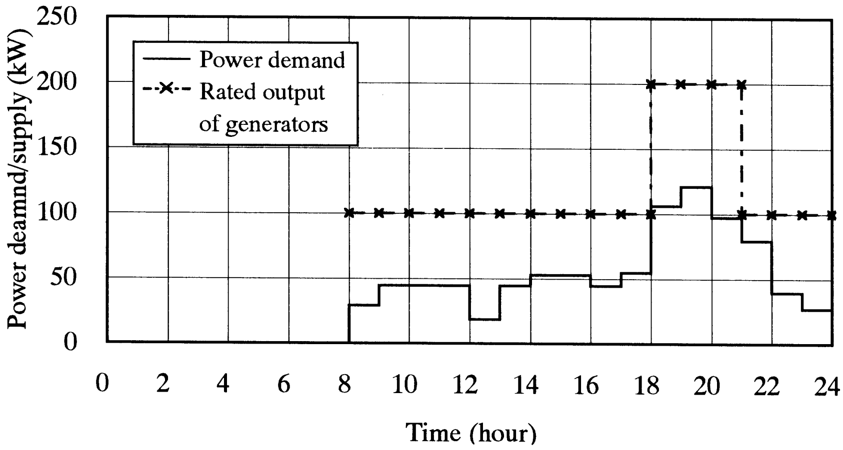
Table 2-5 Number of Generators and Total Generator Capacity (1/2)

Province	Village	60kW	100kW	500kW	Total Capacity	Remarks
BAYANKHONGOR	Gurvanbulag	2			120	
	Zag	2			120	
BAYAN-ULGII	Altai		2		200	
	Altantsugts	2			120	
	Bayannuur		2		200	
	Nogoonnuur		2		200	
	Tolbo		2		200	
	Tsagaannuur		2		200	
DORNOD	Bayandun		2		200	
	Bayan-Uul		2		200	
	Chuluunkhoroot		3		300	
	Dashbalbar	2			120	
	Matad	2			120	
	Sergelen	2			120	
	Sumber		3		300	
DORNOGOVI	Ulaanbadrakh	2			120	
	Delgerech	2			120	
DUNDGOVI	Adaatsag	2			120	
	Delgerkhangai	2			120	
GOVI-ALTAI	Bayan-Uul		2		200	
	Bugat	2			120	
	Delger	2			120	
	Jargalan	2			120	
	Khaliun	2			120	
	Sharga	2			120	
	Taishir	2			120	
	Tugrug	2			120	
	Guulin		2		200	
	Bayantooroy	2			120	
KHOVD	Altai	2			120	
	Durgun	2			120	
	Duut	2			120	
	Mankhan		2		200	
	Uench	2			120	
KHUBSGUL	Alag-Erdene		2		200	
	Burentogtokh		2		200	
	Tosontsengel		2		200	
	Tsagaan-Uul		2		200	
	Tsetserleg		2		200	
	Tumurbulag	2			120	
	Tunel	2			120	
SUKHBAATAR	Asgar	2			120	
	Munkhkhaan		2		200	
	Sukhbaatar		2		200	
	Tuvshinshiree	2			120	
	Uulbayan	2			120	

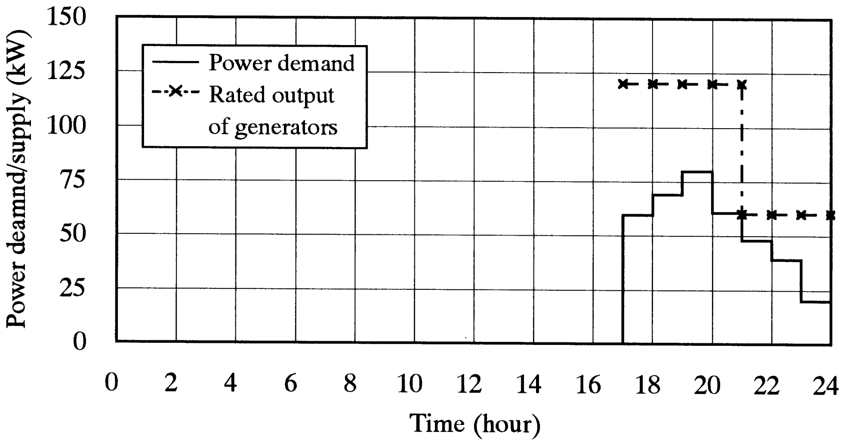
Table 2-5 Number of Generators and Total Generator Capacity (2/2)

Province	Village	60kW	100kW	500kW	Total Capacity	Remarks
UMUNOGOVI	Bayan Ovoo	2			120	
	Bayandalai	2			120	
	Bulgan	2			120	
	Khanbogd	2			120	
	Khurmen	2			120	
	Nombon	2			120	
	Tsogot Ovoo	2			120	
	Tsogttsetsii	2			120	
UVS	Baruunturuun		3		300	
	Bukhmurun	2			120	
	Davst	2			120	
	Khovd	2			120	
	Undurkhangai		2		200	
	Zavkhan	2			120	
UVURKHANGAI	Tugrug	2			120	
ZABKHAN	Aldarkhaan		2		200	
	Bayankhairkhan	2			120	
	Bayantes	2			120	
	Ikh-Uul	2			120	
	Otgon	2			120	
	Telmen	2			120	
	Tsagaankhairkhan	2			120	
	Tudevtei	2			120	
	Shiluustei	2			120	
	Yaruu	2			120	
	Tosontsengel			3	1,500	
	Tsagaanchuluut	2			120	
Total		100	47	3	12,200	

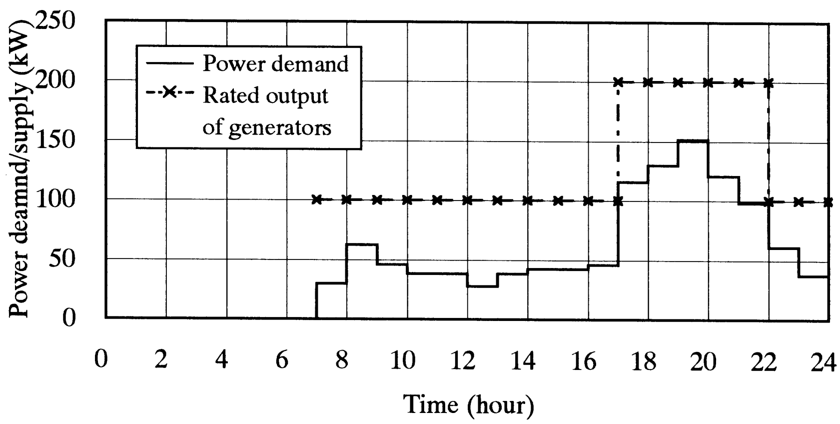
Aimag : BAYAN-ULGII
Sum : Altai
Generator : 2x100kW



Aimag : BAYAN-ULGII
Sum : Altantsugts
Generator : 2x60kW



Aimag : BAYAN-ULGII
Sum : Bayannuur
Generator : 2x100kW



Aimag : BAYAN-ULGII
Sum : Nogoonnuur
Generator : 2x100kW

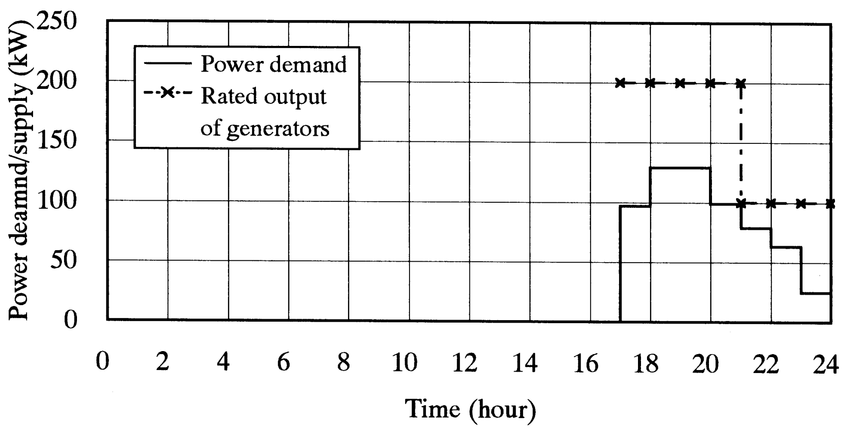
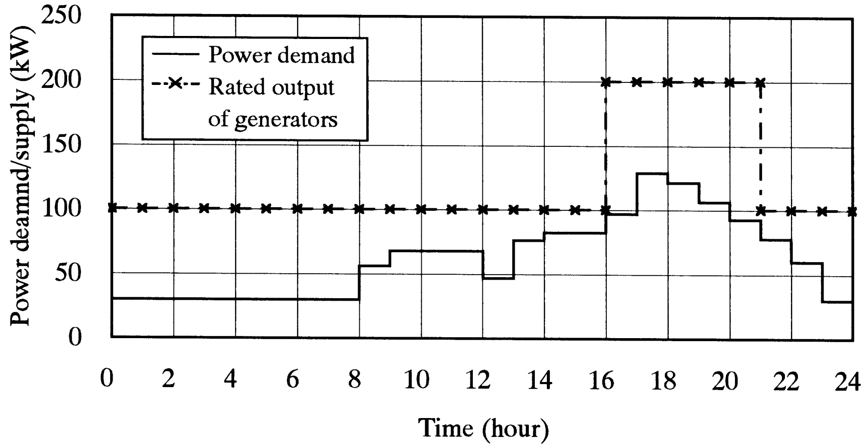
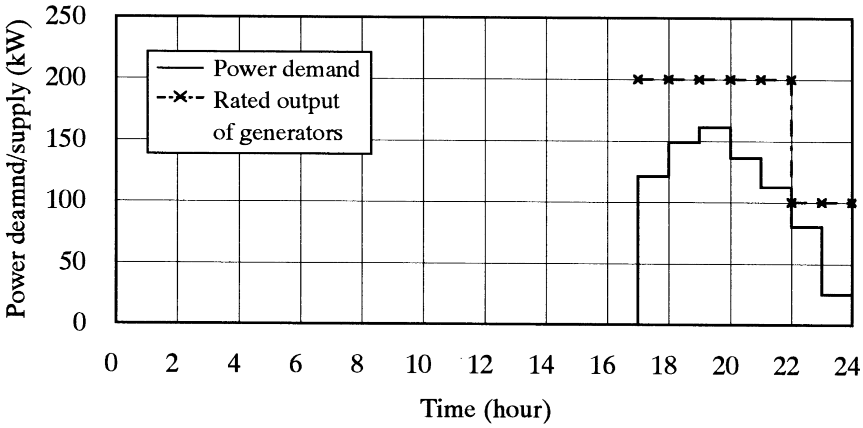


Fig. 2-3-1 Load Curve and Generator Capacity by Villages

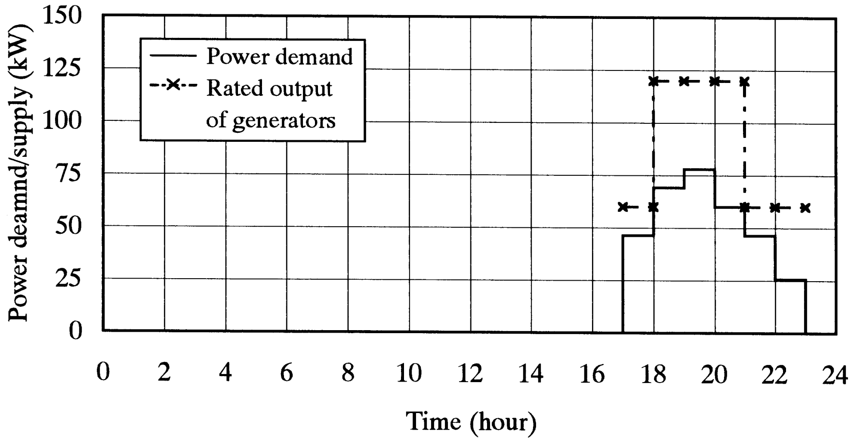
Aimag : BAYAN-ULGII
Sum : Tolbo
Generator : 2x100kW



Aimag : BAYAN-ULGII
Sum : Tsagaannuur
Generator : 2x100kW



Aimag : BAYANKHONGOR
Sum : Gurvanbulag
Generator : 2x60kW



Aimag : BAYANKHONGOR
Sum : Zag
Generator : 2x60kW

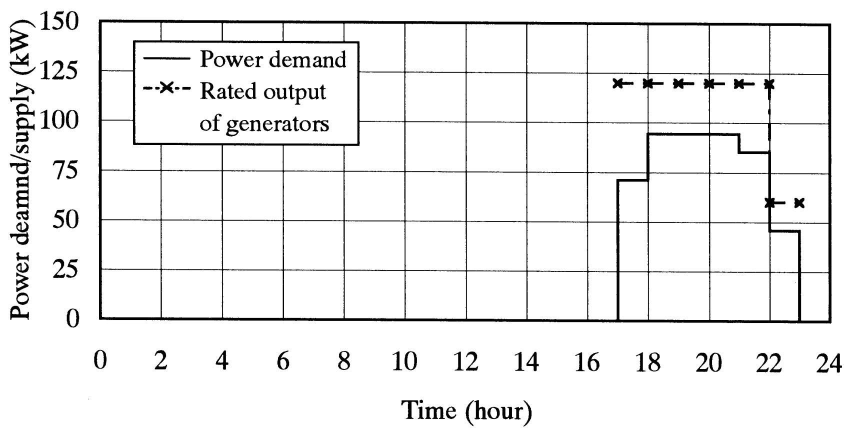


Fig. 2-3-2 Load Curve and Generator Capacity by Villages

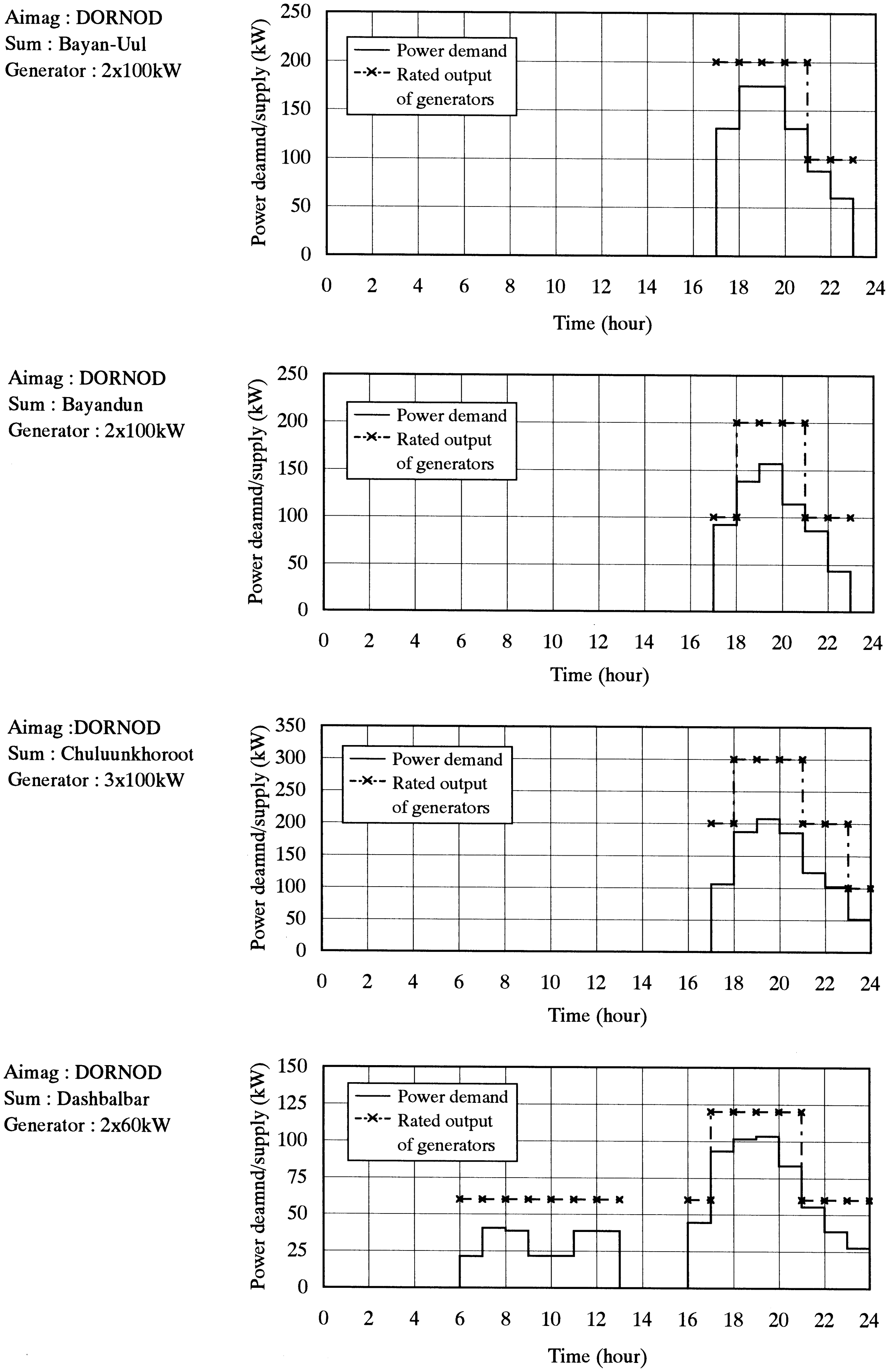
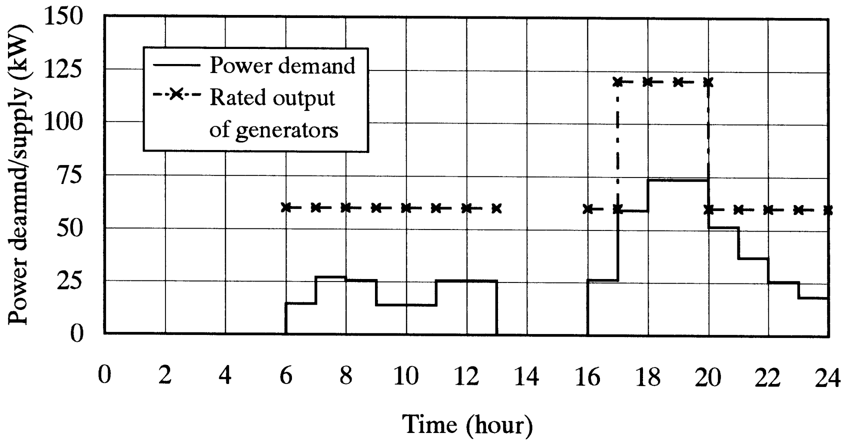
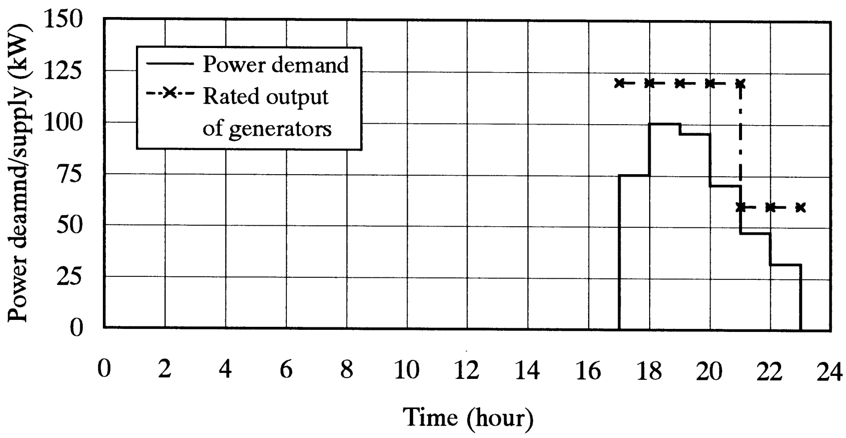


