PART I MASTER PLAN

SUMMARY

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1. Background and Objectives of the Study

1.1 Background of the Study

In Mongolia some 50% of the total population of about 2.3 million are nomadic families. For the nomadic families, Sum centers are key places for supplying their vital goods, and also for taking the public services such as administration, medical care, education, etc.

As of November 1997, the electric power at 117 out of 314 Sum centers in total in Mongolia is being supplied from the national power transmission network. At the remaining 197 Sum centers, the electric power is supplied by the diesel engine generators by Sum centers independently. Most of these diesels generating facilities were manufactured during the former Soviet Union era and installed long ago from 1963 to 1990.

During the Social Republic era of the country, Mongolia depended on the Soviet Union for the supply of spare parts necessary for the maintenance of the generating equipment and technical guidance. Due to the corruption of the Soviet Union's economy in 1991 and associated transition to the market economy, the following four factors caused trouble in the operation and maintenance of the Sum's generating facilities: (1) the lack of business operating senses, (2) the interruption of spare parts supply, (3) the lack of technical capability and (4) shortage of management budget. The operation of much equipment has obliged to be remain stopped after failure as operators cannot repair them. Generation quantity, and inadequate power supply aggravated the conditions of daily lives of people in Sum centers and caused serious effects to the socio-economic activities of the Sum centers.

Under such situations, the Government of Mongolia decided to supply the electric power adequately to the Sum centers by the renewable energy which exists in the country as indigenous and abundant solar and wind energy resources. The adoption of the power supply facilities by the renewable energy is expected to contribute to saving the valuable fossil energy and to reduce outflow of foreign currency reserves.

In 1995 the Government of Mongolia asked the Government of Japan to formulate the master plan on the rural power supply by renewable energy. On the basis of the request from the Government of Mongolia, the Government of Japan dispatched the Project Selection Team to Mongolia in June 1997 and Project Formulation Basic Study Team in December 1997. Then the Preliminary Study Team was dispatched to Mongolia and the scope of work was concluded between THE Government of Mongolia and the Government of Japan in June 1998.

1.2 Objectives of the Study

The objectives of the Study are:

(1) Formulation of a Master Plan

The Master Plan includes the determination of the least cost alternatives of supplying electric power to 167 Sum centers, where the power system interconnection with the grid system is not available by the year 2000, by isolated diesel power generators and various isolated renewable systems such as a solar power system, wind power system and suitable hybrid systems, and the planning of optimum power supply systems and an implementation program for 167 Sum centers.

(2) Implementation of Operation Test by the Pilot Plant

Installation and operation of a renewable energy pilot power plant (hereinafter referred to as "the Pilot Plant") in three Sums centers selected in order to collect technical data and examine the outcome of the systems were implemented.

(3) Establishment of the Management Body for the Pilot Plant

Management bodies are established in each Sum center prior to the installation, and enable them to maintain and operate the Pilot Plant by themselves for more than 10 years.

(4) Transfer of Technology

Developm It is required to transfer relevant technologies and know how to the Ministry of Infrastructure ent (hereinafter referred to as "MOID") counterpart personnel and Sum people concerned in the course of the Study.

In addition to the said four objectives, it is envisaged to promote the development of renewable energy for saving energy and environmental protection instead of the existing power source (diesel power generator). Accordingly, it is recommended to add the fifth objective as given below.

(5) Contribution to the Global Environmental Protection

The development of renewable energy and the effective use of it contribute to global environmental protection.

1.3 General Description of the Study

The Study was carried out by the Study Team in two years from October 1998 to September 2000.

(1) Master Plan

The Master Plan Study began from preparatory work, in the home country and was completed in September 2000 through the sixth field survey works and fourth home study works. For the purpose of fully involving the Mongolian opinion in the Master Plan, an advanced work schedule of the formulation of the Master Plan including economic and financial analysis was taken into consideration in the Study. The Study Team presented the recommended Master Plan in detail and discussed the realization of the project with the counterpart.

(2) Pilot Plant

The Pilot Plant Installation Study was carried out parallel with the Master Plan Study and observed data were collected during a period of one year from July 1999, and collected data and results were reflected for the formulation of the Master Plan. The equipment and materials made in Japan were procured under the guideline of JICA.

(3) Consignment of Field Survey Work

Consignment of field survey works included employment of a local consultant for three physical years for the assistance of the Study Team and monitoring and data collection of the installed pilot plants. In addition, technology transfer to the local consultant was made in advance to the technology transfer seminar and technical guidance to help in their assistance works.

(4) Technology Transfer Seminar

Technology Transfer Seminars were held 3 times in total. In addition to these seminars inventory survey seminars were held at each Aimag center and technical guidance of pilot plants was executed at 3 Sum centers for sustainable and smooth management, operation and maintenance. Three Technology Transfer Seminars were carried out the following schedules.

(a) First Technology Transfer Seminar (Mar. 4, 1999)
(b) Second Technology Transfer Seminar (Mar. 6, 2000)
(c) Third Technology Transfer Seminar (Aug. 3, 2000)

2. Overview of Mongolia

Mongolia is located approximately in the central part of the Asian continent, and is constituted mainly of Mongols. It has the typical continental sub-arctic climate which is extremely dry, and temperature varies rapidly. Temperature variations of as much as 90°C can occur in a year, and more than 30°C in a single day. This big variation in temperature leads to vegetation patterns particular to the Mongolian Plateau, and enables nomadic stock farming.

The population of Mongolia is 2,413,000 (estimate as of the end of 1998). With the population density of 1.5 person per square km, Mongolia has one of the lowest population densities of any country in the world. Traditionally, Mongolian people have supported their lives by nomadism, which means people move from one place to another while raising a lot of livestock. The nomadic life has cultivated their own culture. It is quite unique and completely different from those of agricultural societies in which people settle down in one place. Being required to move frequently, simplicity has an important value. People have sought the simplest way of food, clothing and shelter. They live in a ger, a mobile dwelling which is easy to assemble and simply covered with felt. Their meals are basically prepared with meat, dairy products, and flour, adding salt for seasoning. They neither cook any vegetables nor add any spices. As for clothing, they wear very simple and practical clothes which are loose, have long sleeves, and which become a substitute for nightwear.

During a few years after 1990, the Mongolian political scene showed a drastic change from socialism, which dominated the country for 70 years, to the parliamentary democracy with market economy. Due to the wide land area and small population with low density, the transportation network is not well developed in Mongolia. Article 3 of the existing constitution, which was adopted on January 13, 1992, stipulates the national governing system consisting of Great Hural (Parliament), President, Government and the Judiciary. The territory of Mongolia is administratively divided into 21 Aimag (province) and a capital city, Ulaanbaatar. Aimag is subdivided into Sums (county), Sum into Bags (village), a Capital city into Duuregs (district), and Duureg into Horoos (town).

3. Economy

3.1 Economic Situations of Mongolia

Due to the collapse of the Soviet economic block and the consequent stoppage of economic aid, the per capita GDP of Mongolia in 1993 showed 30% reduction in real terms compared to that in 1989. The transition of the economy to market based regime is showing a positive result, but the progress is still slow. Between 1994 and 1997, the per capita GDP recorded an average annual growth of 1.9%, 0.8% during 1996, 1.5% during 1997 and 3% during 1998. There is no apparent sign of change in the economic structure from a single resource based economy with mineral products comprising more than 50% of the export. In 1999, the cold spell in the winter in addition to the draught that hindered the growth of fodder for cattle culminated in the loss of more than 2 million cattle heads. The rural economy solely based on livestocks is further damaged. Currently the rural areas cannot attract investments to spur economic growth. The unemployment rate, especially among the youth in the rural areas, is quite high. The lag in economic development is due to in part to the lack of infrastructures. Therefore, it is important to promote the development of social infrastructures including power supply to prompt economic growth.

3.2 Economic Situations of Sums under Study

After the collapse of the centrally planned economy, the rural societies absorbed a large influx of immigrants from the urban centers. With the stabilization of the economy, the population movements in Mongolia have reversed its direction again from the rural to urban areas. An increasing number of Sums under our study show a decline in population size. Among all 167 Sum centers under the Study, 113 Sum centers, or 65% of the total, showed population decline. The average household income at the Sum center is 800 thousand Tg per year in cash. The average household earns an additional 32% in kind from in-house production and barter. The occupations at the Sum center used to be dominated by the civil servants. The income from private sector jobs and trades are increasing its share, making the share of wages from civil service to drop 42% of the total cash income. The ownership of electric appliances is disproportionately high for the income level and the poor power supply situation. 90% of all the households own at least one TV.

4. Social Background of Mongolia

4.1 Social Situation of Mongolia

During the socialism era, the Mongolian government had put emphasis on education, spending a large amount of its national budget on education and providing free educational service. As a result, in the 1980's, the enrollment rate had reached almost 100% in primary and secondary education. The literacy rate among those of ages 15 and above reached 96% in 1989. Thus, the educational development had shown a big success. After 1990, along with the system change into democracy, capitalism, and market economy, Mongolia suffered from economic chaos which resulted in various confusions among the education sector. The number of students who do not attend the class has been increasing. Educational problems are more serious in rural areas: increasing number of students who do not attend classes, poor working conditions of teaching staffs, less qualified teaching staffs, shortage of schools and dormitories, shortage of educational materials, problems in teaching methods and curriculum, etc.

In the regional health and medical system in Mongolia, hospitals or health stations in each level of Aimag, Sum and Bag provide medical service. The medical service delivery system is well-established in Mongolia, but more doctors are distributed to the urban areas, while private general practitioners are very few in the rural areas. Like the educational budget, the national budget related to medical service has been actually decreasing since 1992. While Mongolia depends on other countries for most of its medical and pharmaceutical goods and equipment, Mongolia cannot import them sufficiently because of inflation and foreign currency shortage.

Under the market economy, not only are people with entrepreneurship highly required, but experts in the fields of management, financial accounting, human resource management, and law are also necessary in order to operate administrative organizations and business corporations effectively under the rule of capitalism. Another human resource problem which Mongolia is facing after market economy is the lack of engineers who can cope with new technologies.

4.2 Social Situation of the Targeted Sum Centers

The educational service in Sum Center has been deteriorating these years especially in terms of facilities. In schools, due to the limited supply of electricity during daytime, machine tools and language laboratories are hardly used. Heating has not been supplied sufficiently during the winter season since the individual heating system was introduced. In regards to personnel, many Sums point out that teaching staffs have lost the enthusiasm for education because of their low salary and delayed payment of wages.

In recent years health care service in Sum Center has been getting worse in terms of facilities. This is caused by an unstable power supply in many Sums which prevents hospitals frm utilizing electric appliances such as boiled disinfectors, refrigerators for vaccine, x-rays, and lighting.

The characteristics of a poor household in Sum Center lie in the fact that most of them have little cash income and live depending greatly on livestock. They tend to get food, clothes, and commodities through exchange with their livestock. The poor household without sufficient livestock to exchange is faced with the hardship of poverty, and manages to support their daily lives with meat and dairy products such as cheese given by their relatives. Whether they are poor or not, many unmarried mothers are in their teens and twenties.

Our research on the degree of satisfaction with the current social infrastructure and services in the targeted Sums revealed that, in more than half of the targeted Sums, computers in schools, operation facility in hospitals, and factory are evaluated as poorly-served areas.

5. Current Situations of Power Energy Sector and Development Plan

5.1 Power Energy Policy and Administrative Organization

In addition to coal and oil, as mentioned earlier, Mongolia is affluent with renewable energy such as solar and wind power. Since Mongolia can provide energy resources for themselves utilizing such renewable power, it is expected to decrease the fuel import cost and the outflow of foreign currency. This also enables Mongolia to contribute to the protection of the global environment.

The Energy Department in the Ministry of Infrastructure Development, as a rule, takes the role of policy-making, while the electric power supply is conducted by the Energy Authority. The Energy Authority runs three energy systems and operates independent diesel power stations in Aimag Center, while a Sum office runs an independent diesel power station in Sum Center. Most hydropower stations in Mongolia are operated by Hydropower Development Corporation (UCS) under the Energy Authority, although there are some independent private hydropower stations. The Renewable Energy Corporation conducts research and experiments on renewable energy as well as produces or imports and sells photovoltaic & wind power systems. As for production and sales of the photovoltaic power system, the Post and Telecommunication Authority set up the Photovoltaic Power Division in 1998 and started operation of the production line.

Mongolian government is now considering to revise the electricity law and organizational reform of Energy Authority, but there will be little change in operation and maintenance system of Sum power stations. But there is a possibility for the reformed Energy Authority to take charge of rural electrification and renewable energy.

5.2 Current Situations and Issues of the Existing Power Facilities

(1) Generating Facilities

The existing power generation plant in the power system is a coal-fired type thermal power plant. Most of the thermal power plants are deteriorated and operate in low efficiency. The peak demand of the Central Energy System in 1997 was 507 MW, and available maximum power output was 523 MW. Peak power is sometimes imported from Russia due to generator stoppage by the electric faults or accidents. In order to balance the increasing system power demand, it is required to import the shortage power from Russia or to construct new power generation plants. Major features of the existing power generation plants are shown below.

Table I.5-1 Major Features of the Existing Power Generation Plants

Item	P/S No.	Rated	Available	Intercon. W/Russia
CES thermal	5	753 MW	633.3 MW	Intercon.:Peak supply
WES thermal	3(Diesel)	(27.62 MW)	(24.3 MW)	Intercon.:All power
EES thermal	2	38.5 MW	9.2 MW	Independent
Aimag diesel	14	91.38 MW	71.3 MW	Independent
Mini-hydro	5	3078 kW	2078 kW	Independent

Electric power supply in the Aimag center outside the national power system consists of isolated diesel generation plants. These isolated diesel generation plants do not have enough capacity to supply the power to neiboring Sum centers. The old type diesel generation plants are under rehabilitation by USAID from 1997. The existing diesel generation plants have the following issues on the operation and maintenance as well as thermal power plants.

According to the data and information from the UCS State Owned Co., Ltd. which is in charge of development of hydropower plants, there are rich hydropower potentials in the northern and northwestern region. The investigated hydro potential sites for hydropower development are filed at 76 sites in the country, and power output of 1,793 MW is available in total. At present, there are only five mini-hydropower plants in operation in the country. These five mini-hydropower plants are operated in the summer season only, and operation in the winter season is obliged to stop because the river freezes over in winter. The generated power by the five mini-hydropower plants is transmitted to the nearest Sum center. There are lots of mini-hydro potential sites in the country and the Government is proceeding with the survey work for the development step by step.

At present, there are lots of problems to be solved on the existing generating facilities. The following are the major problems to be solved.

(a) Electrical efficiency is low due to deterioration of the plants.
(b) Plant factor is unacceptably low due to increase of station use.
(c) Shortage of spare parts and maintenance tools.
(d) Lack of funds for operation and maintenance.
(e) Lack of technology of staff for operation and maintenance.

(2) Transmission and Distribution Lines Facilities

The existing transmission line system is constituted of three (3) isolated systems that are called (1) Central Energy System (CES), (2) West Energy System (WES) and (3) East Energy System (EES). CES is the biggest system out of the three systems and stable power supply is maintained. The major features of the transmission line facilities are shown below.

Table I.5-2 Major Features of Transmission Line Facilities

Voltage	O/H line	U/G line	Total line	S/S No.	Total MVA
220 kV	1145 km	(-)	1145 km	7	708 MVA
110 kV	3021 km	(-)	3021 km	58	2211 MVA
35 kV	3677 km	(-)	3677 km	162	390 MVA
10 kV	8999 km	664 km	9663 km	2494	605 MVA
0.4 kV	3931 km	1260 km	5191 km	(-)	(-)

CES and WES are interconnected with the Far East Russian Power System. In WES all the power needed is imported and peak power in CES is imported from the Far East Russian Power System. The operation voltages in the transmission systems are of three kinds: 220 kV, 110 kV and 35 kV.

A radial distribution system is applied for the existing high voltage distribution line with a 10 kV 3 phase 3 wire system. Low voltage distribution is also a radial distribution system with a 3 phase 4 wire system of 400 V (3 phase) – 220 V (single phase). The underground distribution system applied at the urban area, and overhead bare annealed wire distribution system is applied in suburban areas and Sum centers. All the distribution line facilities were constructed before the democratization of the country and have mostly deteriorated. As a result, electric faults and accidents sometime occur and consumer services are low. It has been reported that there is a lot of lightning damage by thunderbolt fall.

As described above, there are lots of problems to be solved on the existing transmission and distribution lines facilities. The following are the major problems on the existing transmission and distribution lines facilities to be solved.

(a) Power system stability is quite low.
(b) Power system reliability is quite low in case of electric fault and accident.
(c) Power loss is increased by long transmission line extension.
(d) Difficulty of quick restoration without computer aided SCADA system.
(e) Increment of distribution power losses including non-technical losses.
(f) Repeated electrical faults and accidents by the deterioration of distribution facilities.
(g) Lack of funds for operation and maintenance works
(h) Modernization of power tariff collection system is not applied yet.

5.3 Power and Energy Balance

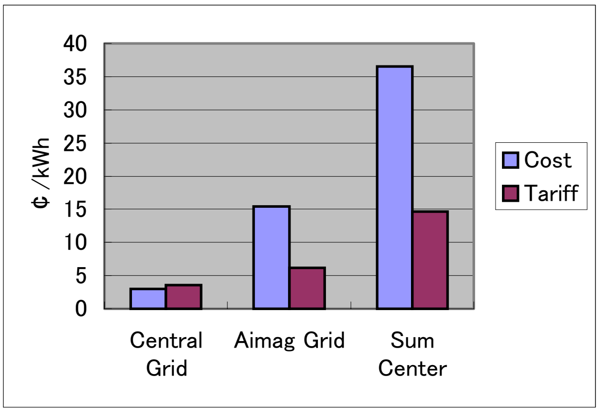
The increase of power demand in the power system will be brought about from the drift of population from rural areas to urban areas, leveling up of home electrification and development of medium and small enterprises. At present, power supply and demand is barely balanced due to the interconnection with the Russian Power System. In case of step out or failing off of a large unit of thermal power plant from the system, there is no possibility of restoration of the power system. On the other hand, power demand in the isolated Aimag centers from the power system is not increased rapidly since there is not a big consumer connection. Therefore, the power supply and demand is barely balanced by the effective operation of the existing generating facilities. For keeping the power and energy balance at each isolated Aimag center, not only the effective operation of generating facilities but also the reduction of distribution losses is required for the future.

Under the above situations in the power system, the following studies are recommended to be made for the expansion of the power system.

(a) Economic assessment
(b) Power system stability and reliability
(c) Needs of consumers

5.4 Electricity Tariff and Collection System

Fig I.5-1 shows the overall structure of electricity tariff systems of the central grid, Aimag, and Sum in Mongolia. The production cost of electricity rises as we move from central authority to rural power producers as well as electricity power prices. Except for the central grid, all rural power suppliers suffer from systematic financial deficit. On the financial statement, the Energy Authority made a surplus of 3－4 billion Togrug in 1997. The rural power systems are not capable of financing the power generation costs by the revenues from power tariffs. Table I.5-3 shows the outline of power tariff systems of the Sums.