Fig. 2-3-3 Load Curve and Generator Capacity by Villages

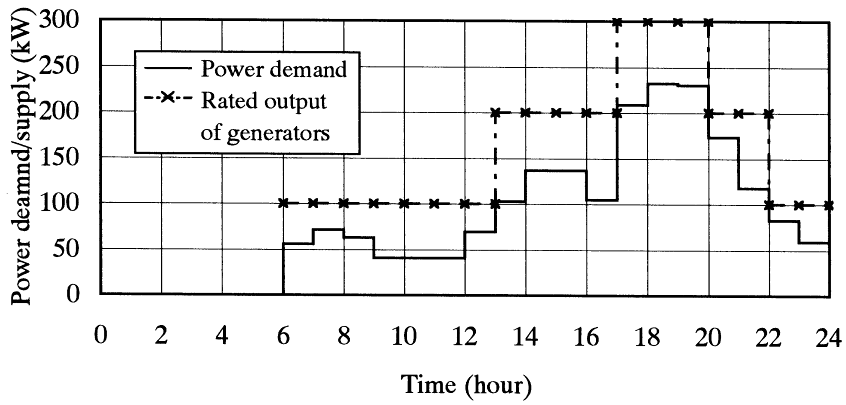
Aimag : DORNOD
Sum : Matad
Generator : 2x60kW



Aimag : DORNOD
Sum : Sergelen
Generator : 2x60kW



Aimag :DORNOD
Sum : Sumber
Generator : 3x100kW



Aimag : DORNOGOVI
Sum : Delgerekh
Generator : 2x60kW

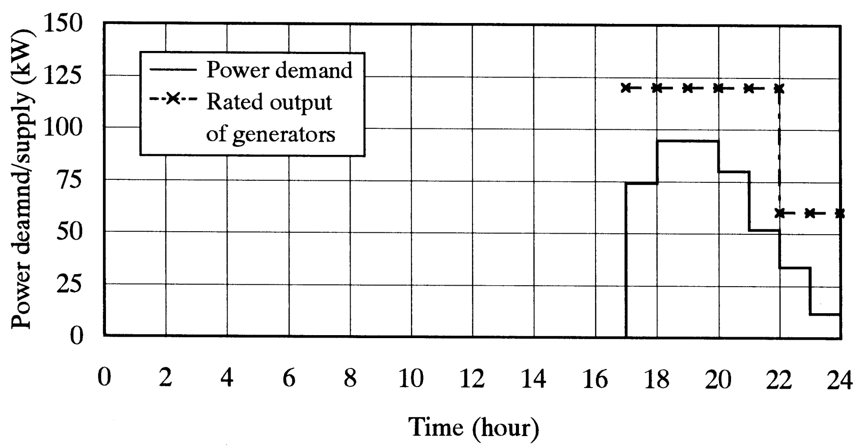
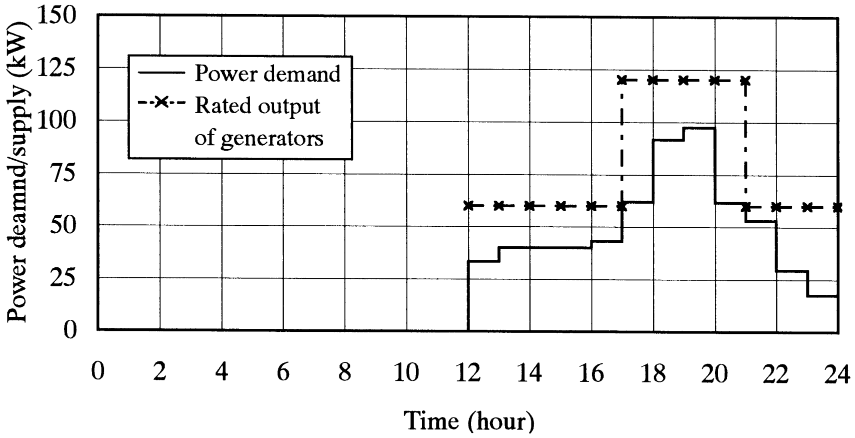
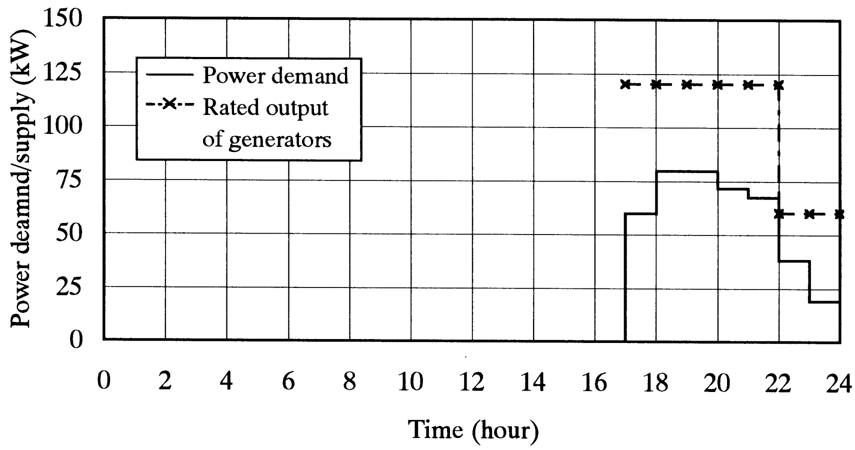


Fig. 2-3-4 Load Curve and Generator Capacity by Villages

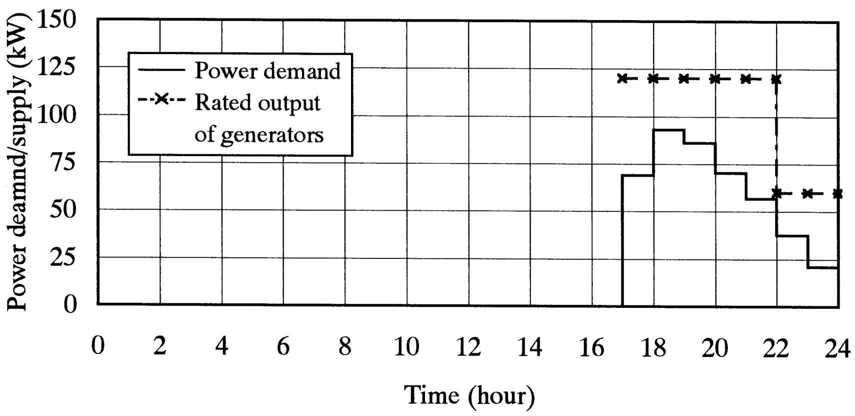
Aimag : DORNOGOVI
Sum : Ulaanbadrakh
Generator : 2x60kW



Aimag : DUNDGOVI
Sum : Adaatsag
Generator : 2x60kW



Aimag : DUNDGOVI
Sum : Delgerkhangai
Generator : 2x60kW



Aimag : GOVI-ALTAI
Sum : Bayan-Uul
Generator : 2x100kW

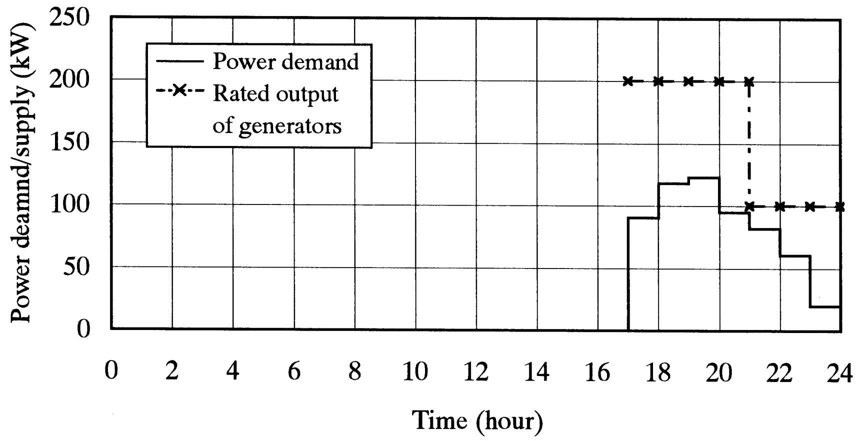
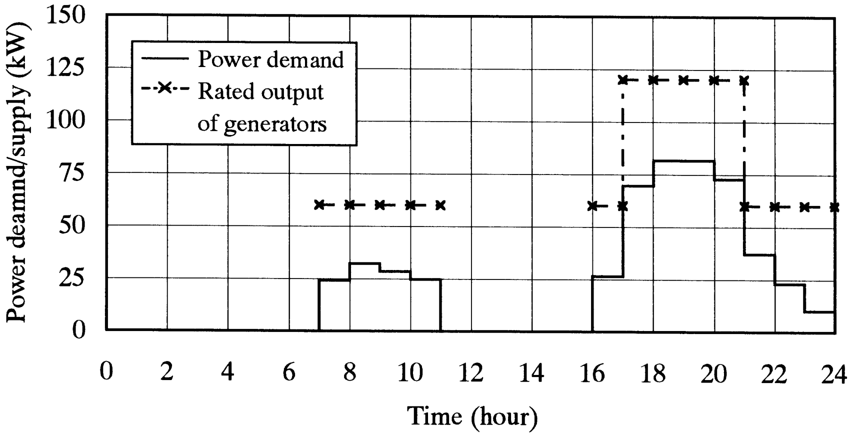
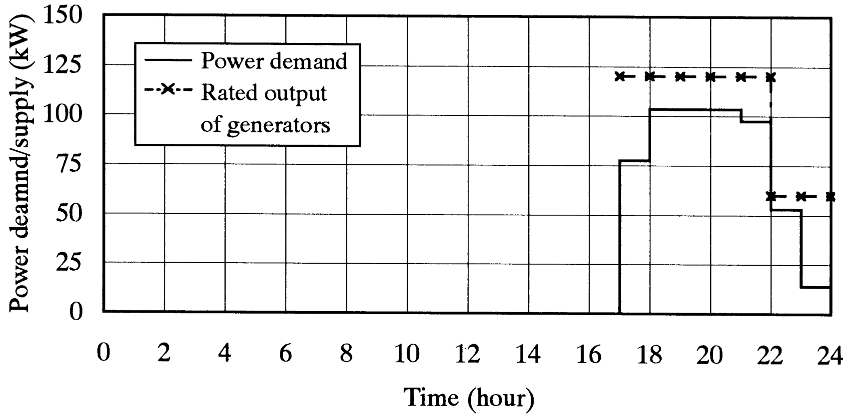


Fig. 2-3-5 Load Curve and Generator Capacity by Villages

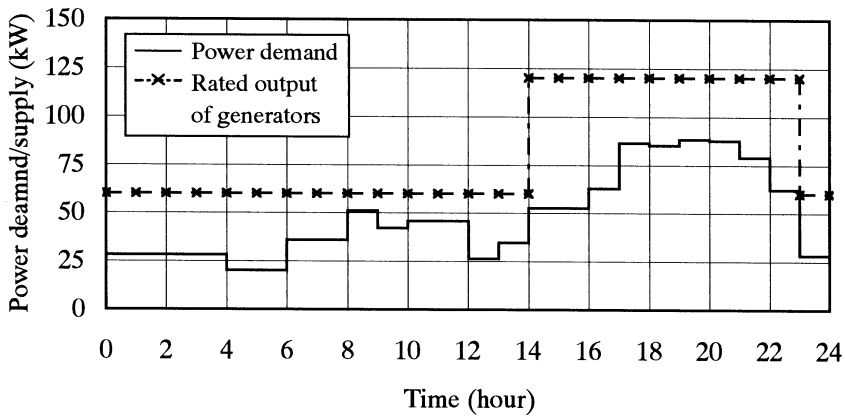
Aimag : GOVI-ALTAI
Sum : Bayantooroy
Generator : 2x60kW



Aimag :GOVI-ALTAI
Sum : Bugat
Generator : 2x60kW



Aimag : GOVI-ALTAI
Sum : Delger
Generator : 2x60kW



Aimag : GOVI-ALLTAI
Sum : Guulin
Generator : 2x100kW

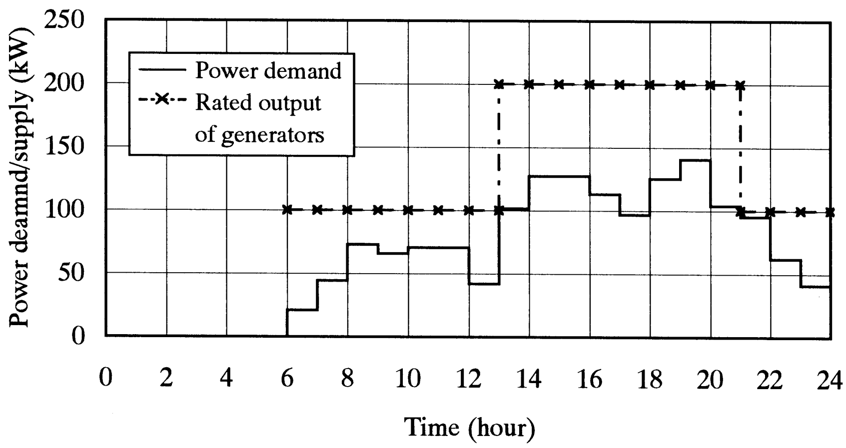
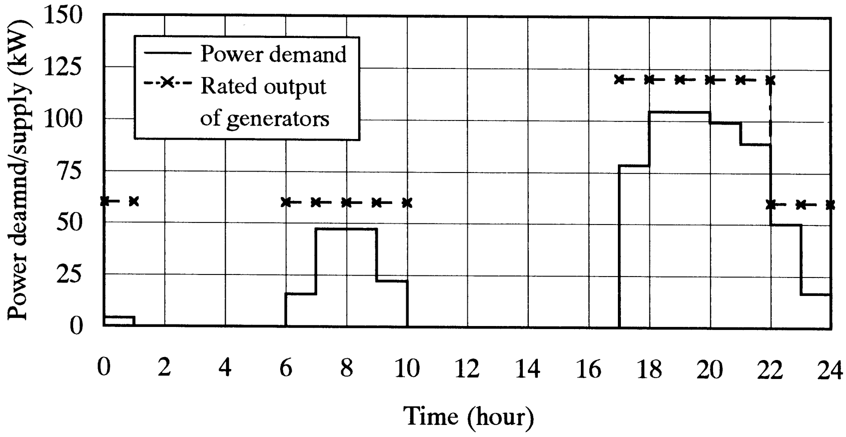
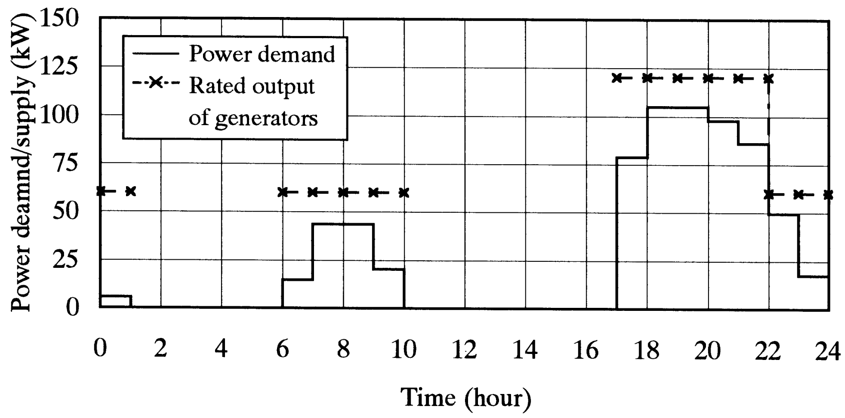


Fig. 2-3-6 Load Curve and Generator Capacity by Villages

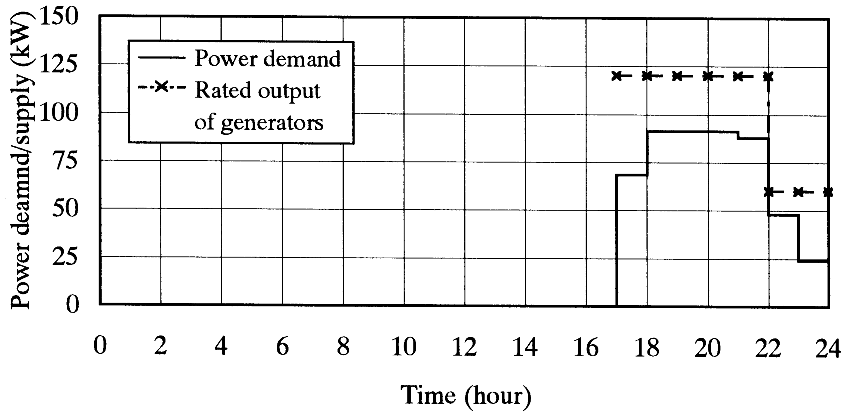
Aimag : GOVI-ALTAI
Sum : Jargalan
Generator : 2x60kW



Aimag :GOVI-ALTAI
Sum : Khaliun
Generator : 2x60kW



Aimag :GOVI-ALTAI
Sum : Sharga
Generator : 2x60kW



Aimag : GOVI-ALLTAI
Sum : Taishir
Generator : 2x60kW

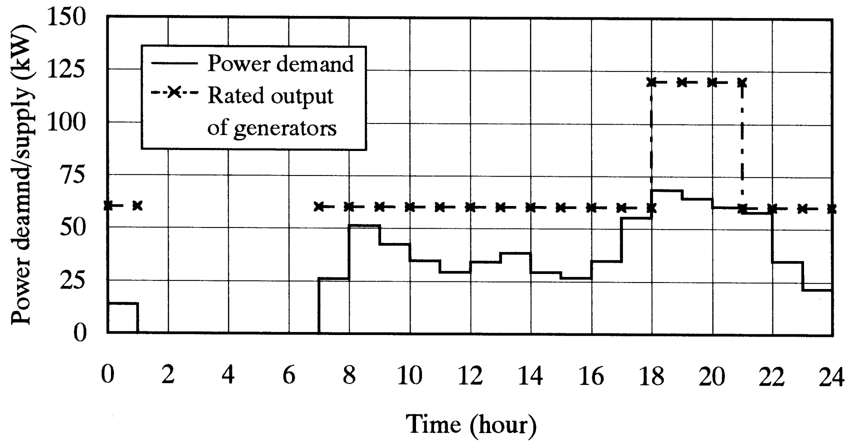
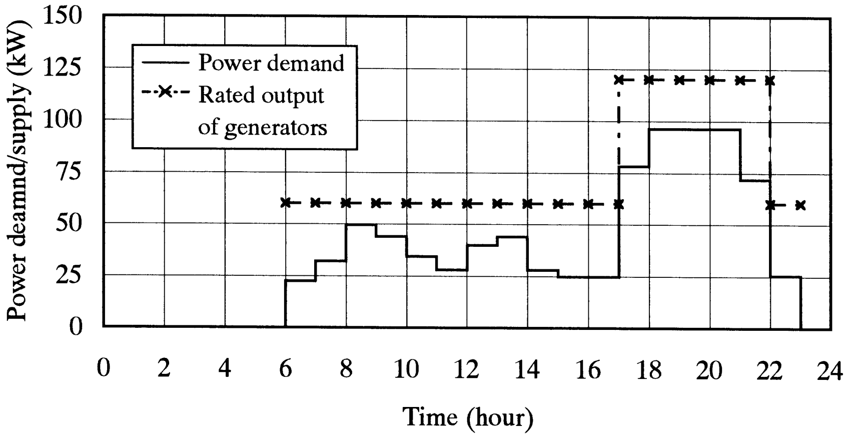
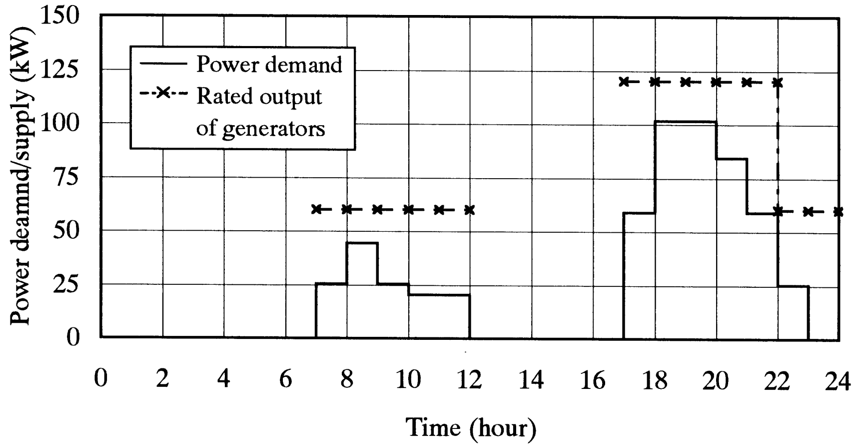