(Source：JICA Master Plan Study for Rural Power Supply)

Figure I.5-1 Power Tariff and Generation Cost

Table I.5-3 Sum Power Supply Tariff System(1998)

Unit: Tg/month

	Fixed Tariff (Tg/month)			**Meter-Rate Tariff** (Tg/kWh)	
	Household		Public Facilities	Household	Public Facilities
	Highest Category	Lowest Category			
Average	4,043	2,824	63,029	91	163
Max	7400	5000	800,000	150	400
Min	1500	800	1,100	40	55

Source：JICA Master Plan Study for Rural Power Supply, Inventory Survey

6. THE PRESENT CONDITION OF THE DEVELOPMENT OF RENEWABLE ENERGY IN MONGOLIAN COUNTRY AND THE FUTURE MOVEMENTS

6.1 Diffusion of equipment

6.1.1 Photovoltaic (PV) generation

In Mongolia there is high potential of power generation by a PV system in the wide range except in some areas of northern region and the western region, which became clear from the result of the analysis of data obtained from the Mongolian meteorological agency, pilot plants of this master plan and from other international donor institution. At present, even though PV power generation system is expensive for the average Mongolian, it became clear that herdsman in the country are using it. In addition this it is being used in schools, a hospital, communication equipment and so on within the Sum center, and it is understood gradually by the general Mongolian people at Sum centers, too. At present there are two types of sales promoters of PV system in the country: production sales and import sales. With their individual characteristics, these sales companies are making their best efforts to develop the related equipment and promotion sales, which is necessary for the power generating system. From these facts the PV power generation system is still expected to diffuse furthermore. Though the number of PV power generation system that herdsmen hold is not clearly grasped at the Sum center, according to the information from the sales company there are 700 sets or more in total as a sales result after 1992. The number of installations by herdsmen holds second place after the telecom center as a utilization type and place. Besides these, there are other installations of PV power generation systems such as, supported by Japanese grass root projects, research and demonstration projects of NEDO, donation projects by other donor institutions, demonstration projects under this master plan and by TACIS to public facilities of the Sum centers. The market price of a small size PV power generation system is 6.3～9.5 US$ for each watt peak (Wp) on an average, though it varies according to the choices of PV module capacity, related components and size of the storage battery, and so on. These PV power-generating systems are used mainly as a power supply source for home light, a TV, a radio and for communication equipment.

6.1.2 Wind Power Generation

The majority of wind turbine generation systems in Mongolia are accounted for by market base small wind turbines used by nomads. The remainder is accounted for by the wind turbines being installed in Sum public facilities by this investigation and TACIS, and by the small wind turbines being installed in hospitals by Japanese NGOs. As far as small wind turbines are concerned, Monmar Co. Ltd. manufactures and sells inside Mongolia, while MALCHIN Ltd. imports from China. Monmar Co. Ltd has sold more than 4000 wind turbines as of March 2000 and MALCHIN Ltd has sold 560 wind turbines as of October 1998. Since many individuals also go to China to purchase small wind turbines direct, it is believed that an even higher number of such turbines are currently being used in Mongolia.

The results of the inventory survey showed that 706 small wind turbines are being used in the Sums targeted. Figure I.6-1 shows the number of small wind turbines by aimag. Many of these are being used in the southern Gobi region. Umnugovi prefecture has the most number of the turbines with 288. By contrast, it was found that small wind turbines are hardly used at all in the north-western region. Of the 706 wind turbines reported in the inventory survey, only 33 are installed permanently in the Sum. This shows that many portable wind turbines are being used by nomads. Further, it was found that Chinese small wind turbines account for 72% of the investigation results, with the use of Mongolian-made wind turbines low by comparison at 15%. The result shows that a higher number of Chinese small turbines is currently being used in Mongolia.

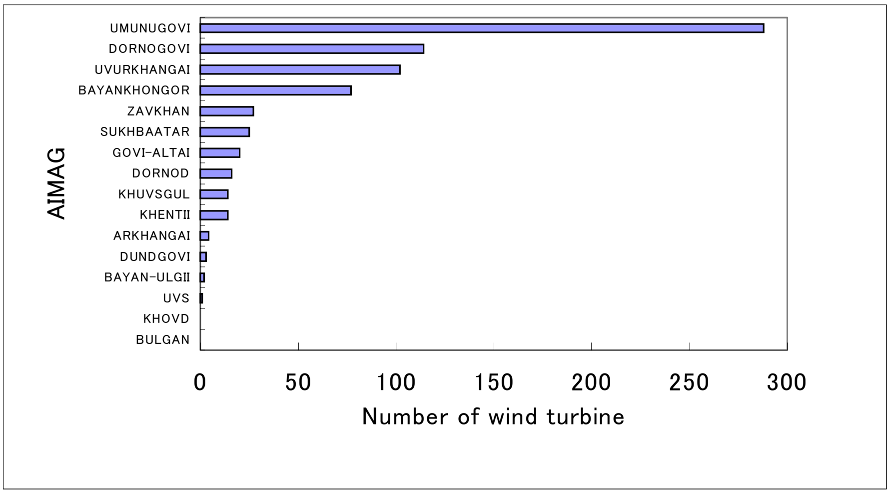


Figure I.6-1 Number of Small Wind Turbines by Aimag

6.2 Development plan and subject

USAID and TACIS have conducted a wind potential survey in Mongolia. The target goal of the USAID project is to create a wind map of Mongolia. TACIS has installed pilot plants that consist of wind, PV and diesel generator and conducting pilot tests.

The project on "Development of Renewable Energy" by Germany (GTZ) was launched in September 1999 as a technical assistance project to the Mongolian government. The period of the project is 30 months and the purpose is to improve the level of the local public welfare by using renewable energies. The main target area of this project is Zavkhan aimag and their plans are to conduct the feasibility study of renewable energies for power plants and mini- hydro plants, improve the quality of production, manpower training, introduction of the new technology and to create cooperation between the other international donor agencies.

A Japanese agency, NEDO (New Energy and Industrial Technology Development Organization) has conducted a demonstration project from 1993 to 1997. Under the project, 200 sets of portable PV systems (200Wp) were provided mainly to the Nomads to monitor their system operation. Renewable energy PV generation systems are provided to primary or secondary schools as a power source for audio visual equipment for education by grass root assistance of the Japanese embassy.

7. Current Situations and Problems of Electricity Supply in the Targeted Sum Centers

7.1 Current Situations and Problems of Maintenance and Management

The maintenance and management situations of the power station greatly depend upon characteristics of the operator. There are some power stations where the diesel power generator remained dusty in a building like desolation, and parts were scattered over the floor, without being cleaned. Many telecommunication stations in Sum Centers are equipped with photovoltaic systems. The staff of the telecommunication station is not taking care of batteries at all, and calls for technical experts in Aimag Center when the battery is damaged or when a problem arises.

As for the maintenance and management system from now on, the preventive maintenance and management system should be emphasized, focusing on daily and periodic checks to avoid damage of machinery, and keeping it clean and in order. It is also important to change operators' attitudes so they are able to maintain and manage by themselves, without completely depending upon technical experts in Aimag Center. For this purpose, it is necessary to train the operators on what is required for daily preventive maintenance and management.

7.2 Current Issues in Financial Management of Sum Power Supply

The Sum power supply operation is in a constant deficit. Since the Sum government does not have credit, the Sum cannot borrow from a bank to meet the financial obligations. Non-fee revenue including subsidies consists of 37.2% of the total revenue. It is generally reported that 80% of electricity consumed by household as electricity is supplied only at night, but the actual revenue share of household payment is only 36.7%. This is largely due to the fixed tariff system. Of the total expenditure, fuel comprises 85.8% whereas repair and maintenance comprises only 4.4% and investment 1.9%. The financial statement depicts the marginalized operation of Sum electricity supply which is basically disinvesting the current facilities.

Table I.7-1 Tariff Collection Methods of Sums

(Unit: No.)

	Household		Public facilities	
Use of Meter	21	12.1%	36	20.8%
Meter only	9	5.2%	31	17.9%
Meter/fixed charge	12	6.9%	5	2.9%
No Use of Meter	152	87.9%	137	79.2%
Total	173	100.0%	173	100.0%

Source：JICA Rural Electrification Master Plan, Inventory Survey

7.3 Current Conditions and Issues of Power Supply Facilities

Power sources of the off-grid Sum centers are all diesel generators except five hydro power stations. Before 1997, all the diesel generators were Russian made, which were manufactured in the 1970s or 1980s and are mostly overage. This condition of the power sources extremely deteriorates the normal power supply. After 1998, installation of the new diesel generators have been executed by Japan's grant aid, and as of May 2000, 74 Sum centers have already received the new generators and the same grant has been committed to 25 Sum centers. Besides that, the basic study for the same grant to 80 to 90 Sum centers is proceeding. By this program, the current issue of the deterioration of the power sources is being improved. However, there are still a lot of problems that remain in order to realize the minimum satisfied level of power supply in the Sum centers. First, the operation of power supply is not financially independent; power supply is limited in the morning and evening during the winter season in most Sum centers due to the lack of the budget to purchase the fuel of diesel generators. According to the survey result, only 24 Sum centers (14 %) execute 24 hours of power supply out of 167 target Sum centers. Second, a lack of maintenance ability; the cost of inspection, repairing and renewal of the facilities is not included in the operation budget of the power supply and the technical ability of the operators is not sufficient, which makes it difficult to have a sustainable power supply in the Sum centers.

The distribution systems in the Sum centers have neither been renewed nor rehabilitated since their first erection. As a result of the sample survey in the 15 Sum centers, it was found that 43 % of distribution poles are declined and 36 % of insulators are damaged. Much distribution losses are also considered; the estimated loss ratio is 20 to 30 %. The deterioration of the distribution system will seriously affect the power supply in the Sum centers in five to ten years because no any realistic rehabilitation plan exists due to the shortage of budget.

7.4 Power Demand and Tariff System

According to the Sample Survey, the power consumption of the users subscribed under a fixed tariff system is three to four times than the users under a meter rated tariff system. The unit charge derived from the total tariff payment and power consumption show that the meter rated tariff users were paying twice as much as the fixed tariff users. It is necessary to reform the pricing mechanism to save cost and to improve the financial difficulties at the Sum center.

7.5 Possibility of Demand Side Management

Demand Side Management (DSM) is not applied to the power supply in the Sum centers at present. However, it was found that the potential demand in the daytime in summer is high; Sum people are eager to use refrigerators and electric stoves for cooking in the daytime in summer. As solar power is higher in the summer season, the potential demand may meet with good potential of power supply. Then, the possibility of DSM is considerably high by means of making a good match of demand and supply. Besides that, shift of peak demand and creation of new demand are also effective way of DSM. In order to apply the peak shift and creation of new demand, it is important to strengthen the tariff collection system and realize the actual needs of power in the Sum centers.

7.6 Socio-Economic Needs

In Mongolia where most population living in rural areas are nomadic, Sum centers play a very important role as a base for social services for nomadic households. In general, hospitals and schools in Sum centers are well equipped in terms of personnel and facility, but unfortunately due to the unstable electricity supply and the budget shortage in Sum offices, hospitals and schools are unable to utilize existing medical and educational equipment. This situation of deteriorating social services in Sum centers makes many households, especially young people, leave Sum and move to urban centers such as Ulaanbaatar. If Mongolia aims at rural development, it has to improve social services in Sum centers as the first step, for which stable electricity supply is a prerequisite.

8. Power Demand Forecast

8.1 Current Power Demand Estimate

Since there is no power consumption record at the Sum level, it was necessary to estimate the current demand first. The power demand was divided into four user groups of general household, BHN institutions, other public and private organizations, and water supply. Table I.8-1 shows the estimated power demand during winter and summer. The household power consumption on the average is 27 kWh/month during winter and 17 kWh /month during summer. The total power demand per household including other user groups is 35 kWh/month during winter and 26 kWh/month during summer.

Table I.8-1 Current Power Demand Estimate

		Monthly consumption/Sum center (kWh)							
		Household	Hospital	School	Sum office	Water Supply	Other	Total	BHN
winter	Average	5,554	328	237	60	86	1,149	7,413	624
	Max	49,628	2,160	893	60	676	6,465	56,909	3,113
	Min	695	43	50	60	0	198	2,954	261
summer	Average	2,357	241	146	42	80	774	3,640	429
	Max	34,392	1,590	551	42	1,167	6,560	41,512	2,183
	Min	357	32	31	42	0	65	847	184

8.2 Power Demand Forecast for Sum Centers

The future power demand depends on the social changes such as population, income level, and electrification. The following assumptions are adopted for the future power demand projection.

(a) The current power demand level stays unchanged until the year 2005.

(b) The electrification will reach 100%.

(c) After the year 2005, the Sum centers that declined during the last two years will remain the same in population size.

(d) When the population changes over the past two years is smaller than that between 1992 and 1997, the last two-year change is used as the population growth rate with the ceiling of 10%.

(e) When the last two-year population change over the past two years is larger than that between 1992 and 1997, the average population change between 1992-1999 is used as the population growth rate with the ceiling of 10%.

(f) Between 2010 and 2015, the same population growth will take place as between 2005 and 2010.

Figure I.8-1 illustrates the monthly power demand projection at an average Sum center during winter and Figure I.8-2 the monthly power demand projection at an average Sum center during summer.

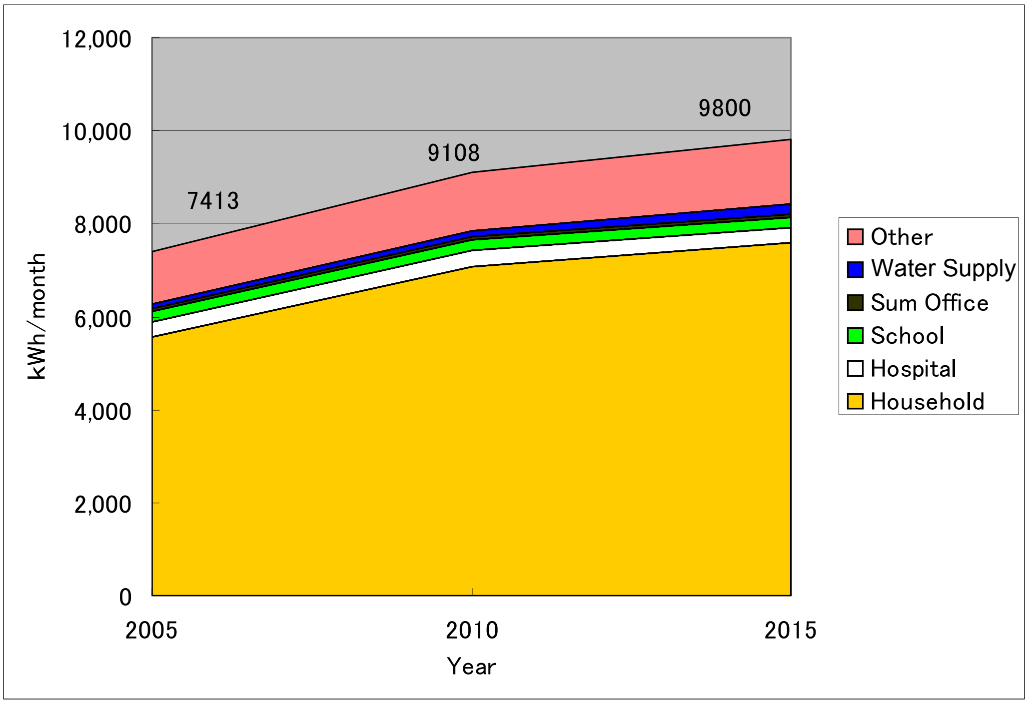


Figure I.8-1 Monthly Power Demand Of Average Sum (Winter)

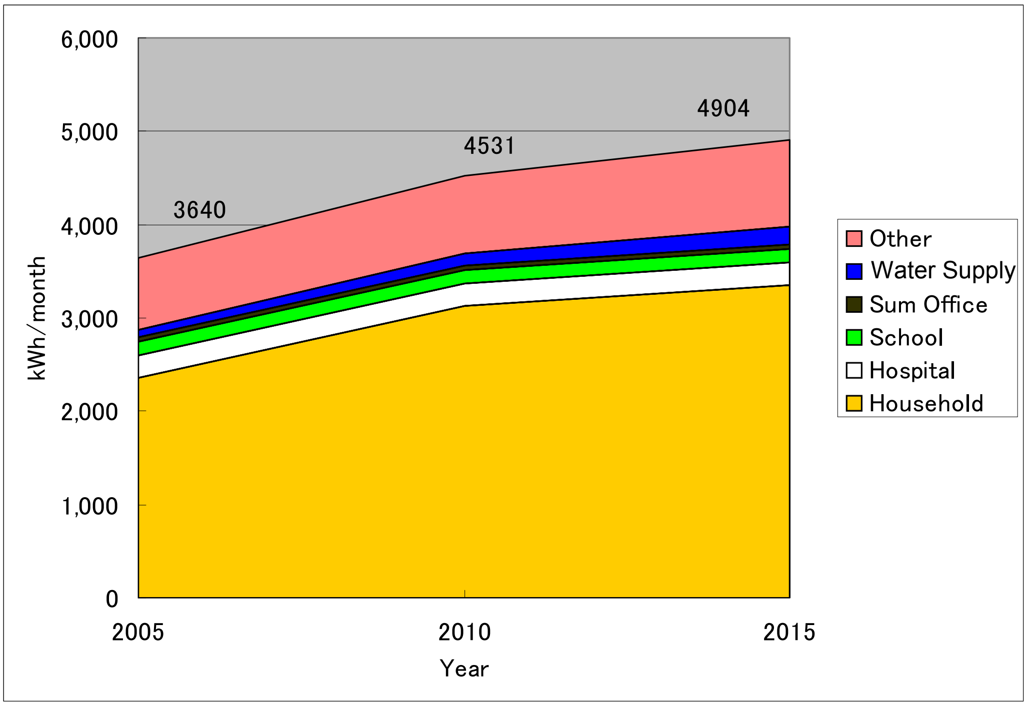


Figure I.8-2 Monthly Power Demand Of Average Sum (Summer)

Table I.8-2 Summary of Monthly Power Demand Of Average Sum

Unit: kWh/month

			Household	Hospital	School	Sum Office	Water Supply	Other	Total	BHN
2005	winter	total	960,818	56,678	40,941	10,380	14,957	198,693	1,282,467	108,000
		average	5,554	328	237	60	86	1,149	7,413	624
		max	49,628	2,160	893	60	676	6,465	56,909	3,113
		min	695	43	50	60	0	198	2,954	261
	summer	total	407,761	41,722	25,258	7,266	13,874	133,895	629,775	74,246
		average	2,357	241	146	42	80	774	3,640	429
		max	34,392	1,590	551	42	1,167	6,560	41,512	2,183
		min	357	32	31	42	0	65	847	184
2010	winter	total	1,227,137	56,678	40,941	10,380	24,033	216,502	1,575,671	108,000
		average	7,093	328	237	60	139	1,251	9,108	624
		max	52,145	2,160	893	60	918	8,251	61,212	3,113
		min	2,431	43	50	60	0	198	3,436	261
	summer	total	541,826	41,722	25,258	7,266	22,316	145,416	783,803	74,246
		average	3,132	241	146	42	129	841	4,531	429
		max	34,392	1,590	551	42	1,208	8,373	43,324	2,183
		min	480	32	31	42	0	65	952	184
2015	winter	total	1,312,933	56,678	40,941	10,380	35,932	238,564	1,695,429	108,000
		average	7,589	328	237	60	208	1,379	9,800	624
		max	66,552	2,160	893	60	1,439	10,531	79,337	3,113
		min	2,730	43	50	60	0	198	3,573	261
	summer	total	580,172	41,722	25,258	7,266	34,343	159,671	848,432	74,246
		average	3,354	241	146	42	199	923	4,904	429
		max	43,894	1,590	551	42	2,610	10,686	57,749	2,183
		min	480	32	31	42	15	65	952	184

8.3 Demand Side Management

Considering power supply by renewable energy, DSM is important for effective use of energy because of intermittent generation of renewable power sources. As effective measures of DSM, (i) education and enlightenment to the consumers, (ii) shift of demand and (iii) creation of new demand are proposed in this Master Plan. Actual application of DSM largely depends on the social and financial conditions of Sum centers and how strong Sum centers have positive minds to DSM. Therefore, it is difficult to estimate the practical increase of demand by means of DSM. Then only new demand for pumping up water, which is a highly realistic plan, is incorporated in the forecasted demand in the Sum centers.