Fig. 2-3-7 Load Curve and Generator Capacity by Villages

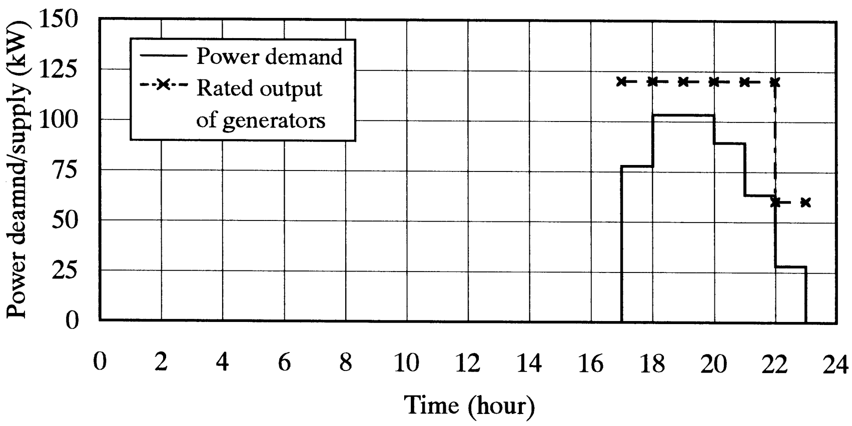
Aimag : GOVI-ALTAI
Sum : Tugrug
Generator : 2x60kW



Aimag : KHOVD
Sum : Altai
Generator : 2x60kW



Aimag : KHOVD
Sum : Durgun
Generator : 2x60kW



Aimag : KHOVD
Sum : Duut
Generator : 2x60kW

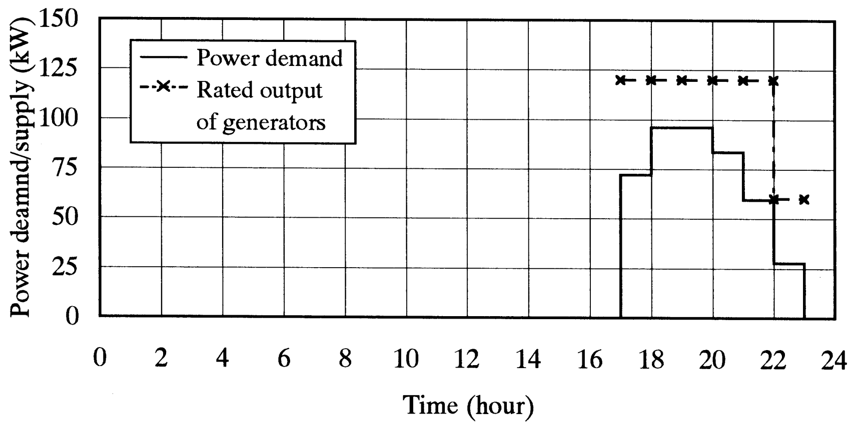
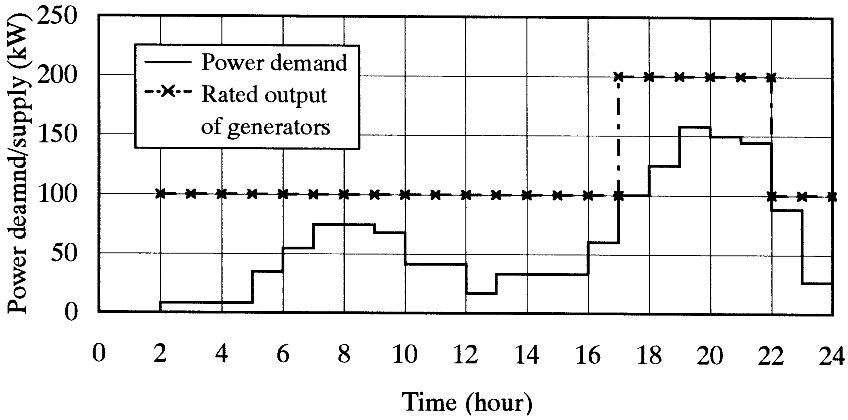
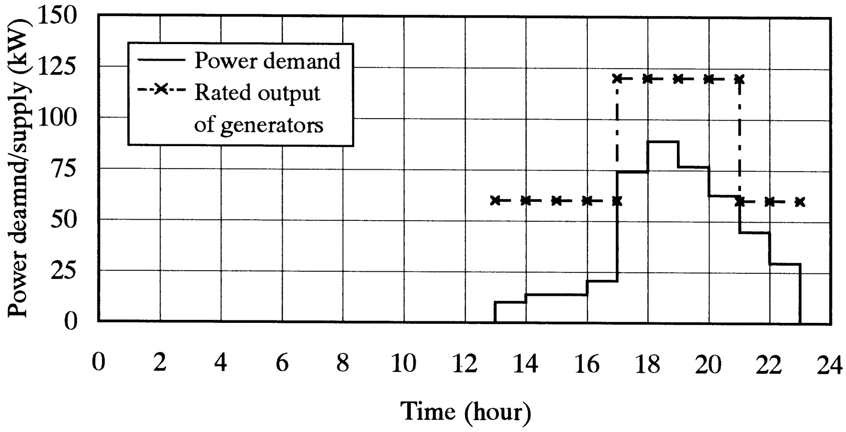


Fig. 2-3-8 Load Curve and Generator Capacity by Villages

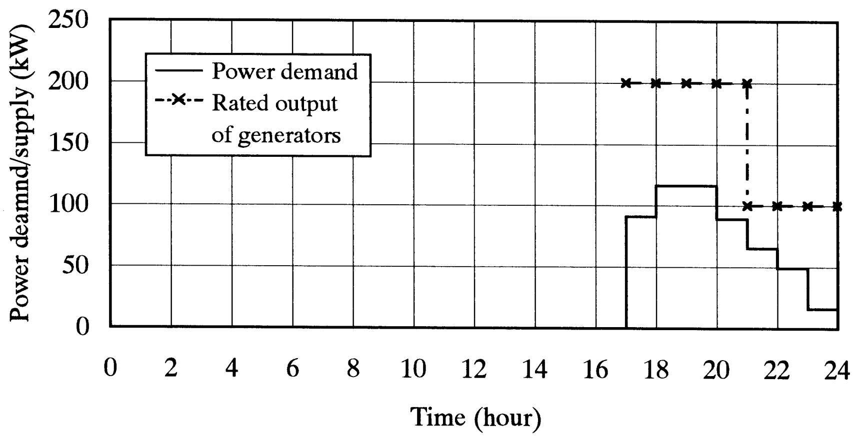
Aimag : KHOVD
Sum : Mankhan
Generator : 2x100kW



Aimag : KHOVD
Sum : Uench
Generator : 2x60kW



Aimag : KHUBSGUL
Sum : Alag-Erdene
Generator : 2x100kW



Aimag : KHUBSGUL
Sum : Burentogtokh
Generator : 2x100kW

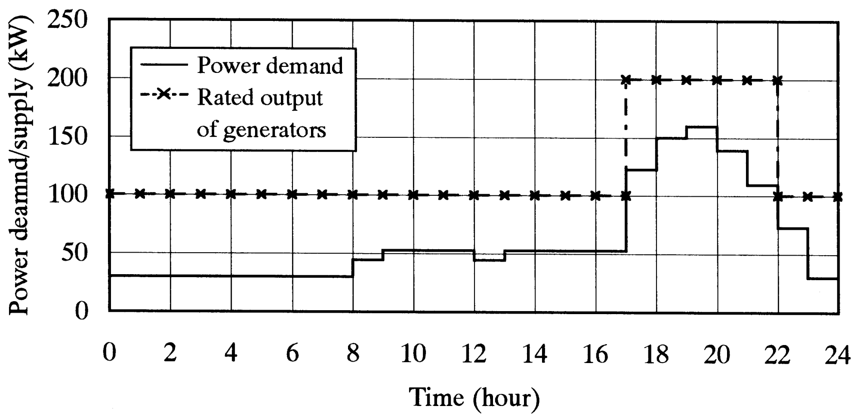
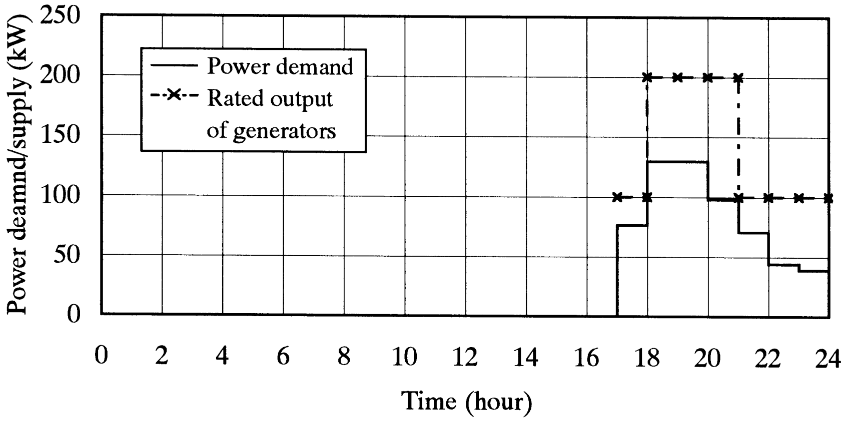
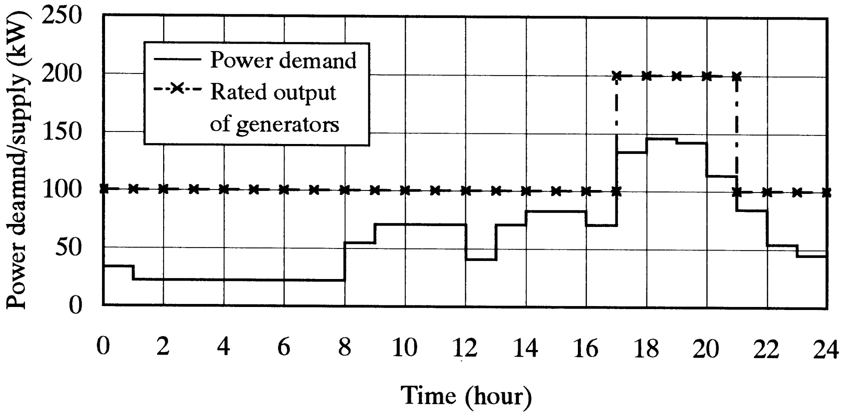


Fig. 2-3-9 Load Curve and Generator Capacity by Villages

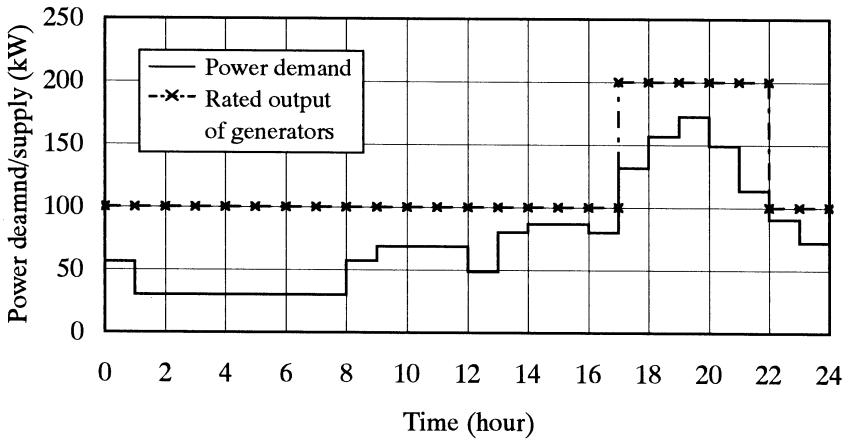
Aimag :KHUBSGUL
Sum : Tosontsengel
Generator : 2x100kW



Aimag : KHUBSGUL
Sum : Tsagaan-Uul
Generator : 2x100kW



Aimag : KHUBSGUL
Sum : Tsetserleg
Generator : 2x100kW



Aimag : KHUBSGUL
Sum : Tumurbulag
Generator : 2x60kW

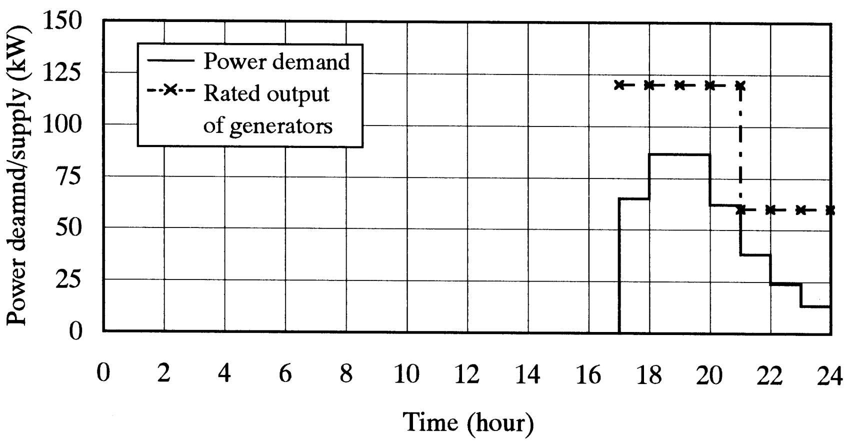
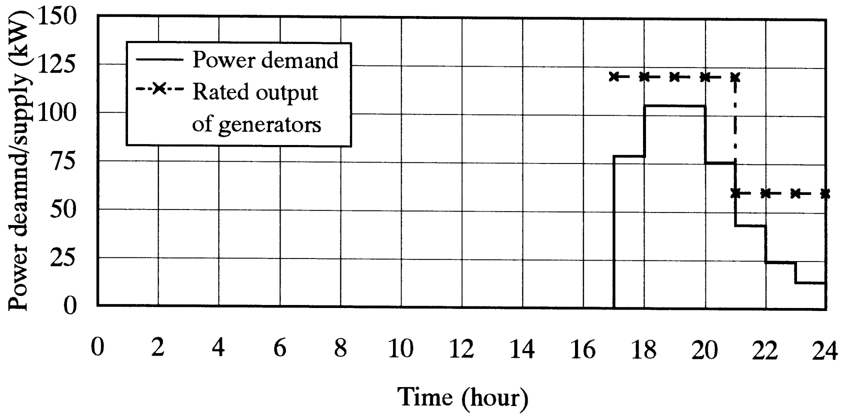
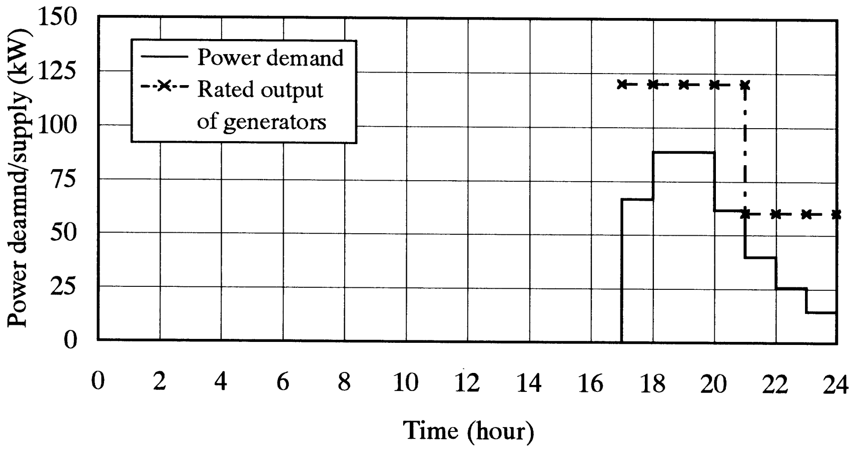


Fig. 2-3-10 Load Curve and Generator Capacity by Villages

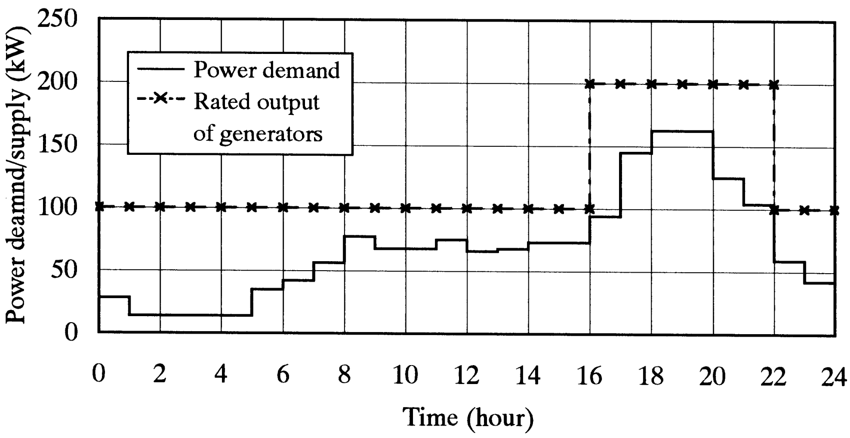
Aimag : KHUBSGUL
Sum : Tunel
Generator : 2x100kW



Aimag : SUKHBAATAR
Sum : Asgat
Generator : 2x60kW



Aimag : SUKHBAATAR
Sum : Munkhkhaan
Generator : 2x100kW



Aimag : SUKHBAATAR
Sum : Sukhbaatar
Generator : 2x100kW

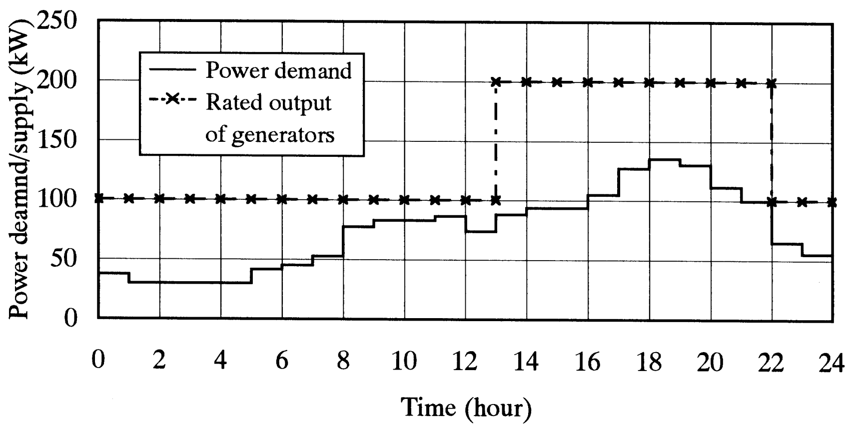
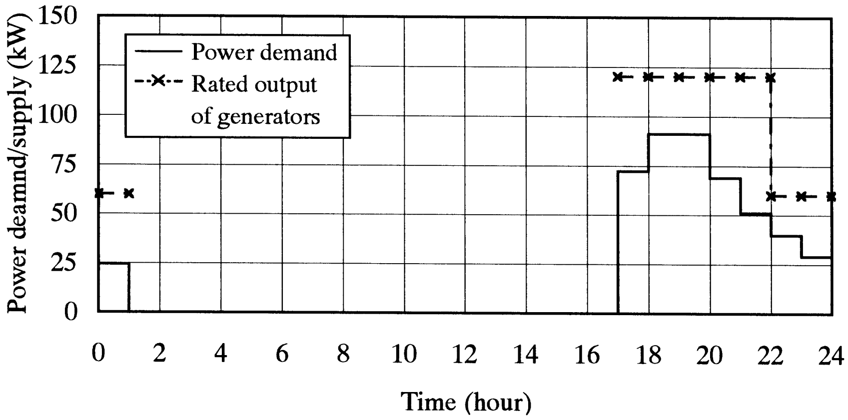
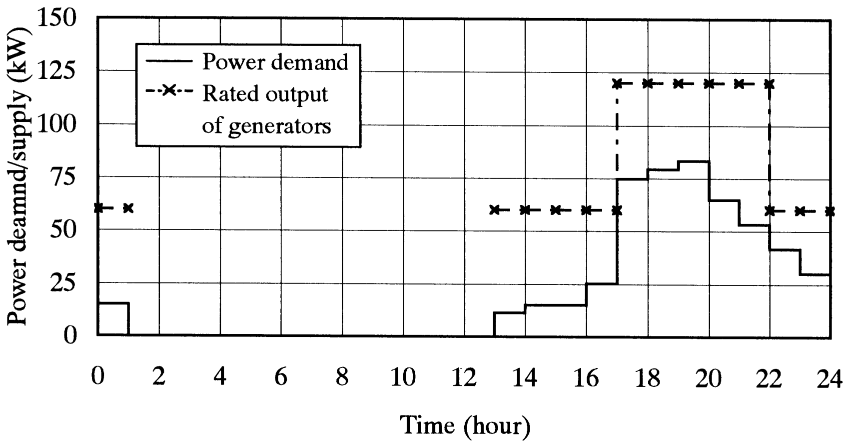