9 Power Development Plans, Renewable Energy Program and Movement of International Donor Agencies

9.1 Power Development Plans and Donors

The major projects in the power sector are the loan projects by Asian Development Bank (ADB), the survey and planning projects by TACIS and USAID and also grant projects by them. All the projects are located around Ulaanbaatar and Aimag centers and do not cover rural Sums, thus consistent and no overlaps.

9.2 Japanese Programs and Projects

The aid from Japan showed a dramatic increase in 1991 and has grown to be the largest among bilateral aids. The financial assistance to Mongolia from Japan started with 8.5 billion yen in 1991, 7 billion yen in 1992, 9.6 billion yen in 1992, 9.6 billion in 1993, 12.9 billion in 1994, 12.6 billion yen in 1995,10.7 billion in 1996, and 9.2 billion yen in 1997. The major cooperation of Japan were the financial aid for economic stabilization (import loan, non-project grant) , humanitarian aid under financial crisis (food aid, food production aid), mid-term economic development infrastructure development grant and loan, development study and technical assistance. The cooperation projects undertaken in the power sector for the Sum centers were grass roots grant assistance, Sum center Diesel Power Plant Rehabilitation Project (Phase I, II and III).

9.3 Development of Renewable Energy Program and Movement of International Donor Agencies

In the field of Renewable Energy USAID and TACIS are conducting surveys on wind power. In the case of USAID, a wind resources map of Mongolia will be made based on the measurement and installation is not planned at present. TACIS has selected three sites out of five measured sites in the southern region of the country and completed the installation of pilot plants during the final week of October 1999.

The project on "Development of Renewable Energy" has been established between the Mongolian and German (GTZ) government since September 1, 1999. At present the period of the project is 30 months and the purpose of the project is to improve the level of the local public welfare by utilizing available renewable energies. The main features of this project is to survey the possibility of utilizing renewable energies for power supply for Sums, feasibility study of small hydro, the quality control and improvement of the enterprising product, training for capable manpower rearing, introducing the new technology within the Sum of Zavkhan aimag, and also creating cooperation between international donor agencies.

In the case of Japan, under the demonstration project, from 1993 to 1997, 200 sets of portable PV systems (200Wp) were distributed mainly to the herdsman families to survey and observe the system utilization. Beside this, as a project of renewable energy, PV generation systems are distributed to primary and secondary schools for visual education system under the grass root project.

10. Rural Power Supply Master Plan

10.1 Transmission Extension

The choice between transmission line extension and independent power generation is largely an economic problem. Based on life-cycle costs of investments and operation and maintenance, the power delivery costs can be compared to reach an objective decision-making.

The distance where two unit power costs are at equilibrium will be called Break Even Point (BEP.) At the Sum centers that are located beyond the BEP, independent power generation becomes more economical while at those within the BEP transmission line extension is more economical.

The Sums that fall into the radius of 50 km are chosen on the map to be deemed economical. As a result 4 Sums in total were selected for transmission extension as shown in Table I.10-1.

Table I.10-1 Potential Sum Centers for Transmission Extension

No.	ID	Sum	Aimag	Distance (km)
1	63	SUKHBAATAR	SUKHBAATAR	40
2	110	TOSONTSENGEL	KHUVSGUL	47
3	170	BAYAN-NUUR	BAYAN-ULGII	15
4	171	ALTAN-TSUGTS	BAYAN-ULGII	5

10.2 Power Supply for Off-grid Sum Centers

In order to establish the power supply plan for the off-grid Sum centers, the first step is to decide the level of power supply in the year stages of 2005, 2010 and 2015 considering social and financial conditions of the Sum centers, and the next step is to examine the actual plan to realize the power supply level in each year stage.

(1) Level of Power Supply

Year 2005

Power supply level in 2005 is decided as follows paying much attention to BHN of the Sum centers.

- 24 hours power supply to hospital, school and Sum office
- To other consumers than the above, depending on Sums' policy

Year 2010

It is expected that the social and financial conditions of the Sum centers and the management for power supply will be improved by the year 2010. Then the level of power supply in the stage is as follows.

- 24 hours power supply to all the consumers in a Sum center

Year 2015

Same as in the stage of 2010, the level of power supply in the year 2015 is as follows.

- 24 hours power supply to all the consumers in a Sum center

(2) Pan of Power Supply

Year 2005

The following two types of power supply system are proposed to realize the above power supply level.

- Diesel generators
- Combination of renewable energy and diesel generators

Here, policy to apply renewable energy is as follows:

- Limiting power supply by renewable energy to three public facilities (school, hospital and Sum office)
- Ensuring a 24 hour power supply by renewable energy only in the summer season
- Supplementing lack of power supply to the public facilities in the winter season with diesel generators

Year 2010

The power supply system in the year 2010 is the same as that in 2005 and the policy to apply renewable energy is as follows.

- Power supply by renewable energy to all the consumers in a Sum center
- Ensuring a 24 hour power supply by renewable energy only in the summer season
- Supplementing lack of power in the winter season with diesel generators

Year 2015

Power supply in winter is supplemented by diesel generators in the stages of 2005 and 2010. On the other hand, the power supply in 2015 is to be realized by renewable energy through a year; without diesel generators. The system of power supply is as follows.

- Renewable energy and fuel cell (including hydrogen production and storing system)
- Fuel cell (including hydrogen storing system)

(3) Mini-hydropower Generation System

As a result of careful review of the feasibility study report of mini-hydropower generation plants, two mini-hydropower generation plants (Monkhairkhan and Baruunturuun) are evaluated as the optimum isolated power source for the Study. The table below shows major features of mini-hydropower plants. In addition, the photographs attached in Data Book show the Monkhairkhan and Baruunturuun power plant sites.

Table I.10-2 Major Features of Mini-hydropower Plants

Hydro-P/S	Aimag	Main Dam H x L	Design Flow	Gross Head	Installed Capacity	Type of P/S	Type of Turbine	Speed	Line Voltage	Line Length to Load
		(m x m)	(m^3/s)	(m)	(kW)			(rpm)	(kV)	(km)
Monkhairkhan	Khovd	2.5 x 90	2.5	8	150	Run-off River	Cross-Flow	375	10	4
Baruunturuun	Uvs	7.6 x 260	3.5	11	200	Dam tow	Cross-Flow	375	10	5

(Data Source: UCS in July 1999)

10.3 Optimum Power Supply System in each Sum Center

(1) Optimum Power Supply System

As mentioned in Clause 10.1, the extension of a transmission line is applied only to four Sum centers. Power sources for the off-grid Sum centers are diesel generators, renewable energy sources and fuel cells. The renewable energy sources are solar, wind and mini-hydro generations.

In the plans of stages 2005 and 2010, diesel generators are applied to all the target off-grid Sum centers to materialize the stable power supply. The image of power supply system is shown in the Figure of the opening pages

As for applying the mini-hydro, two Sum centers are selected under the condition that a qualified level feasibility study report in English exists. Besides, rehabilitation is to be carried out to the mini-hydro station in Mankhan Sum center of Khovd Aimag; this hydro station has been constructed by the Sum center itself.

Regarding application of solar and wind, the following criteria are prepared using corrected data of Mongolian Meteorological Department.

Solar

(Criteria for the Year 2005 and 2010)

Solar irradiation is 4.0 kWh/m^2 per day or above

(Criteria for the Year 2015)

In addition to the Sum centers selected above, the Sum centers, where solar irradiation is expected to be around 4.0 kWh/m^2 per day judging from the locations of the candidate Sum centers referring the locations of selected Sum centers and the topographical natures around the candidates, are selected.

It is necessary to increase the accuracy of meteorological data for the critical judgement in 2015. And a sharp decline in the price of a PV system is expected. Therefore, the above criterion is tentatively prepared at present for the year 2015 under the condition that the meteorological data will be collected by accurate measuring instruments in the future. According to the criterion, additional selection is done from the Sum centers located even in areas with irradiation under 4.0 kWh/m^2 per day consequently.

Wind

(Criteria for the Year 2005 and 2010)

Average wind speed is 4.1 m/s or more at a height of 10 m above ground level.

In July and August, when average wind speeds are at their lowest, the average wind speed is 3.7 m/s or more at a height of 10 m above ground level.

(Criteria for the Year 2015)

Average wind speed is 3.9 m/s or more at a height of 10 m above ground level.

In July and August, when average wind speeds are at their lowest, the average wind speed is 3.5 m/s or more at a height of 10 m above ground level.

Increase in the performance in the range of low wind velocity and a decline in the prices of wind generators are expected. Consequently the application of wind generation becomes available even in areas with lower average wind speeds in 2015.

The number of Sum centers selected with the above criteria is 123 for solar and 45 for wind for the stages of 2005 and 2010. As solar is applied to all the Sum centers selected for the wind, the hybrid system of solar and wind is installed in 45 Sum centers. Similarly 148 Sum centers are for solar and 53 Sum centers are for wind (as hybrid with solar).

A drastic decline in the price and a rise in the performance of fuel cell are expected in the stage 2015. In order to realize stable power supply independent of imported diesel oil, the application of fuel cells is planned for all the off-grid Sum centers.

(2) Power Sources and Number of Sum Centers in each Stage

Power sources and the number of Sum centers including existing facilities are mentioned below. Here only the diesel generators provided under the Japan's Grant Aid are regarded as the existing facilities assuming that all the Russian diesel generators are retired before 2005. Zamiin-Und Sum centers of Dornogovi Aimag are connected to China with transmission lines. However the transmission lines are the property of the Railway, so this Sum center is counted as an off-grid Sum center.

Year 2005

Diesel Individual	:	38
Diesel + PV	:	77
Diesel + PV + Wind	:	45
Diesel + Mini-hydro	:	2
Diesel + Mini-hydro + PV	:	1 (Mankhan)
Grid extension	:	4

Year 2010

Power sources and their combination and the respective number of Sum centers are the same as those in 2005. Only the capacities of the facilities are only to be expanded.

Year 2015

Fuel cell + Hydrogen production and storage + PV	:	93
Fuel cell + Hydrogen production and storage + PV + Wind	:	53

Fuel cell + Hydrogen production and storage + PV + Mini-hydro	:	1 (Baruuntruun)
Fuel cell + Hydrogen storage	:	14
Mini-hydro	:	1 (Munkhkhairkhan)
Mini-hydro + PV	:	1 (Mankhan)
Grid extension	:	4

10.4 Optimum Power Distribution Plan

For the optimization of the distribution system, various problems on the existing distribution system have to be settled. After the settlement of the existing problems, a case study on the modernization of the distribution system is made and then the optimum power distribution plan is to be formulated. The following table shows the problems and improvement plans on the existing distribution system.

Table I.10-3 Problems and Improvement Plans on the Existing Distribution System

Problems	Improvement Plans
1. Large power losses	1. Rearrangement of circuit and increase of Conductor size
2. Unreasonable tariff correction system	2. Installation of Watthour meters and Application of meter rated tariff
3. Poor supply reliability by Earth fault and short circuit	3. Adoption of insulated wire & power cables, installation of circuit breakers
4. Lightning damage and long time power outage	4. Adoption of insulated wire & power cables, installation of lightning arrester and insulation transformer
5. Insufficient management and O/M without quick and effective action	5. Total power operation by communication network, quick and effective operation by computer system
6. Deterioration of facilities	6. Modernization of facilities by replacement of facilities

Based on the above improvement plans and power demand forecast, the optimum power distribution plan is formulated. The optimum power distribution plan is made in coordination to the optimum power generation plan. Therefore, the study years are 2005, 2010 and 2015. The existing distribution system is to be improved step by step considering the economic conditions and urgency of the development. By the target year of 2015, the Master Plan should be optimized totally. The optimum power distribution plan in each study year is shown below and described in Figure I.10-1.

Table I.10-4 Optimum Power Distribution Plan in Each Study Year

Target Year	Power Distribution Master Plan	
2005	1	Watthour meters installation and application of meter rated tariff system
	2	Circuit breaker installation
	3	New distribution line construction
2010	1	Rearrangement of circuits and increase of conductor size
	2	Rehabilitation of existing power facilities
	3	Lightning protection
2015	1	Expansion of power distribution system
	2	Effective power operation and multi-function

10.5 Operation Plan of Power Supply System

(1) Power Supply System

Comparing with grid connection and diesel generators which are able to supply stable power, solar and wind have the wider margin, by their intermittent nature, for raising the efficiency of energy use with operation.

The power supply plan of renewable energy to increase the efficiency of energy use is mentioned below.

(a) Minimizing loss of inverters

The number of inverters in operation is to be minimized to reduce the no load loss.

(b) Reducing waste of energy

The main switch of power supply is equipped at the main entrance of each school and Sum office to avoid waste of energy by forgetting to turn off the power switches when the facilities become unmanned in the nighttime or on holidays.

(c) Effective use of surplus power

Surplus power is expected in the daytime in the summer season. Some efforts are necessary to use the surplus power efficiently. For example, installation of water heaters with thermos tanks in the hospital and pumping up water to water supply tanks will be effective.

(d) Installation of battery charging station

In the case of Sum centers to which solar is applied, it is possible to utilize surplus power to the domestic consumers by charging individual batteries in the battery charging station which is energized by solar power in the daytime.

(2) Intelligent Management System

For the purposes of quick action and effective management of the power operation, an intelligent management system is recommended to be established among the targeted Sum centers, Aimag centers and capital centers by the target year of 2015. The assigned stations (servers) should have the various functions for the power operation. The communications network and computer systems are utilized effectively for the management of the power operation and establishment of the intelligent management system. The following table below shows the functions of each server station.

Table I.10-5 Functions of Each Server Station

Cont.& S/V	SNT SERVER	ANT SERVER	ENET	MOIDT
1. LG & D/T of Operation Condition	1. Collection & D/T of power facilities operation data	1. Collection & D/T of power facilities operation data	1. Collection and analysis of power facilities operation data	1. Analysis of power facilities operation data & policy making
2. LG & D/T of faults	2. Filing & D/T of faults & accidents data	2. Filing & D/T of faults & accidents data	2. Filing & analysis of faults & accidents data	2. Analysis of maintenance data & making improvement plan & command to ENET
3. LG & D/T of Met. Data	3. Filing & D/T of power facilities management data	3. Filing & D/T of power facilities management data	3. Filing & analysis of power facilities management data	3. Storage of various data and documents
4. LG & D/T of Fuels	4. Filing & D/T of operation & maintenance data	4. Filing & D/T of operation & maintenance data	4. Filing & analysis of operation & maintenance data	4. Coordination with other agents on data use & intelligent system
5. LG & D/T of distribution & load condition	5. Recording & D/T of command operation	5. Making optimum operation plan & transmit to ENET	5. Study of optimum operation plan & command to ANT	5. Policy making of integrated energy management system
6. LG & D/T of heating system	6. Filing & D/T of production, use & sale of fuels	6. Making maintenance schedule & transmit to ENET	6. Study of maintenance schedule & command to ANT	
7. D/T of energy management data			7. Preservation of documents	
8. D/T of Public service data				

(Note) S/V: Supervisory, D/T: Data Transmission, L/G: Logging, Met.: Meteorological

The intelligent management system is planned to establish by the target years step by step for playing their roles effectively. The following table below shows the system establishment plan by the target years. And Figure I.10-2 indicates the configuration of intelligent managment system.

Table I.10-6 System Establishment Plan by the Target Years

Target Year	Recommended system plan
2005	1. New server installation at each Sum center 2. New meteorological observation facilities installation and data collection 3. Self-management and efficiency control of works
2010	1. Expansion of observation system and quick data analysis 2. New management server installation 3. Automatic data treatment and high speed decision making
2015	1. Full automatic management system 2. Adoption of supporting agency program

10.6 Implementation Plan

(1) Project Description

The Project site to be implemented under the Project is 167 Sum centers. Project description is indicated hereunder.

(a) Implementing Agency: Ministry of Infrastructure Development (MOID)

(b) Project Site: Transmission Line Extension; 4 sites
Diesel power plant site; 38 sites
Mini-hydropower plant site; 2 sites
Solar and Wind power plant site; 123 sites

(c) Scope of Work: Scope of Work in each phase is shown hereunder.

Table I.10-7 Scope of Work in Each Phase

Facility	2005 (Stage 1)		2010 (Stage 2)		2015 (Stage 3)	
	Q'ty	Description	Q'ty	Description	Q'ty	Description
Grid connection	4 Sums		4 Sums		4 Sums	
Diesel generator	65 Sums		N.A.		N.A.	All retire
Solar power	123 Sums	New, small scale	123 Sums	Expansion, large	148 Sums	Expansion and new
Wind power	45 Sums	New, small scale	45 Sums	Expansion, large	53 Sums	Expansion and new
Mini-hydro power	2 Sums	New, small scale	1 Sum	Rehabilitation	(3 Sums)	No new plan
H2 production plant	0		0		137 Sums	New
H2 storage plant	0		0		161 Sums	New
Fuel cells	0		0		161 Sums	New
Distribution system	376 km	Trans. 334 sets	7014 km	Trans. 668 sets	42 km	Expansion
In/outdoor wiring	90 km	Hospital, etc.	400 km	General consumers	10 km	Add. Consumers
Management system	350 sets	New server	354 sets	Renewal	0 sets	Renewal software
MET observation	105 sets	New	0	Continuous use	0	Continuous use
Power house	123 sets	New	0	Continuous use	0	New

(2) Implementing Schedule

(a) Implementation Policy: 3-stage development up to the target year 2015
Review and detailed design: 10 months
Employment of well experienced consultants

(b) Consulting Services: Review, detailed design and supervision works

(c) Implementing Schedule: Refer to the recommended overall schedule (Table I.10-8)

(d) Mongolian Government Undertaking: Establishment of Implementation Unit by MOID (Refer to the figure below).