Fig. 2-3-11 Load Curve and Generator Capacity by Villages

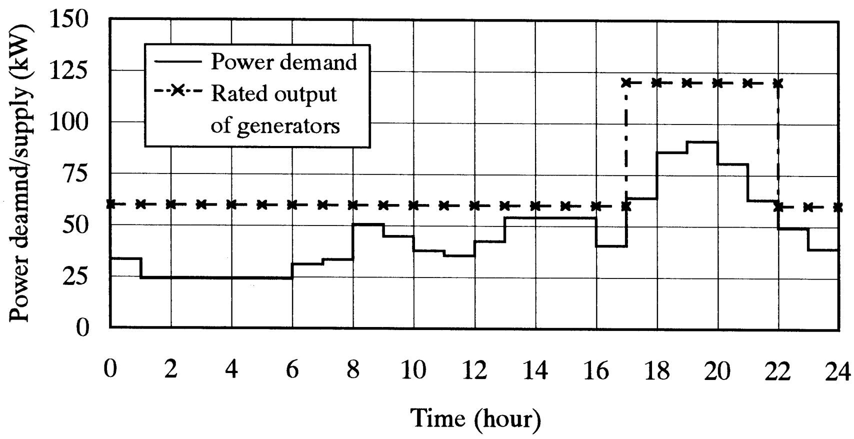
Aimag : SUKHBAATAR
Sum : Tuvshinshiree
Generator : 2x60kW



Aimag : SUKHBAATAR
Sum : Uulbayan
Generator : 2x60kW



Aimag : UMUNOGOVI
Sum : Bayan Ovoo
Generator : 2x60kW



Aimag : UMUNOGOVI
Sum : Bayandalai
Generator : 2x60kW

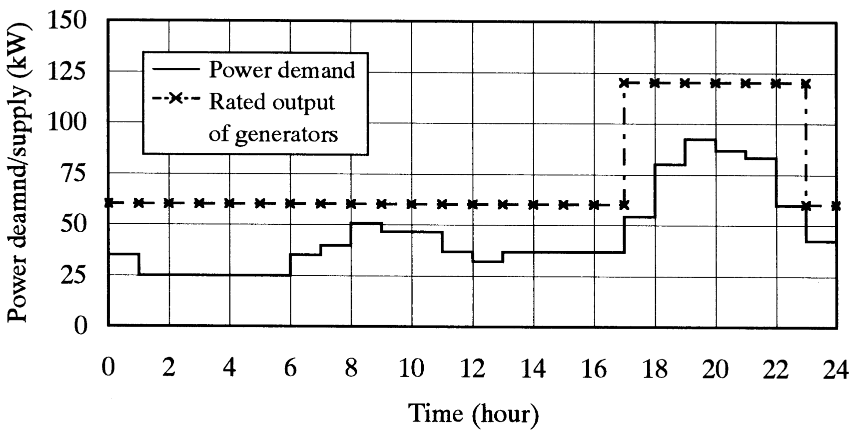
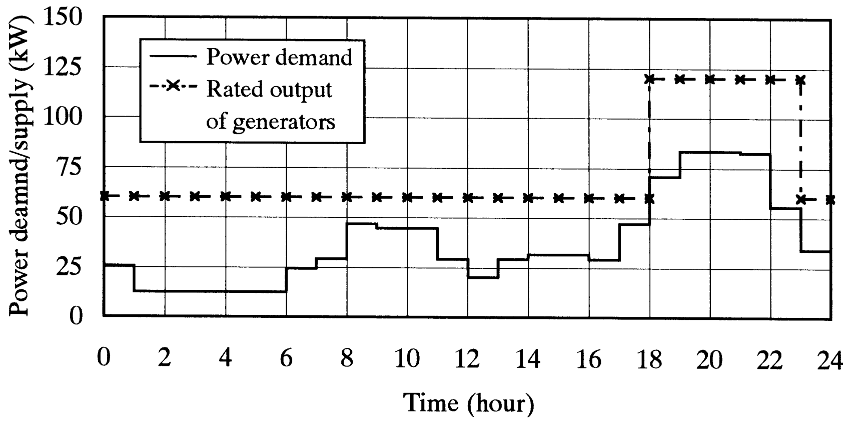
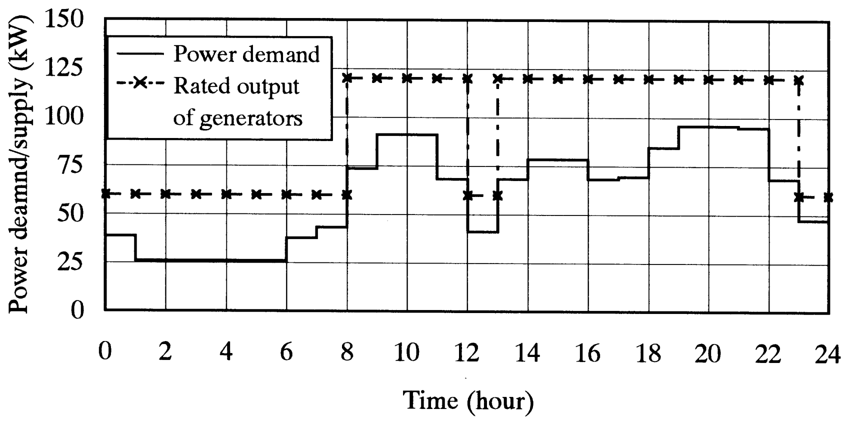


Fig. 2-3-12 Load Curve and Generator Capacity by Villages

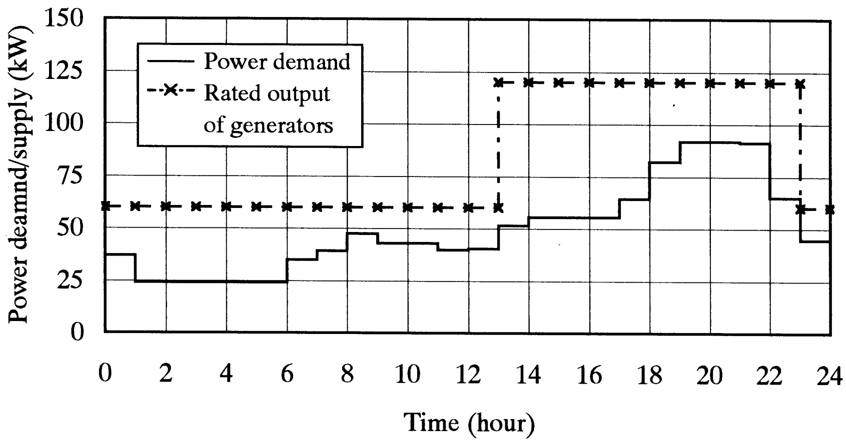
Aimag : UMUNOGOVI
Sum : Bulgan
Generator : 2x60kW



Aimag : UMUNOGOVI
Sum : Khanbogd
Generator : 2x60kW



Aimag : UMUNOGOVI
Sum : Khurmen
Generator : 2x60kW



Aimag : UMUNOGOVI
Sum : Nomgon
Generator : 2x60kW

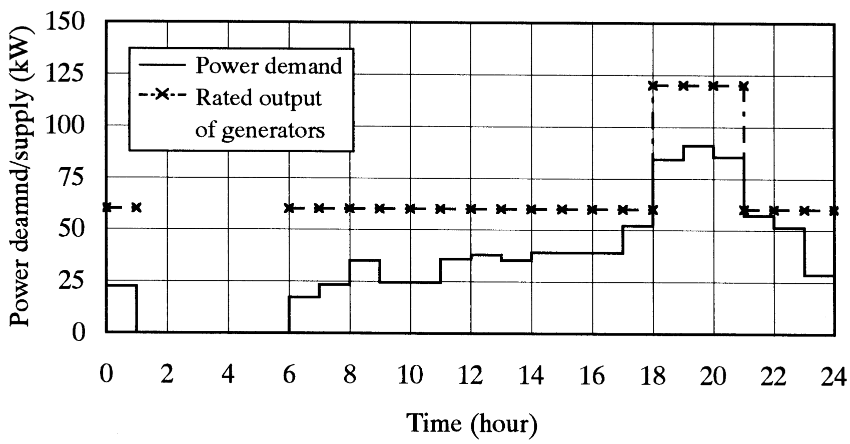
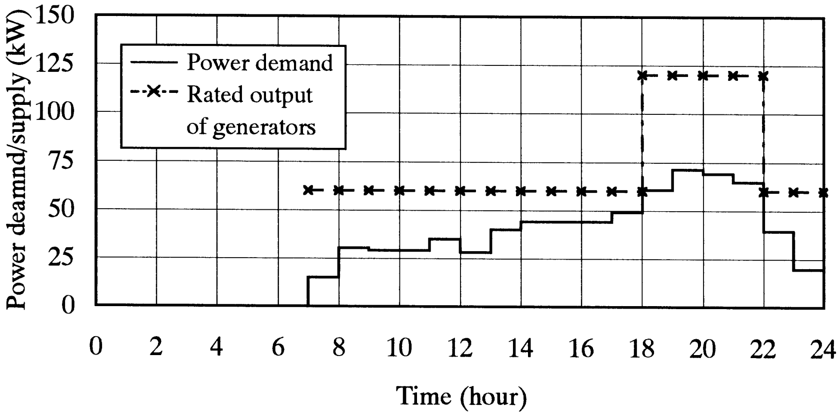
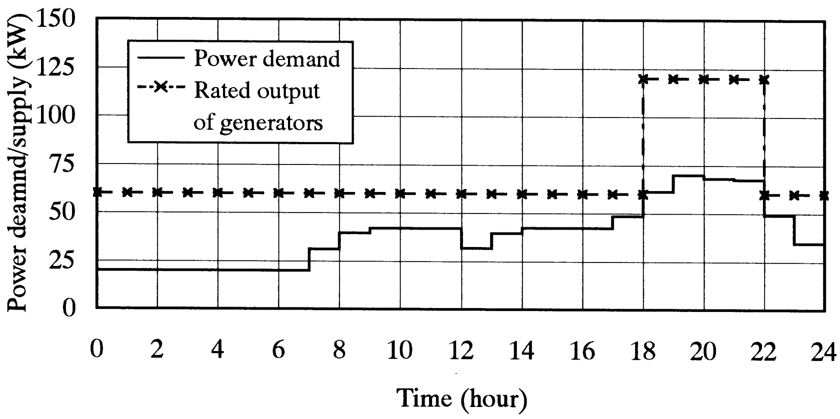


Fig. 2-3-13 Load Curve and Generator Capacity by Villages

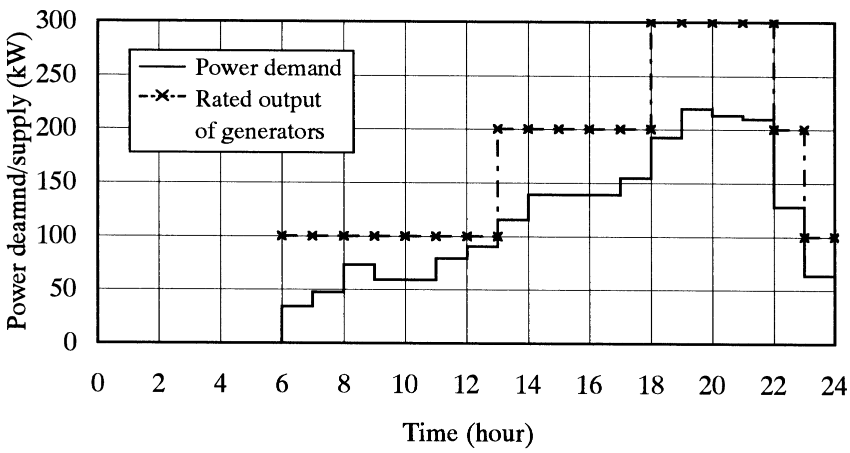
Aimag : UMUNOGOVI
Sum : Tsogt Ovoo
Generator : 2x60kW



Aimag : UMUNOGOVI
Sum : Tsogttsetsii
Generator : 2x60kW



Aimag : UVS
Sum : Baruunturuun
Generator : 3x100kW



Aimag : UVS
Sum : Bukhmurun
Generator : 2x60kW

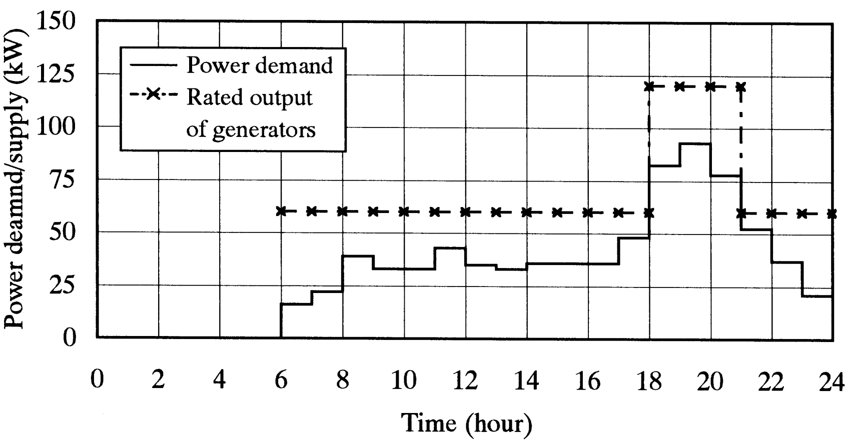
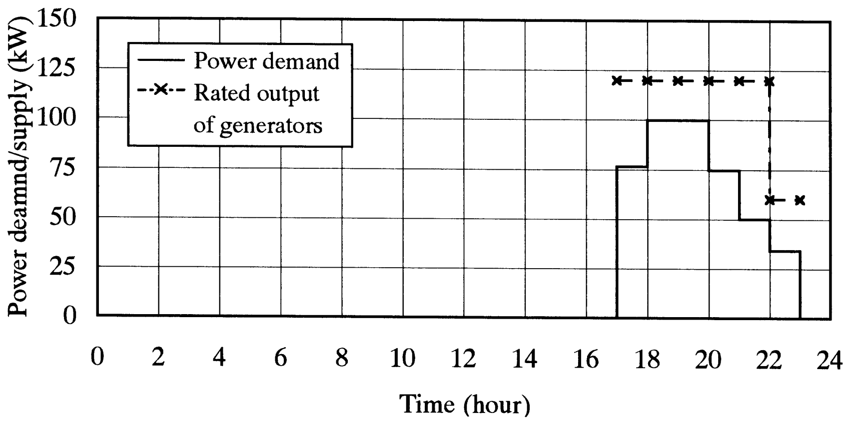
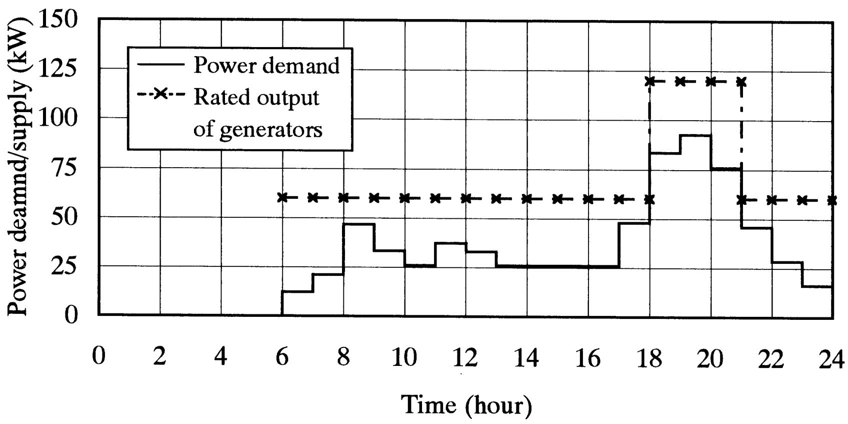


Fig. 2-3-14 Load Curve and Generator Capacity by Villages

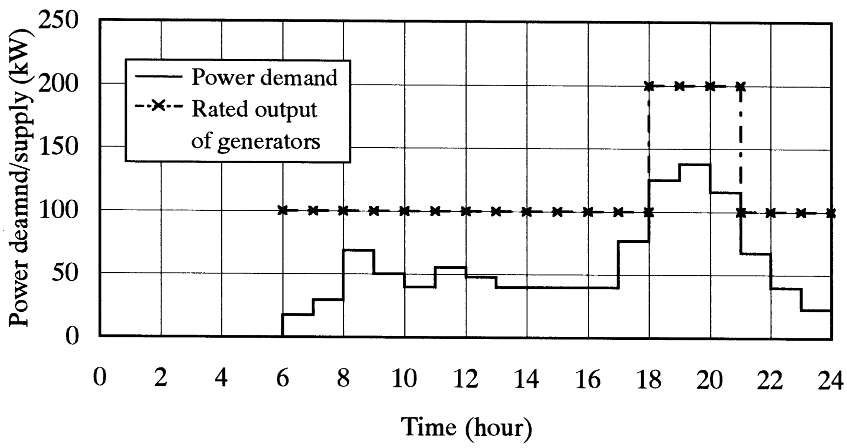
Aimag : UVS
Sum : Davst
Generator : 2x60kW



Aimag : UVS
Sum : Khovd
Generator : 2x60kW



Aimag : UVS
Sum : Undurkhangai
Generator : 2x100kW



Aimag : UVS
Sum : Zavkhan
Generator : 2x60kW

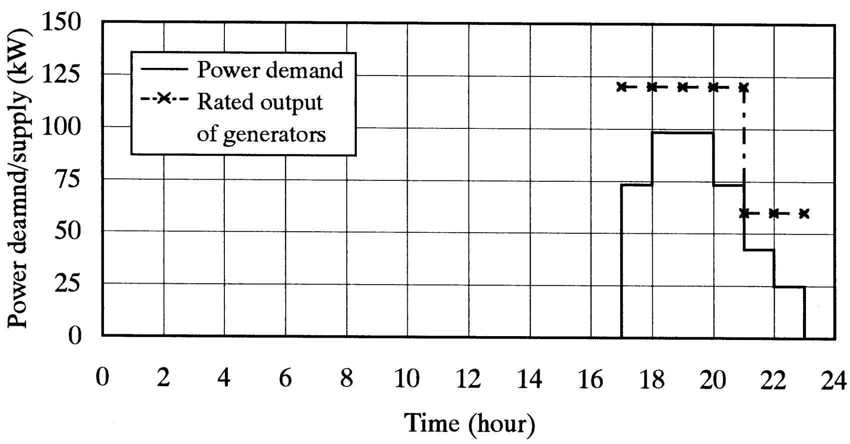
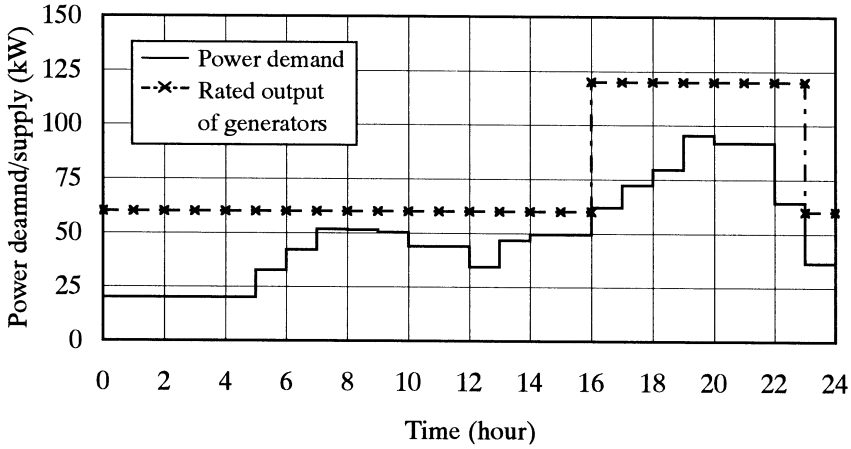
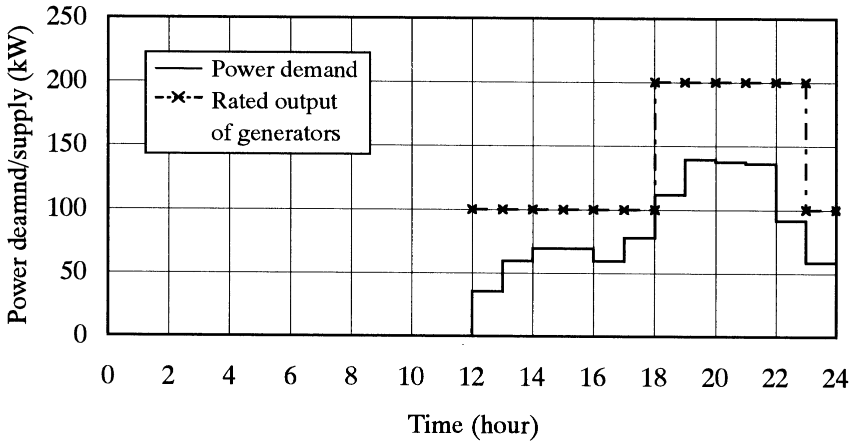