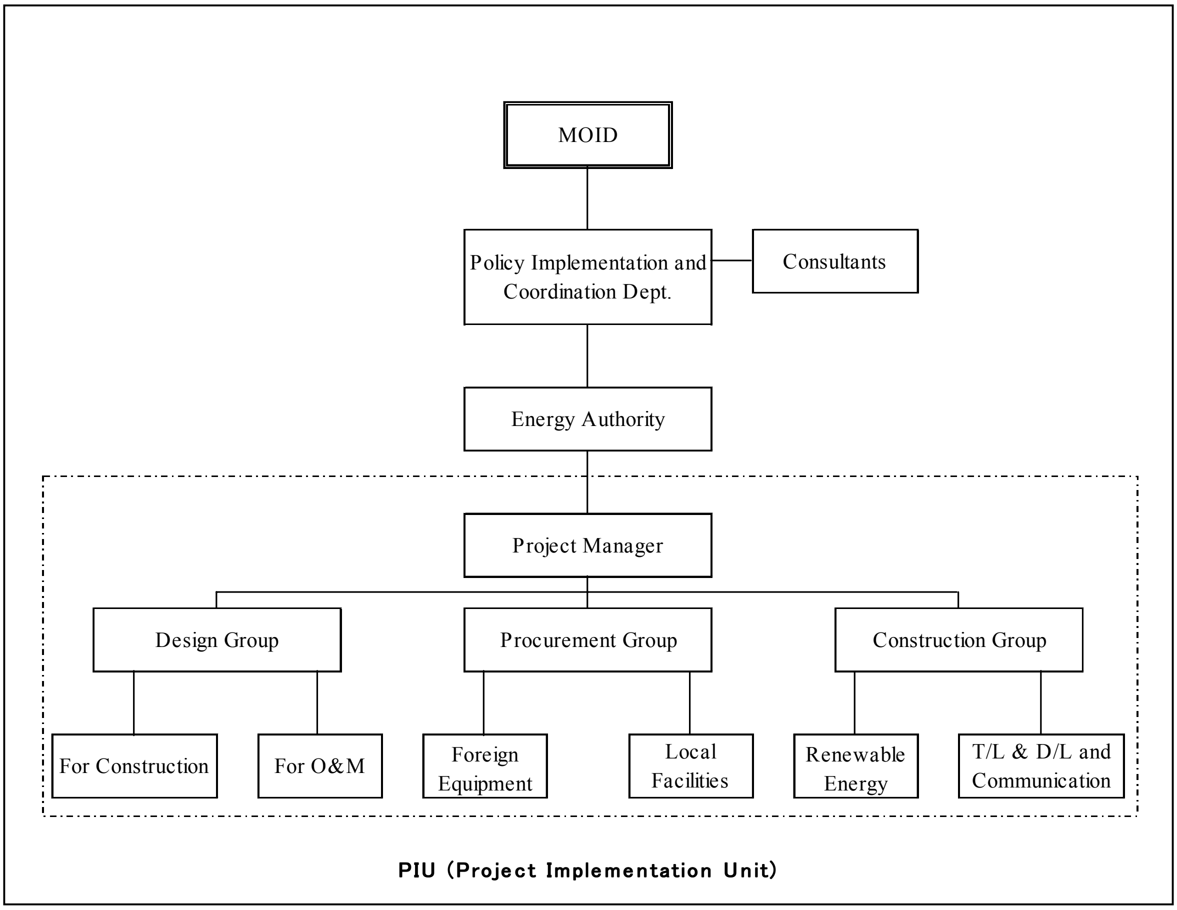


Figure I.10-3 Organization for Project Implementation

10.7 Project Cost

The estimated cost includes the materials and installation for the power supply system of the target 167 Sum centers and for the intelligent management system of the Sum centers, Aimag centers, Energy Authority and MOID.

The conditions of estimate are as follows:

(a)	Target Item	:	Materials, Transportation, Construction and Consultancy
(b)	Estimate Time	:	Based on the cost in 1999, the costs in 2004, 2009 and 2014 are estimated corresponding to the stages 2005, 2010 and 2015, respectively.
(c)	Procurement	:	International competitive bidding
(d)	Currency	:	US Dollar
(e)	Exchange Rate	:	USD1.0 = Tg1000 = Yen110

The estimated cost of each stage is as follows:

(1) Year 2005 : US$23,814,000-
(2) Year 2010 : US$43,859,000-
(3) Year 2015 : US$80,490,000-

The breakdown of the project cost is shown in Table I.10-9.

10.8 Plan of Technology Transfer

In case Japan is concerned with materializing the Master Plan, the proposed technology transfers are described as follows.

(1) Technology Transfer on Social and Economic Survey

Effective and informative technology transfer has been performed to Renewable Energy Corporation and the local consultant through the questionnaire survey at site.

Similarly technology transfer through the actual job is important in the process to realize the Master Plan from now on.

(2) Technology Transfer on Meteorological Data Investigation

The technology of accurate data collection and their analysis is indispensable to realize the power supply in Sum centers by renewable energy. The Master Plan proposes the installation of accurate meteorological observation units across Mongolia. For the collection of data by these observation units and the analysis of them, it is an effective way to dispatch experts from Japan and send trainees to Japan to transfer these technologies.

(3) Technology Transfer on System Planning and Design

The efficient technology transfer becomes possible by involving private sectors of Mongolia in all the activities in the same way as in the social and economic investigation.

(4) Technology Transfer on System Management and Maintenance

The proper management and maintenance setup for the facilities decisively leads the Master Plan to its successful realization. It is therefore recommended that the technology transfer in this field be intensively executed. The actual measures of technology transfer are as follows.

- Long term technology training at sites in the implementation period
- Establishment of training centers to perform constant training programs and setup of the

management system of the center

- Dispatching the expert of management and maintenance

10.9 Project Evaluation

The first stage project in 2005 was recommended as such for the adequacy of BHN because its scale is small for saving cost and realization of the project is very easy. In the second stage project in 2010 power by renewable energy will be supplied to all consumers in the Sum centers. For this purpose, battery capacity should be sized large and capacity building on management, operation and maintenance should be made. As the effect of DSM is expectable remarkably, efficiency evaluation of DSM becomes important. In the third stage project in 2015, the power supply system is planned, attaching importance to the environmental protection. Although this plan seems to be a novel design at present, this is a realistic plan from such a point of view that technical renovation of the energy sector is rapidly proceeding. By the adoption of solar and wind power generation plants, renewable energy is utilized 1.195 GWh/year in 2005, 9.8 GWh/year in 2010 and 34.7 GWh/year in 2015.

11. Recommendation for Energy Saving and Environmental protection

11.1 Environmental Protection and Recommendations

In the Law on Environmental Protection, the environmental impact assessment system is specified in order to prevent the environmental destruction by forecasting and evaluating the influence of development projects on the environment. The Department of Environmental Impact Assessment under the Ministry of Nature and the Environment takes charge of the enforcement. The assessment must be executed by a Mongolian company specialized in environment assessment and authorized by the Ministry, when a great deal of influence on the environment is predicted through screening the project plan which was prepared by the project team and submitted to the Ministry and local government. In Mongolia, the air is heavily polluted by coal thermal power stations and diesel power stations, so it is important to increase the use of clean renewable energy sources from the viewpoint of environmental protection.

Probably the biggest environmental problem in Mongolia is the excessive population concentration in urban cities including Ulaanbaatar. The capital city Ulaanbaatar is now facing difficulty in providing an adequate level of educational and medical services for its increased population. There are many people from rural areas who come to Ulaanbaatar with a herd of livestock in order to sell livestock. This causes an increased number of livestock around Ulaanbaatar, and the severe deterioration of pasture land. Although the parliament is discussing the future transfer of a capital city, the fundamental reason for population inflow and concentration into urban cities is the government's neglect of the rural area and the favorable policy and development for urban residents such as better infrastructure and social services. So the provision of stable electricity and better social services in Sum centers are very important not only to improve living standards of rural households but also to protect Mongolia's environment, because rural development will effectively reduce the pressure on the rural population to move into urban cities.

11.2 Recommendation on Energy Saving and Environmental Protection

The following three points are proposed.

(a) Education and awareness activity
(b) Power tariff collection by meter rated tariff system
(c) Improvement of indoor wiring of the public facilities

It is the most important to change the residents' minds of Sum centers through educational activities and awareness campaigns on energy saving. Conducting the educational activities and awareness campaigns in school classes will be effective.

It is obvious for each consumer to become sensitive about the power consumption by introducing the meter rated tariff system. Although the duty of power supply enterprise on the calibration and inspection of meter will increase, a meter rated tariff system should be installed by overcoming the difficulty.

It is assumed that considerable amount of energy is wasted due to superannuated indoor wiring and over-installed lighting. To improve the problem mentioned above, improvement of indoor wiring will be an immediately effective measure.

11.3 Disposal of Exhausted Batteries

A huge number of batteries will be installed in the years 2005 and 2010 according to the master plan. These batteries will be exhausted and disposed of in the years 2005 and 2010, respectively. In order to alleviate an environmental load, these batteries should be disposed of in a proper manner.

The following are recommended for the proper disposal of batteries with the future technological innovation.

1) To procure the batteries from the manufacturers who obtain the environmental management

standard ISO 14000

2) To oblige the contractors to receive and properly dispose of the exhausted batteries when installing new batteries and fuel cells in 2010 and 2015, respectively.
3) To give Sum centers the responsibility to take care and properly dispose of their own batteries.
4) To explore the possibility to adopt the newly developed high capacity condenser.

12. Management and Maintenance Plan

12.1 Proposals for Operation and Maintenance

Ministry of Infrastructure Development, whose basic mission is policy development and regulation, cannot and should not undertake the actual implementation of supporting the power supply business run by the 167 Sum centers which are scattered over the vast land of Mongolia. It is understaffed and communication is not possible. There needs to be an executing organization with the field offices at Aimag levels. For an immediate and existing candidate for commissioning such management responsibilities is the Energy Authority. The Sum centers that are connected to the central grid belong to the Energy Authority. Even these Sum centers are not fully monitored or supported. It is questionable whether the Energy Authority can extend the support to more complex hybrid power generation systems in the Sum centers. On the other hand, the Energy Authority is one of the few organizations that operate nationwide successfully in Mongolia. If the Energy Authority is to be appointed by the government as a supporting agency, the clear definition of responsibilities should be established in a contract in commissioning to the Energy Authority. The atteched Table I.12-1 shows scheme of management organization.

12.2 Recommendations for Power Supply Management

Requirements for Institutional Building

In order to have properly function three layers of institutions as shown above, there are three conditions to be fulfilled as follows:

1. Adequate financing setup
2. Human resource development
3. Organizational reform

The power supply businesses at Sum centers are not financially sustainable on their own. Therefore, it is an imperative to seek alternative financial sources to maintain the power supply. A pragmatic financial source is the Energy Authority. The Energy Authority already subsidies the Aimag center grids. It is a matter of extension of the assistance to the Sum centers beyond the Aimag centers that are currently subsidized. For the Sum Power System Supporting Organization to function properly at Aimag levels, there is a need for proper financing from the central government level.

The second requirement of human resource development is to develop the core of actual maintenance functions. The current operators of diesel engine generators who lack in electrical and electronic engineering skills need to be trained. The managers of Sum power supply operation need to be trained on modern business practices to reform themselves from lax communal management.

The organizational reform requires time and effort. It is necessary to expose the power supply operation to competitive environment to rid of the lax management culture and also sustain long lasting effects. As the numerous examples show, the introduction of new power systems would be likely to be left idle without serious management effort. Needless to say, the provision of proper maintenance would be possible. In order to solicit an organization-wide reform, it is not possible to establish maintenance system for new power generation and distribution system without having clearly defined management principles. The proposed principles are as follows,

Principle 1.	Financial Normalization
Principle 2.	Introduction of Competition

Pre-qualification for the introduction of a new power system would be a good way to encourage competitive environment in the Sum power operation. By implementing a new power system at the sums that are capable of proper management and operation, the pre-qualification will instigate competition among sums. Under competitive atmosphere, the sums will start to restructure the management system to increase the efficiency. Less innovative sums will observe more progressive sums to learn from their experiences. The screening of the sums with their submitted qualifications regarding management system, technological capacity and maintenance will send the message to the sums immediately to change their lax management attitude that perpetuates inefficiency.