Fig. 2-3-15 Load Curve and Generator Capacity by Villages

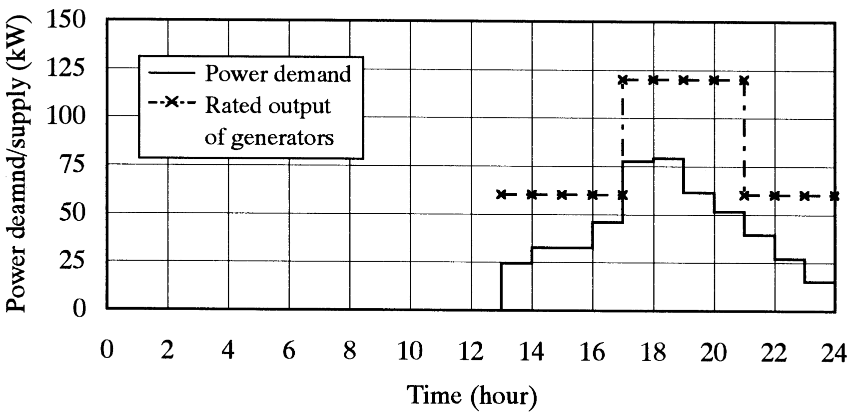
Aimag : UVURKHANGAI
Sum : Tugrug
Generator : 2x60kW



Aimag : ZABKHAN
Sum : Alderkhaan
Generator : 2x100kW



Aimag : ZABKHAN
Sum : Bayankhairkhan
Generator : 2x60kW



Aimag : ZABKHAN
Sum : Bayantes
Generator : 2x60kW

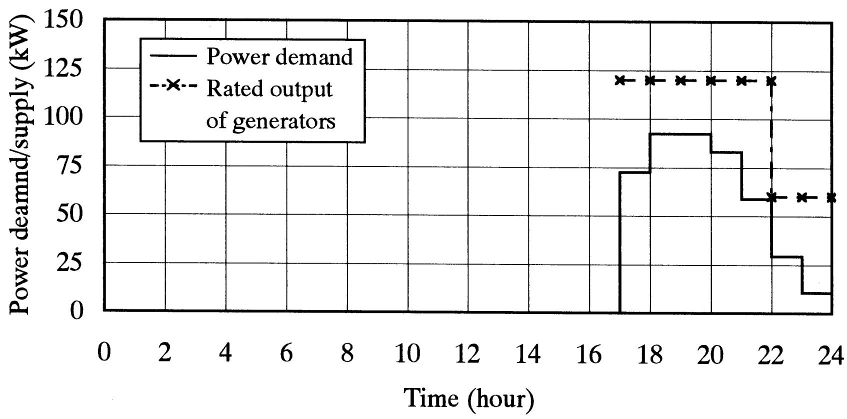
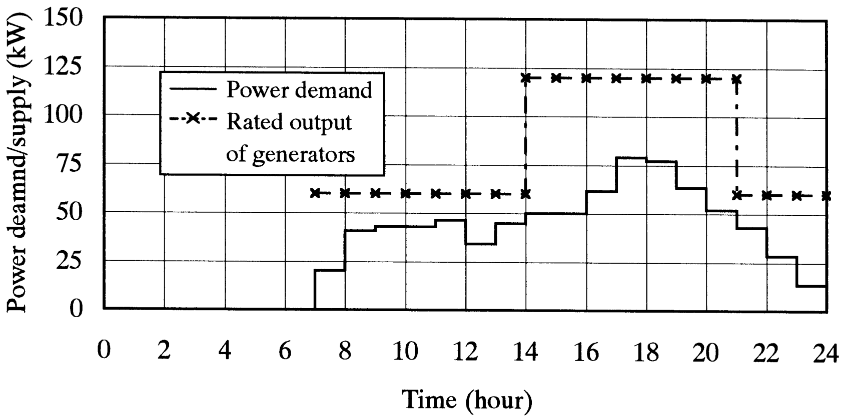
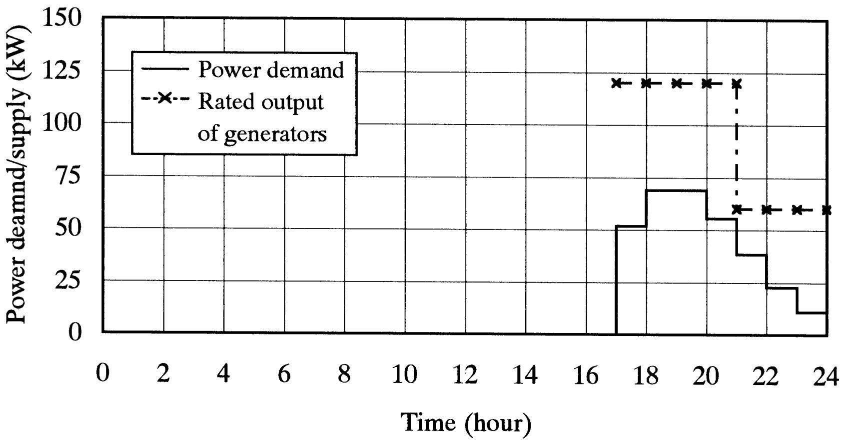


Fig. 2-3-16 Load Curve and Generator Capacity by Villages

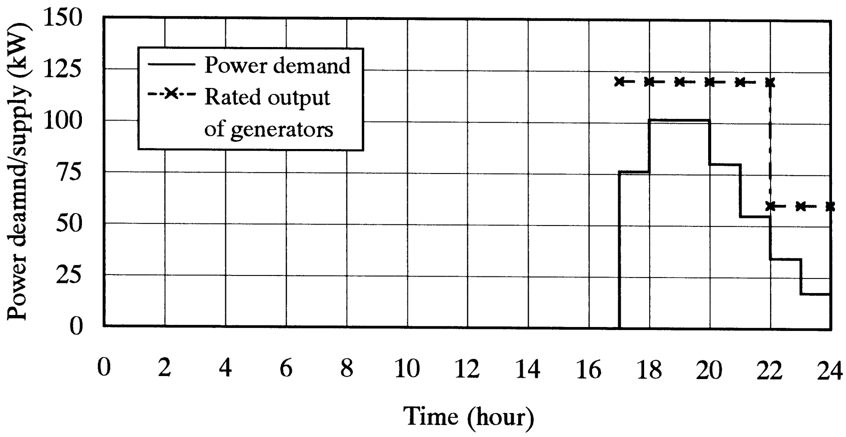
Aimag : ZABKHAN
Sum : Ikh-Uul
Generator : 2x60kW



Aimag : ZABKHAN
Sum : Otgon
Generator : 2x60kW



Aimag : ZABKHAN
Sum : Shiluustei
Generator : 2x60kW



Aimag : ZABKHAN
Sum : Telmen
Generator : 2x60kW

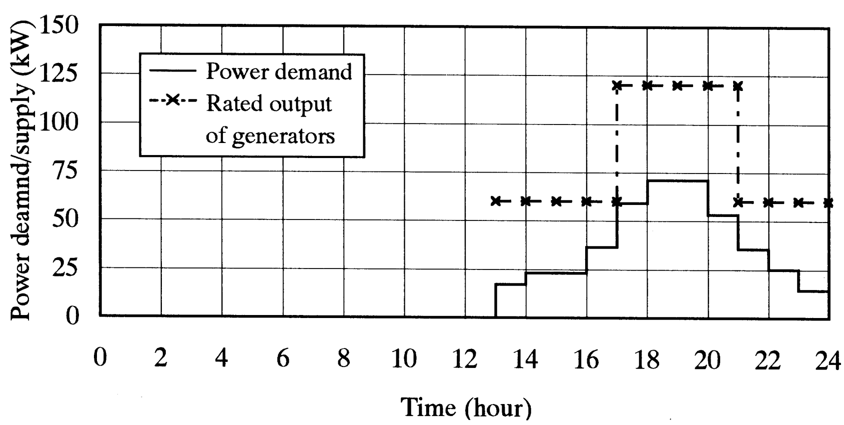
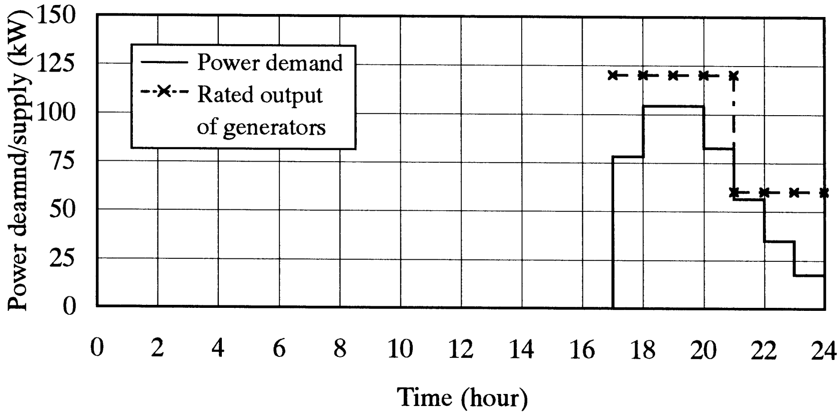
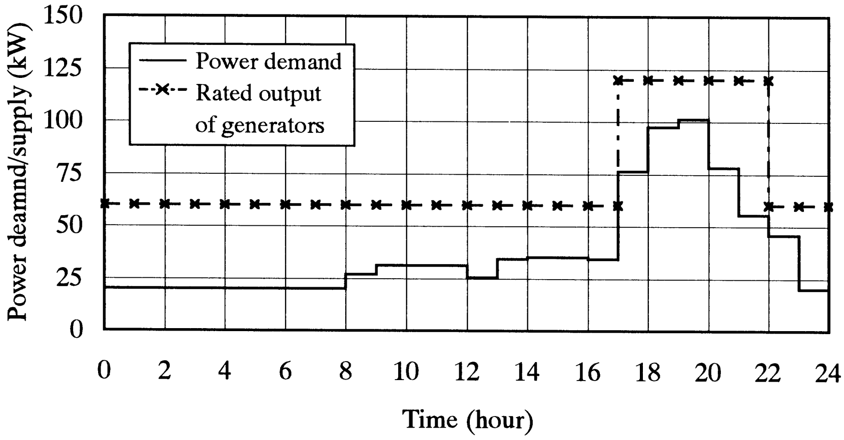


Fig. 2-3-17 Load Curve and Generator Capacity by Villages

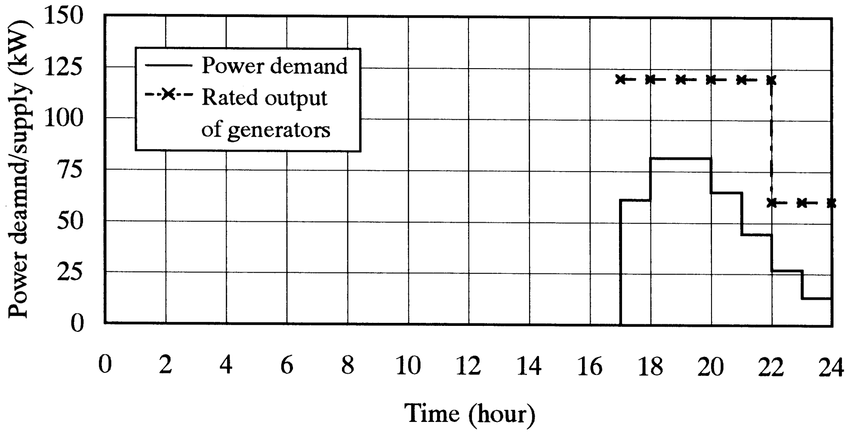
Aimag : ZABKHAN
Sum : Tsagaanchuluut
Generator : 2x60kW



Aimag : ZABKHAN
Sum : Tsagaankhairkhan
Generator : 2x60kW



Aimag : ZABKHAN
Sum : Yaruu
Generator : 2x60kW



Aimag : ZABKHAN
Sum : Tudevtei
Generator : 2x60kW

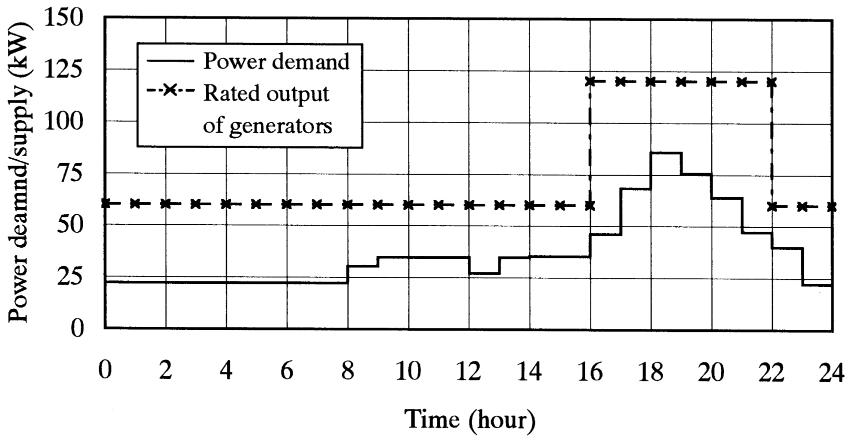


Fig. 2-3-18 Load Curve and Generator Capacity by Villages

2-3-3 Basic Design

(1) Codes and Standards

Following codes/standards or equivalent codes/standards will be applied for design of equipment and materials

1) Japanese Industrial Standards (JIS)
2) Standards of the Japanese Electrotechnical Committee (JEC)
3) The standards of the Japan Electrical Manufacturer's Association (JEM)
4) Japanese Cable Standard (JCS)
5) International Electrotechnical Commission (IEC)
6) Technical guideline for construction equipment issued by Ministry of Construction (60 kW/100 kW diesel engine)
7) Japanese Air Pollution Control Law

(2) Protection for cold temperature

The objective Sums are located at elevation of 620 to 2,400m from mean sea level. In order prevent power loss due to low atmospheric pressure, the diesel engines will be furnished with turbo charger.

Cooling water system (radiator) will be used for the diesel engine, also antifreeze liquid is necessary to be added on cooling water.

The following problems are expected when engine restart after the shut down for a long time.

1) Lubricant Oil - Damage of bearing due to high viscosity.

2) Fuel Oil system - Power loss of engine due to trouble of fuel injection system

3) Starter Battery - The engine cannot start due to the performance loss of the battery by low temperature.

Therefore, stoves for heating the diesel generating room is necessary to maintain the room temperature in the certain level.

(3) Environmental Protection

Low emission type diesel engine will be applied to 60kW/100kW DG in order to reduce NO_X level in exhaust gas. For 500kW DG, a engine which clears the requirements of the Japanese Environmental Regulation will be applied.

(4) Facility Design

1) Existing facilities

Most of existing powerhouses are possible to be utilized after necessary renovation is done. However, Mongolian side shall remove all existing equipment in order to prepare the necessary space for installation of the new diesel engine generating system. Since the new generating system is designed to be used independently, therefore, the existing diesel generator can be used for other purpose.

2) Generator foundation

The foundation of the diesel generator will be designed to isolate the vibration from diesel generator to the surrounding structure (Standard details of the foundations are shown in Drawing No. 1-C-00-01, 1-C-00-02 and 1-C-73-01 ~ 03).

3) Stove

In order to maintain the room warm to avoid the accident of the equipment such as the engine and battery caused in raw temperature, the stoves are necessary. The stove is so designed simply to minimize the maintenance cost and time. The stove will be purchased from the local market in Mongolia. The heating ratio of the stove will be approx. 17,200 kcal/hr, the standard drawing is attached hereinafter as Drawing No. 1-M-00-02.

4) Waste oil incinerator

One incinerator for each Sum will be provided to treat the waste lubricant oil deposed from the diesel engine. Approx. 25-30 l / 250-300hr of waste oil will be disposed from each 60/100kW size diesel engine and 1000l/year from each 500kW diesel engine (plus 1000 l of waste flush oil will be disposed from common pit). The following specification will be applied commonly for all Sums including Tosotsengel (Zabkhan).

Waste oil incinerator

a)	Capable burning oil	Engine waste oil, gear waste oil, diesel oil
b)	Burning system	Forced burning system
c)	Burning capacity	3 to 7 l/hr
d)	Ignition method	Manual
e)	Input voltage	1 Ph. 230
f)	Blower capacity	4 to 80 W

5) Maintenance Vehicle

The technical particulars of vehicles shall be as follows:

a)	Type	Pick up type, left handle, 4WD, single cabin
b)	Seating capacity	3 persons
c)	Engine	Diesel engine w/turbo charger, direct injection
d)	Piston displacement	4 cylinders in line, 2,700 CC or more
e)	Output rating	74 (100) kW (PS)/3,800 rpm or more
f)	Fuel	Diesel fuel (GOST No. 305-73)
g)	Fuel tank capacity	75 liters or more
h)	Transmission	Manual, 5-speed
i)	Maximum speed	135 km/h or more
j)	Maximum load	1 ton
k)	Container	Aluminum made lockable type
l)	Racks	Removable type

(5) Electric System

1) 60 kW/100 kW generator

Generator electric system of 3-Phase, 4-wire, 400/230V, 50 Hz with isolated neutral system is applied. Distribution (insulation transformer secondary) electric system of 3-Phase, 4-wire, 400/230V, 50 Hz with neutral direct earthed system is applied. One line diagram for each case is shown in Drawing No. 1-E-00-02, 1-E-00-03, 1-E-00-04 and 2-E-00-02, 2-E-00-03, 2-E-00-04.

2) 500 kW generator

Generator electric system of 3-Phase, 3-wire, 6,300V, 50 Hz with isolated neutral system is applied. Distribution voltage will be step down from 6,300V to 400/230 V by utilized existing transformer (transformer neutral direct earthed). One lie diagram is shown in Drawing No. 1-E-73-02 and 2-E-73-02.

(6) Equipment Specifications

1) 60 kW/100 kW generating system

① Diesel engine

		100kw	60kw
a)	Type	4 cycle, water-cooled, Turbocharged,	Same as left
b)	Rated output	150 Ps or over	95Ps or over

c)	Rated speed	1500 rpm	Same as left
d)	Overload capacity	110 % (30min)	Same as left
e)	Lub.oil supply system	Gear pump (forced lubrication)	Same as left
f)	Cooling system	Water cooling by radiator with fan	Same as left
g)	Starting system	Starter motor	Same as left
h)	Air intake system	Turbocharger	Same as left
i)	Exhaust system	Silencer	Same as left
j)	Fuel oil	Diesel oil (Gost No.305-73)	Same as left
k)	Governor type	Mechanical (bosh type or similar)	Same as left
l)	Preheating system	Glow plug type	Same as left
m)	Nox value of exhaust Gas	9.2 g/kWh or less	Same as left
n)	Number of unit	47 Nos. (Stage 1 : 28 Nos.) (Stage 2 : 19 Nos.)	100 Nos. (Stage 1 : 62 Nos.) (Stage 2 : 38 Nos.)

② AC Generator

		100kw	60kw
a)	Type	3 phases synchronous generator	Same as left
b)	Ration	Continuance	
c)	Rated output	125 KVA	75 kVA
d)	Rated voltage	3-phase, 4-wire, AC400V single phase AC 230V	Same as left
e)	Rated frequency	50 Hz	Same as left
f)	No. of pole	4	Same as left
g)	Power factor	0.8	Same as left
h)	Rated speed	1500 rpm	Same as left

i)	Insulation	Class F	Same as left
j)	Excitation	Brushless type with AVR	Same as left
k)	Cooling system	Air cooled, self ventilation	Same as left
l)	No. of unit	47 Nos. (Stage 1 : 28 Nos.) (Stage 2 : 19 Nos.)	100Nos. (Stage 1 : 62 Nos.) (Stage 2 : 38 Nos.)

③ DC supply panel

1) Type: Self-stand type, indoor
2) Input rated Voltage : AC single phase 230 V, ±10%
3) Output rated Voltage : DC 27.3 V, ±2 %
4) Rated output current DC 8 A
5) Rectifier unit Automatic voltage controlled full wave rectifier
6) Cooling system Natural air

④ Low voltage switchgear

1) Standard : JEM 1265 CX
2) Type indoor, self-standing
3) Voltage : 3 phase, 4 wire, 400 V, 50 Hz
4) Neutral : Direct grounded

⑤ Insulation transformer

1) Type: Inner panel mounted type, indoor
2) Rated Capacity : 150 KVA, 250 KVA, and 400 KVA
3) Rated Voltage : 3-phase, 4- wire, 400 V/400-230 V, 50 Hz
4) Connection Vector : Dyn 11
5) Cooling system : Oil-filled, self-cooled

2) 500 kW generating system

500 kW diesel generating system will be installed at Tosontsengel (Bulnai) as specified as follows;

① Diesel Engine

Type Single acting 4 cycle, Solid injection, Turbocharged and inter-cooled

No. of unit	3
Rated output	500 kW (625 KVA) or more
Rated Speed	750 rpm or less
Governor	Hydraulic, Automatic type
Starting method	Compressed Air
Noise level	110 dB(A) or less (1m beside engine)
Nox contents in exhaust gas	950 ppm or less

② Auxiliaries

a) Air compressor

Type:	Vertical, Air-cooled, Double stage compression AC motor driven and engine driven one set each

b) Air receiver

Capacity:	Starting shall be possible at least 3 time without recharging

c) Fuel oil transfer pump

Type:	Gear pump, AC motor driven

d) Fuel oil service tank with stand

Type:	Indoor, self-stand
Storage capacity:	1,950l or more

e) Radiator

Radiator shall be with cooling water expansion tank

h) Lub oil priming pump

Type:	Gear pump, AC motor driven

i) Silencer

Noise level:	95 dB (A) at 1m from the exhaust gas out let duct

③ Generator

Type	Revolving field, 3-phase, synchronous generator
Nos of unit	3
Rating	Continuous
Protection	Open-protected (IP20)

Rated output	500 kW (625 kVA)
Overload output	110 % 1 hr.
Over speed	120 % 2 min.
Rated voltage	6,300 V
Current	57.3 A
Phased	3 phase
Frequency	50 Hz
Rated speed	750 rpm
Power factor	80 % (Lagging)
Exciter	Blushless type
Cooling method	Self-cooling, air type
Bearing type	Sleeve bearing or ball bearing
Insulation class	Class F
Voltage variation	±1.5 %
Frequency variation	±5.0 %

④ Panels

The components of the panels are as follows:

a) Genrator Panel

Main circuit breaker:	VCB 7.2 kV, 400A, 12.5 kA R.C.
Number of panel:	3 Nos.

b) Synchronizing Panel

Number of panel:	1 No.

c) Feeder Panel

Main circuit breaker:	150 kV, 400 A, 12.5 kA R.C.
Number of panel:	1 No.
Number of trans:	1 No.

d) Transformer Panel

Transformer rating:	150kVA, 6.3kV/400-230V, 3ϕ4W, 50Hz
Number of trans:	1 No.

e) Low Voltage Auxiliary Panel

Number of panel:	1 No.

f) DC Power Source Panel

Battery type:	Acid Battery
Battery capacity:	Manufacturer's Standard
Battery voltage:	110 V
Charge type:	Thyristor Full Wave Rectifier
Charge output voltage:	110 V
Charge rated output:	Manufacturer's Standard

3) Installation materials

Major material for installation work are showed as follow

(a) Power and control cables and terminal processing materials
(b) Pedestal and hunger
(c) Conduit pipes and fittings
(d) Grounding material
(insulated conductor, grounding rods, connecting clamps, etc.)
(e) Lightning arrester

(7) Operation and Control method

1) Single unit operation

For operation & control system of the 60kW and 100 kW generator sets, the manual operation system that is same method as for Phase 1, 2 and 3 will be used. For operation and control system of the 500kW generator sets, the machines will be operated in accordance with the sequence linked to the start order by an operator. The static relays will be installed for main circuit breaker automatic tripping system including alarm and indication lamp. For resetting manual operation is applied. The basic information is shown below;

		60 kW/100 kW	500 kW
① Basic system	:	Manual, one-man operation and control system	One touch, automatic sequential control
② Starting system	:	By cell motor	By compressed air
③ Shut down	:	By manual	By manual
④ Protection system	:	Main circuit breaker automatic trip, indication and alarm system with associated relays (both 60kW/100 kW and 500 kW)	
⑤ Recovery system	:	By manual	By manual

2) Parallel operation

Since the power generation system is so design to avoid low load operation, the plural numbers of generator is design for each power plant. The plural generators need to be operated when the load is high. The manual synchronization method, which is easy for maintenance, is selected for the project. For synchronization, mechanical governor is used for adjusting the load balance and revs. Since the identical generator is design to installed, there will be no difference for load balance, however, by difference in impedance, there will be cross current will cause.

Generally automatic synchronization system is used for middle and large class generating system and manual synchronization system is used for small size generator. In most of the cases people in Sum use the 60kW/100kW power generation at evening for 5-6 hours every day. In this case manual operation system is most applicable. The load limiter is also provided. For 500kW generator's parallel operation, automatic synchronizing and automatic load balance system will be emplyed. The basic information for parallel operation is shown below.

		60 kW/100 kW	500 kW
① Synchronizing	:	Manual operation, with synchro indicator	Manual/Automatic, with synchro scope
② Operation, load balance	:	By manual governor control, with load limiter	By automatic load balance device
③ Nos. of unit control	:	2 ~ 3units	2 ~ 3 units

(8) Layout of equipment

All installed equipment will be earthed. The following points have been carefully checked for design of the equipment layout.

① Easiness for operation (one man operation) and safety
② Accessibility for maintenance, space for spare parts storage.

The equipment layout of the Power plants for each Sums are show in the following drawings in the attachment.

(a) Equipment layouts for generator sets with rated outputs of 60kW and 100kW

Drawing Nos. 1-G-01-01 to 1-G-44-01 and 2-G-45-01 to 2-G-72-01.

(b) Equipment layouts for generator sets with a rated output of 500kW

Drawing Nos. 1-G-73-02 and 2-G-73-02.

(9) Factory inspection and Tests

Factory inspection and tests for equipment and materials are to be carried out check their compliance with technical specification prior to the shipment to Mongolia. Each factory shall inspect the entire product, and the client will jointly inspect 10 % of total product of each factory. However actual schedule of joint inspection will be suitably adjusted at project implementation stage. All the equipment and material shall be subject to the approval of factory inspection and review of inspection sheet for all equipment and material. The equipment and materials to be inspected are;

1) Diesel engine
2) Generator
3) Auxiliary equipment and accessories
4) Protection and Control Panel
5) Low voltage distribution board
6) Insulation transformer
7) DC Supply Panel
8) Distribution and Installation material
9) Spare Parts

(10) Spare parts

Spare parts including consumables are designed to install for 3 years operation. The spare parts for daily maintenance and consumables are separated and will be stored at each Sum, and remained spare parts will be stored at Aimag where mobile maintenance crew is located. The maintenance crew shall take responsibility to secure and control of spare parts. Spare parts list is shown in the Drawing No. 1-S-00-01, 1-S-73-01 and 2-S-00-01, 2-S-73-01.

(11) Maintenance tool

Maintenance tool is also classified in two categories. The maintenance tool for the operator of diesel generator at each Sum is for daily maintenance. The maintenance tool for the mobile maintenance crew requires special tools for reassembling and repairing including overhaul maintenance. Maintenance tools list is shown in the Drawing No. 1-T-00-01, 1-T-00-02, 1-T-73-01 and2-T-00-01, 2-T-00-02, 2-T-73-01.

(12) Design Documents

Official language used of all design documents will be in English language.

CHAPTER 3

IMPLEMENTATION PLAN

CHAPTER 3 IMPLEMENTATION PLAN

3-1 Implementation Plan

3-1-1 Implementation Concept

(1) Procurement Policy

This project shall be implemented in accordance with the guidelines of Japanese Grant Aid. Design and procurement of equipment will be implemented by Japanese entities, duly registered in Japan, which make direct agreements with the Mongolia Government for execution of the project. Such agreements are subject to approval of Ministry of Foreign Affairs of Japan prior to its execution. Implementation agency on the Mongolia side is Ministry of Infrastructure ("MOI").

Procured equipment will be transported and installed by local subcontractors in Mongolia. Although local procurement of equipment and construction materials is limited, it is intended to locally procure equipment and materials as much as practicable. Concerning the equipment and materials that cannot be procured from the local sources, working expenditures will be calculated on the basis of the plan of procurement of all such items from Japan.

(2) Construction Approach

1) Phasing Plan

This project is intended to furnish and install 150 generators to 73 villages. Construction period is determined in consideration of such factors as seasonal accessibility to the subject villages due largely to unpaved or non-existent access roads. Especially severe cold season is not effective for surface transport and should be avoided for concrete work for generator foundation. Favorable construction window in Mongolia is usually the period between May and October. All foundation work and transport/installation of equipment should be completed within this six-month period. Under this time limitation, the project will be implemented in phases.

In consideration of urgency and implementation efficiency, the first phase should include 45 villages near Ulaanbaatar where natural conditions are comparatively milder. For the second phase, the remaining villages located far from

Ulaanbaatar should be implemented where natural conditions are more adverse. An exception is Tosontsengel (Zabkhan), which must be implemented without any interruptions to existing power supply system; thus, Tosontsengel will be implemented in two phases. The phasing plan is illustrated in Table 3-1.

Table 3-1 Phasing Plan

Stage 1		
Aimag	Sum	
BAYANKHONGOR	Gurvanbulag	2x60kW
	Zag	2x60
GOVI-ALTAI	Bayan-Uul	2x100
	Bugat	2x60
	Delger	2x60
	Jargalan	2x60
	Khaliun	2x60
	Sharga	2x60
	Taishir	2x60
	Tugrug	2x60
	Guulin	2x100
	Bayantooroy	2x60
DORNOD	Bayandun	2x100
	Bayan-Uul	2x100
	Chuluunkhoroot	3x100
	Dashbalbar	2x60
	Matad	2x60
	Sergelen	2x60
	Sumber	3x100
DORNOGOVI	Delgerekh	2x60
	Ulaanbadrakh	2x60
DUNDGOVI	Adaatsag	2x60
	Delgerkhangai	2x60
SUKHBAATAR	Asgat	2x60
	Munkhkhaan	2x100
	Sukhbaatar	2x100
	Tuvshinshiree	2x60
	Uulbayan	2x60
UVURKHANGAI	Tugrug	2x60
KHUVSGUL	Alag-Erdene	2x100
	Burentogtokh	2x100
	Tosontsengel	2x100
	Tsagaan-Uul	2x100
	Tsetserleg	2x100
	Tumurbulag	2x60
	Tunel	2x60
UMUNOGOVI	Bayan Ovoo	2x60
	Bayandalai	2x60
	Bulgan	2x60
	Khanbogd	2x60
	Khurmen	2x60
	Nomgon	2x60
	Tsogt Ovoo	2x60
	Tsogttsetsii	2x60
ZABKHAN	Tosontsengel	2x500

Aimag:10 Sum:45 Total:92 units / 7,520kW

Stage 2		
Aimag	Sum	
BAYAN-ULGII	Altai	2x100kW
	Altantsugts	2x60
	Bayannuur	2x100
	Nogoonnuur	2x100
	Tolbo	2x100
	Tsagaannuur	2x100
KHOVD	Altai	2x60
	Durgun	2x60
	Duut	2x60
	Mankhan	2x100
	Uench	2x60
UVS	Baruunturuun	3x100
	Bukhmurun	2x60
	Davst	2x60
	Khovd	2x60
	Undurkhangai	2x100
	Zavkhan	2x60
ZABKHAN	Aldarkhaan	2x100
	Bayankhairkhan	2x60
	Bayantes	2x60
	Tsagaankhairkhan	2x60
	Tdudevtei	2x60
	Shiluustei	2x60
	Yaruu	2x60
	Tsagaanchuluut	2x60
	Ikh-Uul	2x60
	Otgon	2x60
	Telmen	2x60
	Tosontsengel	1x500

Aimag:4 Sum:29 Total:58 units / 4,680kW

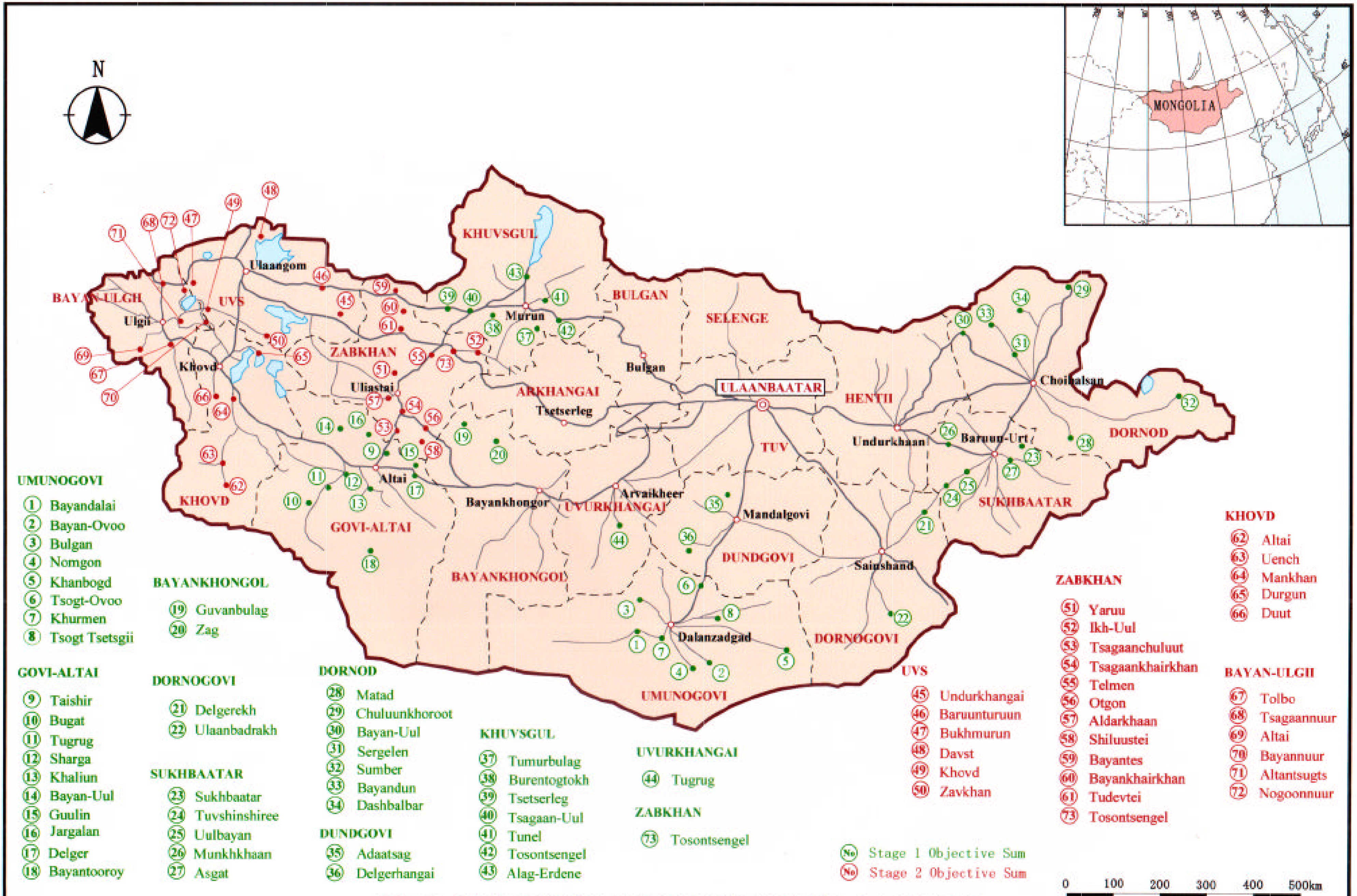


Fig 3-1 PHASING PLAN BY GEOGRAPHICAL LOCATION

2) Procurement Policy of the Equipment

Contractors (inclusive of subcontractors, material/equipment suppliers, vendors, etc.) shall deliver goods, products, materials, and services with strict compliance with the specifications prepared by the consultant including but not limited to design (inclusive of working/shop drawings), manufacturing, painting, factory testing/inspection, packing, shipping, installation, local commissioning/inspection, and operation inspection of all goods, equipment, and services and materials provided. Contractors shall be responsible for preparing documents including drawings for the use of applying permits, approvals, licenses, etc, to transport, install, and construct the contracted work. Contractors are also responsible preparation of necessary work related documents for the for support services during power interruptions and he shall consult with MOI. Mongolia Government is responsible for securing all permits and approvals and for support services for construction works mentioned above.

Installation work shall be made in compliance with the following rules.

- Preliminary Survey

The project is implemented on the basis of installing new generators and auxiliary (appurtenant) equipment in the existing plants. It is a prerequisite for Mongolia side to have completed preparatory work prior to the commencement of generator foundation work. Since there are quite a few recipient villages with a variety of implementation conditions existing in this project, contractors responsible for installation have to reconfirm equipment transport routes, detailed construction plans, and readiness of the recipient villages and plants. Contractors must inform MOI of such preliminary survey results.

- Installation Work

Since a number of generators have to be installed in a short period, most of wiring work shall be completed in Japan so as to reduce construction period and prevent errors and omissions in wiring work as much as possible. And contractors will be obliged to transfer operation and maintenance technology to villagers while Japanese engineers are installing generators.

3) Design and Construction Supervision

Scope of service for consulting work is as follows.

Work in Japan

- Final confirmation of project scope,
- Preparation of tender documents,
- Tendering and tender evaluation,
- Contract negotiation and assistance in negotiation,
- Inspection at manufacturing plants and inspection prior to shipment,
- Inspection during construction and issuance of test certificates, and
- Explanation and report to the concerned agencies.

Work in Mongolia

- Preparation of supplemental installation work drawings for generator and its auxiliary equipment,
- Review and revisions to construction scheduling for inland transportation and site installation,
- Construction supervision and schedule management for inland transportation and site installation,
- Safety management,
- Technology transfer,
- Approval of the execution plan for acceptance inspection, and attendance to inspection,
- Preparation of monthly reports,
- Issuance of progress and payment certificates,
- Preparation of completion records,
- Confirmation of the performance after one year of taking over,
- Report to the concerned agencies,
- Implementation of Soft Component (training program)

3-1-2 Implementation Conditions

For implementation of the project, precautionary measures should be taken as listed below.

(1) Transport of Equipment

The project calls for a long haul of heavy equipment such as diesel engine generators, auxiliary equipment, panel board, etc. During transit, loading, and unloading, safety measures for workers involved and damage prevention measures of equipment must be prepared and complied.

(2) Scheduled Power Interruptions

Power stoppage for installation work should be planned and scheduled so as not to cause any sudden interruptions to users.

(3) Safety Assurance for Electrical Work

Safety for electrical work must be ascertained for adjustment and inspection of energized equipment by clearly defining energized equipment since part of equipment may be already electrically charged.

3-1-3 Scope of Work

Table 3-2 illustrates responsible scope of work shared by Mongolia and Japan.

Table 3-2 Scope of Work by Mongolia and Japan

Scope of Work	Japan	Mongolia
1. Provision of construction sites and assurance of access rights		●
2. New construction or refurbishment of power plant housing facilities for equipment		●
3. Removal and relocation of existing facilities and equipment including the existing concrete foundations, which will be not necessary after the installation of new equipment by the Project		●
4. Provision and improvement of equipment access roads		●
5. Provision and improvement of power distribution network		●
6. Provision and installation of diesel engine generators, low voltage distribution panels, insulation transformers, control panels, DC supply panels, concrete foundation for D/G, exhaust ducts, waste oil incinerators.	●	
7. Provision and installation of cable connection from the distribution panel to the first electric pole outside the powerhouse.	●	
8. Provision of vehicles for Mobile Maintenance Unit Systems.	●	
9. Soft Component	●	

3-1-4 Consultant Supervision

The consulting service shall be rendered in accordance with the guidelines of Japanese grant aids. Government of Mongolia and the Japanese consultant will enter into an agreement with for consulting services for design and construction supervision. Such agreement is subject to approval of Ministry of Foreign Affairs of Japan prior to its execution. The scope of service for the consultant is described in subsequent paragraphs.

(1) Design Service for Implementation

1) Design

The Consultant, on the basis of the results of the Basic Design Study, and also on the basis of the Exchange of Notes (E/N) will execute the detail planing, prepare drawings and technical specifications that are necessary for calculations by participants of the tender on procurement of equipment.

2) Preparation of Tender Documents

The consultant will select qualified tenderers, review tender methods with MPR's implementing agency, and conduct tendering on behalf of such agency. Tender documents include the following documents.

- Preparation of tender documents,
- Public notice for tender,
- Review of prequalification records of prospective tenderers,
- Distribution of tender documents,
- Tendering, and
- Tender evaluation.

(2) Construction Supervision

The consultant will check, inspect, and administrate adequacy of procurement/installation work, monitor the implementation schedule, and inspect adequacy of specified products, equipment, and materials. During the construction period, the consultant will assign one (1) Project Manager stationed in Ulaanbaatar, and one (1) resident engineer for each construction group in order to assure time and quality control of the project. Furthermore, the consultant will report to and communicate with the concerned agencies as needed. The service includes issuance of completion certificate, hand-over service, and final project report. Moreover, the consultant will attend testing and inspection of equipment at manufacturing plants to ascertain equipment quality.

3-1-5 Procurement Plan

(1) Procurement Sources

1) Local Conditions of Procurement

Mongolia imports many construction equipment and materials from Russia, China, Korea, and other foreign countries. Naturally, more common goods are available in the market but special goods are extremely difficult to obtain from the market.

Locally available items include cement, aggregates, reinforcing bars, heating apparatus (fixed type stove), and lumber for temporary work in consideration of quality and available quantity. Other items can be procured; however, their quality and availability will be questionable. Locally available items should be most economically procured in Ulaanbaatar since supplies are stable.

2) Procurement of Japanese Goods

The previous Japanese grant projects have proved that equipment procured from Japan had been reliable in quality.

The field study confirmed that spare parts for Japanese equipment are available for future repair and maintenance; thus, major equipment will be procured from Japan.

3) Procurement Sources

The above analysis is tabulated in Table 3-3: List of Procurement Sources.

Table 3-3 List of Procurement Sources

Equipment and Materials	Source	
	Mongolia	Japan
1. Diesel engine generator		●
2. Auxiliary equipment		●
3. Heating stove	●	
4. Low voltage distribution panel		●
5. Insulation transformer		●
6. Battery charger		●
7. Waste oil incinerator		●
8. Power and control cables		●
9. Grounding materials		●
10. Cement/Aggregate/Re-bar	●	
11. Connecting materials with existing lines		●
12. Spare parts and consumption materials		●
13. Tools for traveling maintenance team		●

(2) Transport Plan

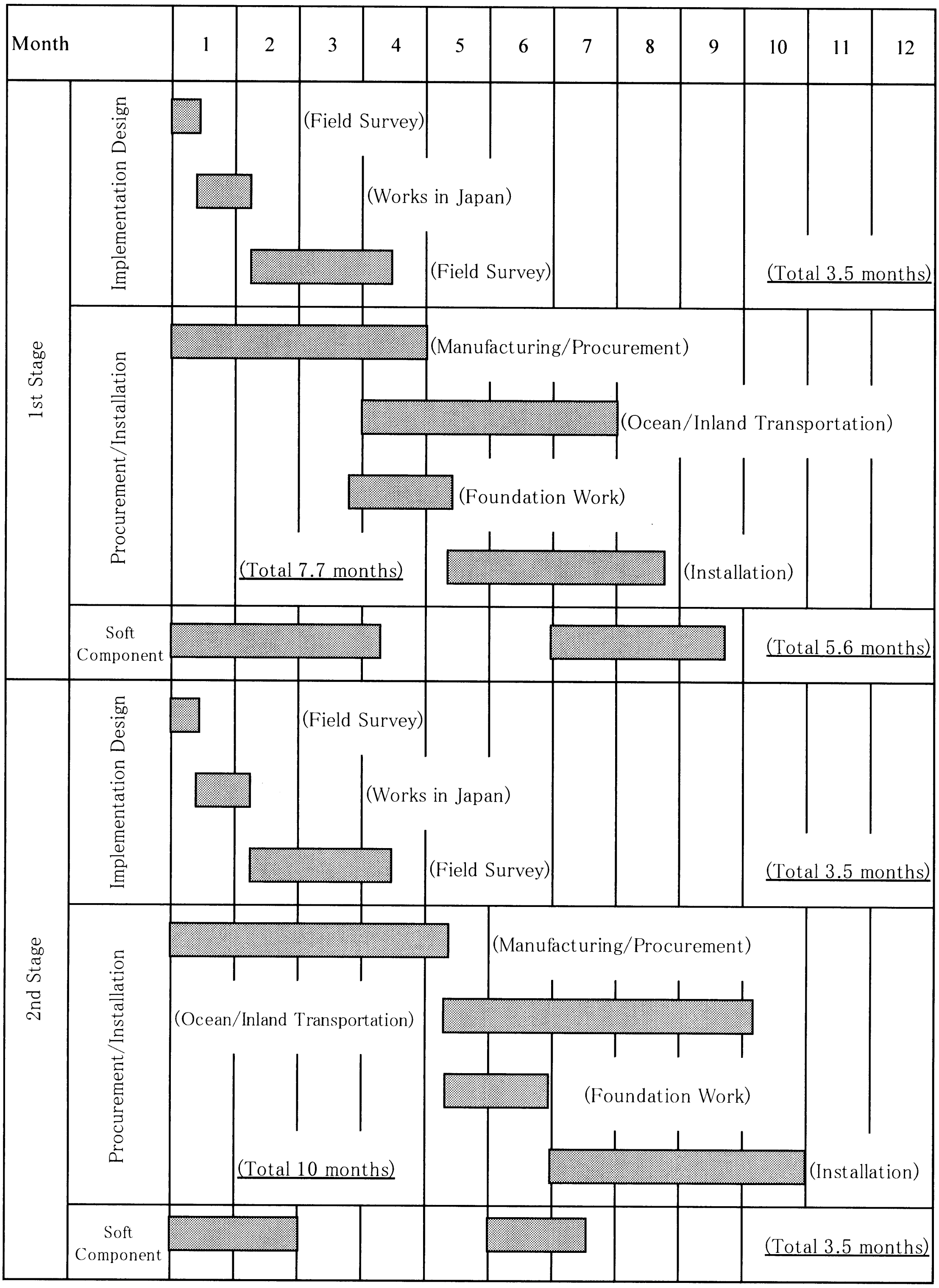
Chinese route is recommended for transport of Japanese products in consideration of transport time, paper work, and reliability. This route begins with loading at the Port of Yokohama, unloading at the New Port of Tianjin, surface transport to Beijing and Datong, then to Ulaanbaatar. It is important to ascertain reservation of China Railway's freighter trains in advance. Freighters passing China are generally not subject to disinfections inspection if shipments are transported by containers. Containers will not be opened for fumigation from the origin to the destination.

Trucks will provide transport from Ulaanbaatar to each village.

3-1-6 Implementation Schedule

Implementation schedule for Japan's contribution is illustrated in Table 3-4.

Table 3-4 Implementation Schedule



3-1-7 Undertakings of the Government of Mongolia

It is envisaged that in case this Project is implemented according to Grant Aid System of the Government of Japan, the Government of Mongolia will execute the following measures.

(1) To secure buildings and make necessary repairs prior to the installation of facilities and equipment provided through the Japanese Grant Aid.

(2) Removal and relocation of existing facilities and equipment, which will not be necessary after the installation of the new facilities and equipment provided through the Japanese Grant Aid.

(3) Implementation of necessary repair to the existing transmission and distribution lines.

(4) Acquisitions of transport access to and in the site.

(5) To obtain all licenses and permits necessary to implement the Project.

(6) Public announcement and execution of power interruption necessary for work execution.

(7) Conclusion of interbank agreement (Banking Arrangement) with bank located within Japan.

(8) To obtain import/export permits and bear the related expenses.

(9) To exempt necessary equipment and material to be imported for the Project.

(10) To exempt Japanese nationals from custom duties internal taxes and other fiscal levies which will be imposed in the recipient country with respect to the supply of the products and services under the Verified Contracts.

(11) To accord Japanese nationals, whose services may be required in connection with the supply of the products and services under the Verified Contracts, entry permits and stay permits in Mongolia.

(12) To maintain and use the facilities constructed and equipment purchased under the Grant Aid properly and effectively.

(13) To bear all the expenses other than those covered by the Grant Aid, which are necessary for implementation of the Project.

3-1-8 Soft Component

(1) Contents of the Task

1) Schedule

1st Stage

- First Session Approx. 3 month
- Second Session Approx. 3 month

2nd Stage

- First Session Approx. 1 month
- Second Session Approx. 1 month

(2) Manpower Requirements

The manpower to execute the work is as below.

Japanese Staff

① Operation and maintenance of diesel engine generator (Sum)
Expert on diesel engine generator and incineration of waste oil.
② Operation and maintenance of diesel engine generator (Aimag centers)
Expert on diesel engine generator.
③ Operation and maintenance of power supply utility
Expert on operation of public utilities.

Mongolian Staff

① Interpreter-cum-assistant-1
② Interpreter-cum-assistant-2
③ Interpreter-cum-assistant-3

(3) Expected Trainees

Table 3-5 Expected Trainees

	Operation and maintenance of diesel engine generator	Operation and maintenance of power supply utilities
Sum chief / Sum manager		○
Sum power station chief and operators	○	
Aimag power utility engineers (members of traveling maintenance team)	○	
MOI officer in charge	○	○

(4) Location of Training

The first session, which its task is "operation and maintenance of diesel engine generator" will be opened in Ulaanbaatar. The second session will be opened at the Aimag center near the target Sums (Phase I at 9 Aimag centers, Phase II at 4 Aimag centers).

(5) Contents of the Training

Contents of the training are shown in the table below.

Table 3-6 Contents of Training (1/2)

	Period	Activity		Outputs	Direct Effect
First Session	After arrival of diesel engine generator in Ulaanbaatar	Operation and maintenance of power supply utility	· Lecture and practice on clarification of tariff deciding criteria (recovering of expenditures for maintenance and management) and decision of reasonable tariffs. · Public relations with inhabitants related to power supply activities, guidelines related to contract between power utility and beneficiaries and preparation of articles of association (model)/(lecture and practice). · Lecture and practice related to formation of tariff collecting system. · Lecture and practice related to management procedures on purchase of spare parts, procedures to request fault repairing. · Lecture on preparation and filling method of monitoring format. · Preparation of basic manual related to bases of management. · Lecture on record keeping and its importance.	· Basic manual · Recording formats · Model of guideline related to contract between power utility and beneficiaries	Construction of a foundation of the power utility operation in each Sum. An actualization of an efficient power utility operation.
		Operation and maintenance of diesel engine generator and associated equipment	· Lecture on basic technology related to generating facilities. · Practice on daily operation and maintenance. · Lecture and practice on basic trouble shooting technology. · Handling practice on inspection apparatus, special tools and meters. · Lecture and practice on fault diagnosing and repairing technologies. · Lecture and practice on operation and maintenance of the waste oil incinerator. · Lecture on methods of preparing and entering in monitoring formats · Preparation of basic manual for operation and maintenance. · Lecture on record keeping and its importance.	· Basic manual related to operation and maintenance. · Recording formats	Actualization of a planned maintenance.

Table 3-6 Contents of Training (2/2)

	Period	Activity		Outputs	Direct Effect
Monitoring (by the Mongolian side)	2 months period after starting operation of the facilities	Data collection of operation and maintenance at Sums and Mobile Maintenance Unit System	· Utilizing the PCM method and collection of account records, operation and maintenance logs. · Collection of monitoring sheet prepared in the first session.	· Monitoring report	Clarification of the problems/dificulties of the Sums.
Second Session	After data collection of 2 month period operation	Operation and maintenance of power supply utility	· Analysis and evaluation of monitoring results. · Evaluation of power tariff level and expenditures for maintenance and management (lecture and discussion). · Evaluation of results of public announcement and articles of association (lecture and discussion). · Evaluation of tariff income and tariff collection system (lecture and discussion). · Evaluation of management procedures for purchase of spare parts, procedures for requesting fault repair, etc. (lecture and discussion). · Inspection of Sum sites.	· Examination results of technical achievements	Enables a concrete training course based on actual practice of the Sums, which will lead to the best solutions.
		Operation and maintenance of diesel engine generator and associated equipment	· Analysis and evaluation of monitoring results. · Evaluation of the daily operation and maintenance conditions and review of the problems (lecture and discussion). · Evaluation related to trouble shooting (lecture and discussion). · Evaluation related to handling practice on inspection apparatus, special tools and meters (lecture and discussion). · Evaluation related to fault forecasting (lecture and discussion). · Evaluation related to fault diagnose and repairing (lecture and discussion). · Evaluation on the operation and maintenance of the wast oil incinerator (lecture and discussion).	· Examination results of technical achievements	A down – to –earth training which will lead to a improvement of managing power supply facilities.

3-2 Project Cost Estimation

The cost to be beard by the Mongolia side in the case of extension of Japanese grant aid is as below.

Table 3-7 Mongolia's Contribution

Project Components	1st Stage (Tg)	2nd Stage (Tg)
1) Removal and/or reconstruction of existing plant buildings	48,648,000	48,848,000
2) Repair and/or refurbishment of existing plant buildings	22,297,000	22,307,000
3) Excavation or trenching for generator foundation	30,405,000	30,405,000
Sub-total	101,350,000	101,560,000
Total	202,910,000 Tg.	

3-3 Operation and Maintenance

Each subject village has its own operation and maintenance system; however, no daily routine check system has not been conducted. Operation of these village operated power supply systems are becoming more difficult due to higher electricity charges beyond user's payment ability, which might be accelerated by an abrupt price hike in diesel fuel last year.

Remedial measures are proposed herein in order for the subject villages to establish a sustainable operation and maintenance system for newly installed equipment.

(1) Establishment of Village Operation/Maintenance System, Mobile Maintenance Unit System, and MOI Support System

Mobile Maintenance Unit System has a key to the success of village level operation and maintenance. It is understood that MOI is preparing codes and regulations to define scope of work and cost bearing responsibility between village and mobile maintenance unit. It is a must to establish mutually agreeable rules and guidelines for compliance so that stable and sustainable power supply operation may be attained. Furthermore, close communication network between villages, mobile units, and MOI is also required for routine checks as well as emergency repairs. In this regard, MOI is strongly advised to constantly monitor the status of each and every power plant.

(2) Soft Component

Soft Component is intended to convey know-how of basic operation and maintenance principles to operation/maintenance trainees in conformance with manufacturer's operation & maintenance manuals. Trainees sufficiently learn daily operation/maintenance procedures, precaution measures during winter, and other necessary know-how and skills for equipment operation. In addition, various reporting formats such as operation records, repair records, inspection records, and parts ledger will be provided together with operation/maintenance manual as part of Soft Component. Formats for maintenance checklist is also include in Soft Component so as to avoid any omissions and errors.

(3) Daily Routine Check

Daily routine check includes visual inspection of overall external inspection and engine inspection (e.g. lubricant, coolant, indicators, air filters, etc.) Check of start-up voltage and load condition during operation is also included. Load variances by hours, daily inspection report, and incident reports should be routinely prepared by village operators. Necessity and importance of daily routine check must be thoroughly conveyed to operation trainees as an important part of Soft Component.

In addition, oil and filter change at predetermined interval enhances life span of equipment and prevention of accident and costly repair.

(4) Regular Maintenance Check and Overhaul

Regular maintenance check and overhaul shall be conducted at intervals prescribed in the manual. Technical training of regular maintenance procedures, check points and parts replacement will be given to diesel operators and mobile maintenance members through practice and seminars of overhaul as part of Soft Component. Sustainable maintenance can be only attained by effective maintenance of Mobile Maintenance Unit based on the work plan formulated by both well-communicated village operators and Mobile Maintenance Unit members. Trainees will be taught of preparation of work plan for Mobile Maintenance Unit in Soft Component.

(5) Spare Parts

This project includes spare parts for three years of operation and maintenance. Each village is allowed to store only parts necessary for ordinary wear and tear and daily maintenance check. Person in charge of each village is responsible to prepare parts ledger and keep inventory of parts. Beyond the three-year period, supply of necessary parts will be determined based on the track record of parts usage. This will lead to a sustainable operation of power plant in the future.

For regular maintenance, spare parts should be kept and administrated by Mobile Maintenance Unit responsible for a predetermined service area. In this manner, effective use of spare parts is possible within such service area.

(6) Mobile Maintenance Unit

Planned management of Mobile Maintenance Unit is a necessity for sustainable operation and maintenance of village power plants. Although each village has operation/maintenance personnel, existing personnel is generally capable of handling basic operation and maintenance but not major repair work and regular maintenance without assistance from provincial engineers (simultaneously members of Mobile Maintenance Unit.) Mobile Maintenance Units are to be established in nine provinces. This project will add seventy-one (71) villages to service domain (except for Bulnai, which is directly managed by province and out of Mobile Unit's service responsibility.) One Mobile unit is believed to service 10 villages (on the basis of the study.) Thus, this project requires such Mobile units in nine (9) provinces (refer to 1-3-1(4).) Each Mobile unit consists of 1 to 3 engineers, who are provincial power plant engineer and mostly also an engineer in charge of energy. In this project, four provinces such as Govi-Altai, Bayanhongol, Khuvsgul, and Zabhan will be allocated two (2) Mobile units each. In Japan, a crew of 1 to 2 engineers is common for regular maintenance. The subject provinces have similar crew formation of 3 to 6 power plant engineers and 1 to 3 electrical engineers. Crew size of daily operation and maintenance for larger generators at provincial level is fairly small. Thus, it is possible for two units per province to conduct regular maintenance check (1,000 hours, 2,000 hours, and overhaul) provided that work schedule of Mobile unit service and provincial power plant maintenance are rationally planned in advance. However, budget allocation for Mobile Maintenance Unit has not been provided. Immediate budgeting for the Mobile units is required. This budget allocation issue for Mobile Unit will be discussed and confirmed by MPR in writing at the time of the draft final study presentation scheduled in August 2000. Wages and salaries of Mobile Unit are borne by province since Mobile Unit members are also provincial employees.

(7) Management of Power Generation Business

This project will greatly alter the picture of power supply status by installing new power generators and plants. This will inevitably stimulate more energy consumption by general and industrial sectors and consequently create more demands. It is anticipated that such changes in consumption pattern will cause unfairness in pricing structure. Fixed charge system may be incompatible with various quantities and patterns of household consumption. Comparative case study of fixed charge vs. meter charge systems will be conducted in Soft Component. In addition, managers of each village power plant will learn how to prepare service agreements between provider and users.

In the Soft Component, technology will be transferred to each Sum. This will enable the current diesel engine operators and electric engineers (consist of 2 or 3 staffs) to carry out the basic operation/maintenance works required. In case of major repair work and regular maintenance, the newly established Mobile Maintenance Units (consist of 1 to 3 staffs) and technology transfer to them, which are included in this Project, will enable adequate support to the Sums.

(8) Operation and Maintenance Costs

Power supply service is a self-supporting enterprise for villages. This principle will not be altered even after new equipment is introduced. However, government subsidy is made to each village for public use of electricity in response to annual village's budget request. Increased fuel price and consequent large price hike of electricity last year has caused increased shutdown of some village power plants due to user's inability to pay. Such raising fuel price is a serious issue for power supply industry and its users. It is requested for MPR to take up this problem as national issue to reduce fuel price. Rough estimate of average fuel price for new equipment ranges from 120 to 130 Tg/kWh. This cost range is approximately 2.5 times more than an average user cost of 50 Tg/kWh, connected to the Central Grid System.

CHAPTER 4

PROJECT EVALUATION AND RECOMMENDATION

CHAPTER 4 PROJECT EVALUATION AND RECOMMENDATIONS

4-1 Project Effects

4-1-1 Direct Effect of the Implementation of the Project

The direct effect of implementing the Project will be to secure a stable supply of electricity for the targeted seventy-three (73) Sums. Total installed capacity of new power generating sets for target Sums amounts to 12,200 kW, which is 1.78 times as much as the total generating capacity in 2000 (6,850 kW). By implementing the Project, the power generating facilities for all the remaining Sum centers, which have independent power supply systems, are to be renewed.

The new generators have a lower fuel consumption rate than that of existing ones, and therefore a reduction in carbon dioxide emissions is expected. With better fuel efficiency, fuel consumption will be reduced by 13 percent initially, and that in 5 years reduced by 34 percent based on the demand projection, power demand being 1.5 times the present value. In turn, it will contribute to a reduction in operation costs of power generating facilities. Furthermore, it provide a more stable supply of electricity and sustainable O & M.

As for environmental considerations, low emission type generator sets are to be adopted in order to reduce the air pollution due to the exhaust gas. Furthermore, forced-burning type incinerators are to be installed in each Sum. This will effectively prevent air pollution and soil contamination caused by dumping of oil waste compared with the traditional disposal method (combustion by home stoves). Furthermore, with its lower fuel consumption, emission of carbon dioxide (CO_2) will be reduced by 13 percent, and that in 5 years reduced by 34 percent based on the demand projection.

Nine (9) Mobile Maintenance Units to be newly formed in the Project will contribute to the formulation of O & M systems for power generating facilities for the targeted Sum centers. Moreover, in implementing Soft Component, in which training in both financial and technical aspects will be given to O & M staff of targeted Sums, the technical level of O & M staff will be highly improved, and O & M capability of power generating facilities for targeted Sums enhanced.

4-1-2 Indirect Effect of the Implementation of the Project

The indirect effect of implementing the Project will be to activate the regional economy and to improve public services and people's standard of living.

The improvement of electric power supply will enable reopening of factories which are now suspended due to power shortage, promotion of new industries and revitalization of the industry as a whole. This will bring about an increase of employment, and thence economic activities will be encouraged. Improvement and augmentation of public facilities will enable public services to be improved. The stable supply of electricity will promote use of radios and television, in turn, village people will be better informed.

4-1-3 Confirmation of the Justification of the Project by Japan's Grant Aid

The Project meets all the requirement of Japan's Grant Aid as shown in the following, and it is therefore confirmed that the implementation of the Project is justified.

(1) Total number of electric power consumers as the main beneficiaries of the project amounts to 82,500 people, which is the public in general.

(2) The purpose of the Project conforms with the requirement for basic human needs ("BHN"), education and character building of the people, and a stable power supply will contribute towards stable living conditions and improvement in living standards; therefore the Project needs to be urgently implemented.

(3) Mongolia, the recipient country of the Grant Aid, is capable of maintaining, managing, and operating the power generating facilities with its own funds, personnel, and technology.

(4) The Project will assist in the accomplishment of the middle- and long-term development plan of Mongolia.

(5) As the Project is aiming primarily at improvement of living condition of the people in general, there will be no direct profits generated by the Project.

(6) The environmental effect will be carefully considered in the Project, and negative impact properly addressed.

(7) The Project can be implemented with no special difficulty as a Grant Aid project pf Japan.

4-2 Recommendations

As discussed in preceding sections, the Project will bring about large benefits and contribute to improvement of people's BHN, and it is therefore concluded that that implementation of the Project by Japan's Grant Aid is justified. However, the following matters should be dealt with so that the Project will be implemented more effectively.

(1) In implementing Soft Component, in which O & M staff for each Sum are trained to acquire basic knowledge of operation/management of power generating facilities, it is also important to establish a system confirming the actual state and effectiveness of implementation. For this purpose, MOI should inspect the management body of each Sum periodically by interviewing the management chief and other staff, and thereby grasp the actual situation and give advice if necessary.

(2) Each Sum is lacking in knowledge of Japanese equipment/material. In implementing Soft Component it is intended to provide O & M staff in both provincial central managing offices and managing offices in Sums with lectures on O & M methods for Japanese equipment/material, and it is favorable for managing offices to continue to conduct training by themselves and/or in cooperation with sales agent of equipment manufacturers under the guidance of MOI. As a first step, the O & M methods should be established through technical instruction by Mobile Maintenance Crew at the time of periodical inspection and the technical seminars to be held by managing offices.

(3) In order to establish sustainable operation of Mobile Maintenance Unit, it is necessary, at an early stage, to define the activities of Mobile Maintenance Unit, assign the responsibility between each Sum and Mobile Maintenance Unit, and work out the budget for operation costs of Mobile Maintenance Unit.

Table 4-1 Fuel Consumption Rate and Emission of Carbon-dioxide (1/2)

Aimag	Sum	Comparison of fuel consumption rate*			Present annual	Projected Power demand after 5 years			Comparison of CO_2 emission	
	Name	Power demand (kWh/day)	Existing generators (liter/day)	New generators (liter/day)	Fuel consumption (ton/year)	Power demand (kWh/day)	Fuel consumption (liter/day)	Fuel consumption (ton/year)	At present (ton/year)	After 5 years (ton/year)
BAYAN-ULGII	Altai	240	66	60	11	860	215	37	34	112
	Altantsugts	240	64	60	11	376	94	16	33	49
	Bayannuur	320	88	80	15	1,128	282	48	46	147
	Nogoonnuur	200	68	50	12	620	155	27	36	81
	Tolbo	240	96	60	16	1,502	375	64	50	196
	Tsagaannuur	750	180	188	31	784	196	34	94	102
BAYANKHONGO	Gurvanbulag	154	68	39	12	426	107	18	36	56
	Zag	300	40	75	7	324	81	14	21	42
DORNOD	Bayan-Uul	450	150	113	26	760	190	33	78	99
	Bayandun	278	68	70	12	628	157	27	36	82
	Chuluunkhoroot	200	60	50	10	960	240	41	31	125
	Dashbalbar	300	192	75	33	768	192	33	100	100
	Matad	360	84	90	14	512	128	22	44	67
	Sergelen	215	90	54	15	420	105	18	47	55
	Sumber	275	126	69	22	1,964	491	84	66	257
DORNOGOVI	Delgerekh	295	73	74	13	440	110	19	38	57
	Ulaanbadrakh	463	100	116	17	608	152	26	52	79
DUNDGOVI	Adaatsag	306	110	77	19	415	104	18	57	54
	Delgerkhangai	240	107	60	18	433	108	19	56	57
GOVI-ALTAI	Bayan-Uul	600	120	150	21	588	147	25	63	77
	Bayantooroy	400	60	100	10	512	128	22	31	67
	Bugat	300	99	75	17	552	138	24	52	72
	Delger	810	360	203	62	1,152	288	49	188	150
	Guulin	840	280	210	48	1,520	380	65	146	199
	Jargalan	210	170	53	29	678	169	29	89	89
	Khaliun	420	100	105	17	667	167	29	52	87
	Sharga	360	78	90	13	501	125	21	41	65
	Taishir	1230	300	308	51	724	181	31	157	95
	Tugrug	900	200	225	34	836	209	36	105	109
KHOVD	Altai	369	80	92	14	567	142	24	42	74
	Durgun	240	80	60	14	465	116	20	42	61
	Duut	300	70	75	12	434	109	19	37	57
	Mankhan	1000	340	250	58	1,380	345	59	178	180
	Uench	450	44	113	8	436	109	19	23	57
KHUVSGUL	Alag-Erdene	275	60	69	10	544	136	23	31	71
	Burentogtokh	1062	65	266	11	1,480	370	63	34	193
	Tosontsengel	375	90	94	15	588	147	25	47	77
	Tsagaan-Uul	1164	233	291	40	1,521	380	65	122	199
	Tsetserleg	1197	407	299	70	1,798	449	77	213	235
	Tumurbulag	300	68	75	12	375	94	16	36	49
	Tunel	400	135	100	23	445	111	19	71	58

* : The fuel consumption estimated based on actual results of power demand in winter.

Table 4-1 Fuel Consumption Rate and Emission of Carbon-dioxide (2/2)

Aimag	Sum	Comparison of fuel consumption rate*			Present annual	Projected Power demand after 5 years			Comparison of CO_2 emission	
		Power demand	Existing generators	New generators	Fuel consumption	Power demand	Fuel consumption	Fuel consumption	At present	After 5 years
	Name	(kWh/day)	(liter/day)	(liter/day)	(ton/year)	(kWh/day)	(liter/day)	(ton/year)	(ton/year)	(ton/year)
SUKHBAATAR	Asgat	300	102	75	17	385	96	16	53	50
	Munkhkhaan	1270	250	318	43	1,676	419	72	131	219
	Sukhbaatar	984	361	246	62	1,804	451	77	189	236
	Tuvshinshiree	364	85	91	15	467	117	20	44	61
	Uulbayan	285	98	71	17	508	127	22	51	66
UMUNOGOVI	Bayan Ovoo	806	288	202	49	1,104	276	47	150	144
	Bayandalai	870	330	218	57	1,092	273	47	172	143
	Bulgan	820	165	205	28	903	226	39	86	118
	Khanbogd	576	198	144	34	1,462	366	63	103	191
	Khurmen	816	392	204	67	1,192	298	51	205	156
	Nomgon	915	90	229	15	822	205	35	47	107
	Tsogt Ovoo	250	80	63	14	712	178	31	42	93
	Tsogttsetsii	624	90	156	15	932	233	40	47	122
UVS	Baruunturuun	700	225	175	39	2,152	538	92	118	281
	Bukhmurun	192	70	48	12	771	193	33	37	101
	Davst	250	60	63	10	435	109	19	31	57
	Khovd	1159	394	290	68	701	175	30	206	92
	Undurkhangai	425	125	106	21	1,051	263	45	65	137
	Zavkhan	200	56	50	10	409	102	18	29	53
UVURKHANGAI	Tugrug	1576	350	394	60	1,188	297	51	183	155
ZABKHAN	Aldarkhaan	460	82	115	14	1,044	261	45	43	136
	Bayankhairkhan	1137	386	284	66	487	122	21	202	64
	Shiluustei	360	100	90	17	464	116	20	52	61
	Bayantes	250	112	63	19	438	110	19	59	57
	Ikh-Uul	1154	392	289	67	788	197	34	205	103
	Otgon	285	80	71	14	317	79	14	42	41
	Telmen	300	80	75	14	429	107	18	42	56
	Tsagaanchuluut	300	70	75	12	478	120	20	37	62
	Tsagaankhairkhan	1184	403	296	69	920	230	39	210	120
	Tudevtei	450	212	113	36	890	223	38	111	116
	Yaruu	260	82	65	14	373	93	16	43	49
Total		38,550	11,078	9,638	1,898	58,085	14,521	2,488	5,788	7,588

* : The fuel consumption estimated based on actual results of power demand in winter.

Table 4-2 Fuel Consumption and Electricity Charge (1/2)

Aimag	Sum	Unit rate of fuel	Number of household		Electricity charge per household				Electricity charge (Tg/kWh)			
					At present		After 5 years		At present		After 5 years	
	Name		At present	After 5 years	Existing facility	New facility	Existing facility	New facility	Existing facility	New facility	Existing facility	New facility
BAYAN-ULGII	Altai	450	220	320	4,166	3,835	14,118	8,201	127	117	175	102
	Altantsugts	380	150	230	5,089	4,815	6,179	4,578	106	100	126	93
	Bayannuur	400	250	380	4,260	3,915	12,224	7,983	111	102	137	90
	Nogoonnuur	425	310	360	2,887	2,221	6,457	5,103	166	127	147	116
	Tolbo	470	220	300	6,059	3,982	23,695	15,523	206	135	186	122
	Tsagaannuur	460	270	315	8,705	9,050	9,436	7,797	116	121	149	123
BAYANKHONGOR	Gurvanbulag	459	190	260	4,997	3,073	5,408	5,341	228	140	129	128
	Zag	455	150	260	3,987	6,854	6,437	4,161	74	127	203	131
DORNOD	Bayan-Uul	432	400	690	4,661	3,567	3,421	3,262	153	117	122	116
	Bayandun	432	156	675	5,819	5,932	3,170	2,795	121	123	134	118
	Chuluunkhoroot	436	64	505	13,091	11,252	7,419	5,658	155	133	153	117
	Dashbalbar	437	118	265	20,102	8,403	10,123	8,610	293	122	137	116
	Matad	430	171	214	6,327	6,734	11,731	7,222	111	118	192	118
	Sergelen	430	120	201	9,596	6,089	7,253	6,428	198	126	136	121
	Sumber	442	458	503	3,570	2,079	13,820	11,378	220	128	139	114
DORNOGOVI	Delgerekh	433	180	193	5,334	5,383	8,974	7,026	121	122	154	121
	Ulaanbadrakh	420	130	143	9,544	10,917	15,373	12,377	99	114	142	114
DUNDGOVI	Adaatsag	480	110	125	13,930	9,983	15,236	11,297	185	133	180	133
	Delgerkhangai	450	125	212	11,254	6,685	8,464	6,534	217	129	162	125
GOVI-ALTAI	Bayan-Uul	470	350	370	4,679	5,766	7,551	5,186	101	125	186	128
	Bayantooroy	465	120	145	7,166	11,351	16,680	11,446	80	126	185	127
	Bugat	480	165	197	8,422	6,537	9,668	9,292	172	133	135	130
	Delger	464	210	250	21,984	12,588	19,310	14,198	211	121	164	121
	Guulin	457	175	350	20,398	15,462	17,763	13,101	157	119	160	118
	Jargalan	480	138	160	16,738	5,703	16,493	13,851	407	139	153	128
	Khaliun	467	147	180	9,303	9,732	14,285	11,818	121	126	151	125
	Sharga	468	188	250	5,810	6,617	7,442	6,550	112	128	146	128
	Taishir	480	103	120	38,783	39,727	26,887	19,645	120	123	175	128
	Tugrug	472	183	180	14,511	16,252	18,442	14,764	109	122	156	125
KHOVD	Altai	487	295	335	3,927	4,473	7,986	5,676	116	132	185	132
	Durgun	465	200	277	5,555	4,300	6,163	5,486	171	133	144	128
	Duut	470	99	155	10,050	10,691	11,123	9,310	123	131	156	130
	Mankhan	474	480	550	9,304	6,905	12,153	7,868	165	123	190	123
	Uench	479	230	292	2,938	6,790	7,514	5,046	56	129	197	133
KHUVSGUL	Alag-Erdene	460	180	390	4,777	5,381	7,020	4,493	116	130	197	126
	Burentogtokh	470	180	390	5,220	19,355	18,227	11,773	33	121	188	122
	Tosontsengel	450	292	420	4,138	4,294	5,838	4,390	119	124	164	123
	Tsagaan-Uul	468	302	480	10,129	12,555	14,250	9,782	97	121	176	121
	Tsetserleg	475	428	500	11,256	8,348	14,365	11,201	165	123	157	122
	Tumurbulag	460	130	240	7,317	7,986	7,043	5,178	117	128	177	130
	Tunel	465	180	275	10,009	7,568	6,208	5,317	167	126	150	129

Table 4-2 Fuel Consumption and Electricity Charge (2/2)

Aimag	Sum	Unit rate of fuel	Number of household		Electricity charge per household				Electricity charge (Tg/kWh)			
					At present		After 5 years		At present		After 5 years	
	Name		At present	After 5 years	Existing facility	New facility	Existing facility	New facility	Existing facility	New facility	Existing facility	New facility
SUKHBAATAR	Asgat	433	140	190	9,280	7,025	8,418	6,340	160	121	163	123
	Munkhkhaan	436	301	390	10,158	12,798	17,507	12,345	89	112	160	113
	Sukhbaatar	427	189	220	22,628	15,613	33,380	23,036	161	111	160	110
	Tuvshinshiree	437	130	200	8,535	9,080	9,402	7,209	113	120	158	121
	Uulbayan	435	189	280	6,654	4,992	8,589	5,538	163	123	186	120
UMUNOGOVI	Bayan Ovoo	432	110	125	31,508	22,336	31,804	25,457	159	113	141	113
	Bayandalai	439	125	133	32,145	21,478	31,368	24,046	171	114	150	115
	Bulgan	438	185	250	11,124	13,681	16,115	10,653	93	114	175	116
	Khanbogd	432	130	160	18,586	13,741	32,283	26,053	155	115	139	112
	Khurmen	436	105	150	44,965	23,887	31,187	23,034	214	114	154	114
	Nomgon	432	140	245	8,260	19,820	12,450	9,818	47	112	146	115
	Tsogt Ovoo	425	110	125	9,315	7,490	22,984	16,568	152	122	158	114
	Tsogttsetsii	427	161	186	7,107	11,833	20,433	14,403	68	113	160	113
UVS	Baruunturuun	457	150	700	19,385	15,272	10,925	9,226	154	121	139	118
	Bukhmurun	465	190	300	5,187	3,733	10,434	8,094	190	137	159	123
	Davst	500	150	200	6,111	6,336	9,125	7,636	136	141	165	138
	Khovd	460	100	320	11,708	8,891	9,681	6,870	172	131	173	123
	Undurkhangai	457	387	400	4,282	3,684	12,629	8,051	144	124	188	120
	Zavkhan	480	134	187	6,212	5,632	9,399	7,460	154	140	168	134
UVURKHANGAI	Tugrug	475	166	189	27,683	31,083	24,592	19,779	108	121	153	123
ZABKHAN	Aldarkhaan	460	123	276	9,212	12,545	15,019	11,662	91	124	156	121
	Bayankhairkhan	451	138	200	11,206	8,444	11,060	7,705	165	124	178	124
	Shiluustei	451	138	200	9,597	8,714	11,060	7,384	136	124	187	125
	Bayantes	450	215	300	6,825	4,028	5,981	4,664	217	128	161	125
	Ikh-Uul	458	280	390	4,356	8,172	8,989	6,263	64	120	174	122
	Otgon	467	196	250	5,691	5,128	6,856	4,339	145	131	212	134
	Telmen	450	149	215	7,239	6,832	10,267	6,382	133	126	202	125
	Tsagaanchuluut	465	130	148	7,581	8,064	11,535	10,536	122	129	140	128
	Tsagaankhairkhan	470	160	330	7,884	8,661	13,069	8,783	116	127	184	124
	Tudevtei	450	201	254	13,346	7,331	16,823	10,613	221	121	188	119
	Yaruu	460	140	180	8,036	6,528	9,391	6,872	160	130	178	130
Average		**453**	**191**	**283**	**10,661**	**9,528**	**13,113**	**9,770**	**145**	**124**	**163**	**121**