There are three pre-requisites for the Sum center power supply organization to fulfill before introducing a new power supply system as follows:

Year 2005 – Responsible Management

1. **Meter-Rated Tariff Collection**
2. **Technical and Financial System for Maintenance**
3. **Proper Record Keeping in Operation and Finance**

Once the targets for the year 2005 is cleared, it would be possible to gradually step to a higher level of target. The targets for the year 2010 and 2015 are as follows:

Year 2010 Targets —Stable Supply and Accumulation of Technologies

1. **Year Round Operation**
2. **Replacement Funds**
3. **Reduction of Transmission Loss**

Year 2015 – Self-Sustainable Development

1. **Quality Improvement**
2. **Power Generation Cost Reduction**
3. **Complete Self-Sufficiency**

12.3 Recommendations for Power Tariff System

- Energy Saving Through Conversion To Meter Tariff System
- Correction of Tariff Gap

The tariff system needs to be changed to meter-based collection system as quickly as possible. Though the transition will require some investment in purchases of meters, but the investment is affordable to the Sum by itself. The transition to meter-based tariff collection will require the management to forecast the expenditure and revenue and determine the tariff level to meet the financial requirements arising from fuel payment and unanticipated maintenance needs. Only such situation will create the sums to realize the importance of management.

There is a huge gap between the tariff levels of urban and rural power customers. It is estimated that the rural electricity users who have less cash income on the average are obligated to pay as much as four times the tariff that the urban counterparts are paying. There is a report that the fuel price hike in 1999 led to the total suspension of power supply even during the winter peak times at half of the Sum centers. Currently the Energy Authority is providing a 60% subsidy of the power generaiton cost for the Aimag Center power supply systems while there is no assistance at all to the Sum center power supplies. Needless to say, it is the Sum centers that need financial assistance badly since it is unavoidable to have a higher power generation cost. In view of social equity, it is a government obligation to make available the minimum social services to both urban and rural dewellers. If so, a subsidy is a must to have a functionable rural power supply.

12.4 Enhancement of Maintenance Organization of Diesel Generator

The maintenance organization of diesel generators in Sum centers have been improved and being improved with the grant aid assistance by Japan to provide diesel generators. The Soft Components have been conducted in the series of these grant projects to transfer the technology of operation and maintenance. At same time the mobile maintenance teams were organized in the nine Aimag centers. The teams conduct maintenance patrol and repair the diesel generators in Sum centers.

It is important to succeed to the stream of the above improvement to establish the proposed operation and maintenance organization in this master plan. The proposed measures are as follows:

① To place mobile maintenance team as a part of the Sum power system supporting organization.

② To conduct Soft Component harmonizing with that of the grant aid project in case of project execution by Japan’s grant aid.

③ To supplement the tools and facilities of the mobile maintenance team and conduct technology transfer to enable the team to deal with solar, wind and hydro generating facilities

13. Economic and Financial Analysis

13.1 Economic Analysis

(1) Economic Evaluation for Year 2005

FigureI.13-1 shows the summary of economic evaluations by the type of power generation system for the year 2005 program. There are seven types of projects of 1) PV alone, 2) PV + Wind, 3) PV + New Diesel, 4) PV + Wind + New Diesel, 5) Transmission extension, 6) Micro hydro power, and 7) New diesel alone. In addition, two cross Sum programs of the introduction of a meter tariff system and distribution network rehabilitation are evaluated separately. The economic returns are evaluated with and without the benefits of carbon dioxide reduction. The internal returns on investment (IRR) are negative except for PV + Wind, transmission extension, meter system introduction, and distribution network rehabilitation. The inclusion of carbon dioxide reduction benefits pushes up the economic viability marginally.

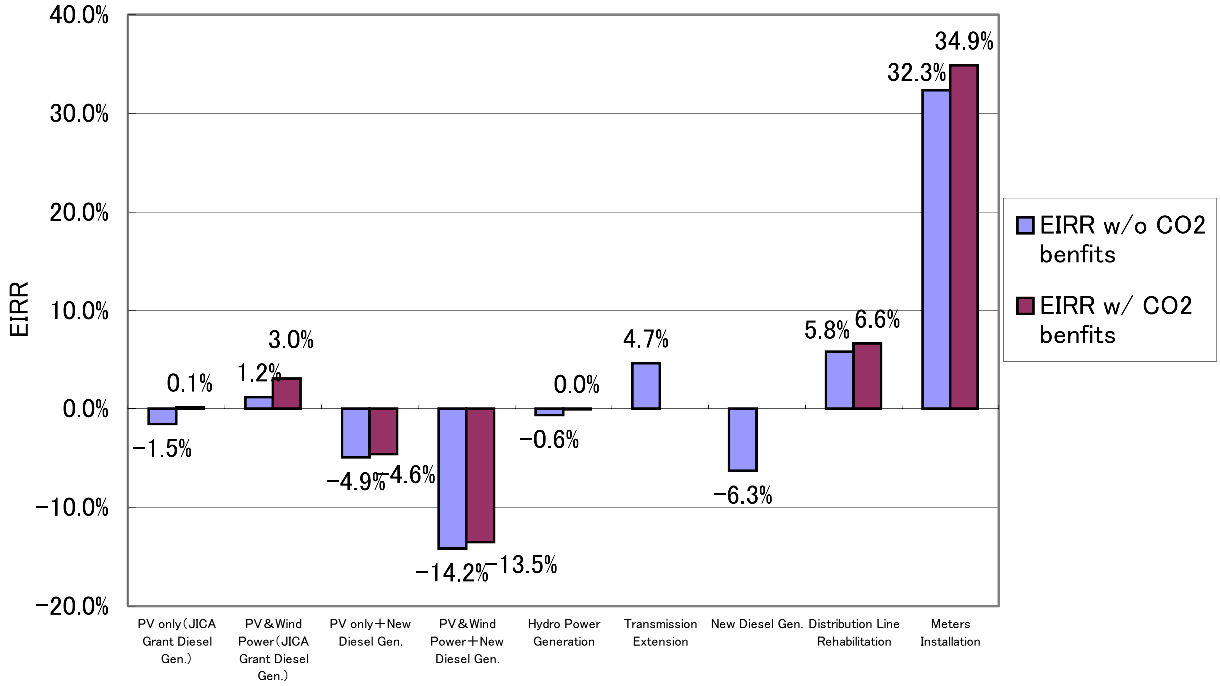


Figure I.13-1 Economic Evaluation By Project Type For Year 2005

(2) Financial Evaluation for Year 2005

Financially, all the project types are negative for the year 2005 program.

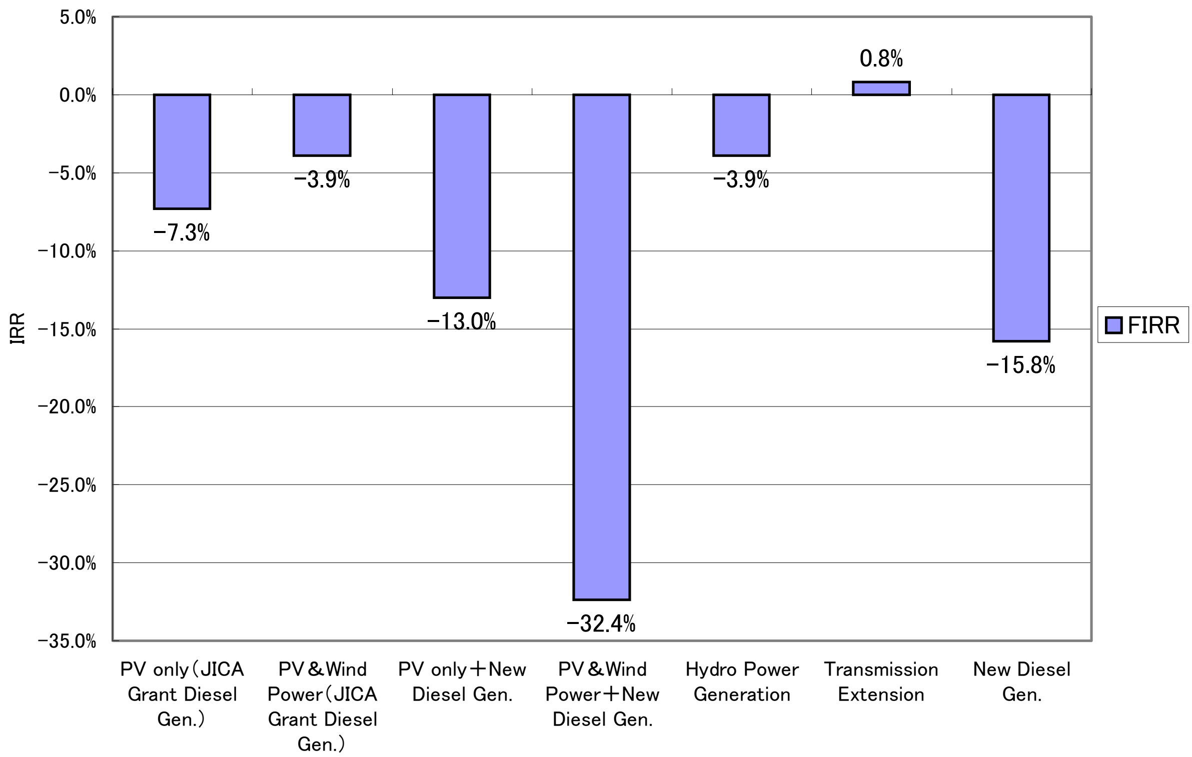


Figure I.13-2 Financial Evaluation For Year 2005

(3) Least Cost Analysis For Year 2005

In comparison to the alternative system of diesel engine power generation, all the project types except for hydropower show positive IRRs.

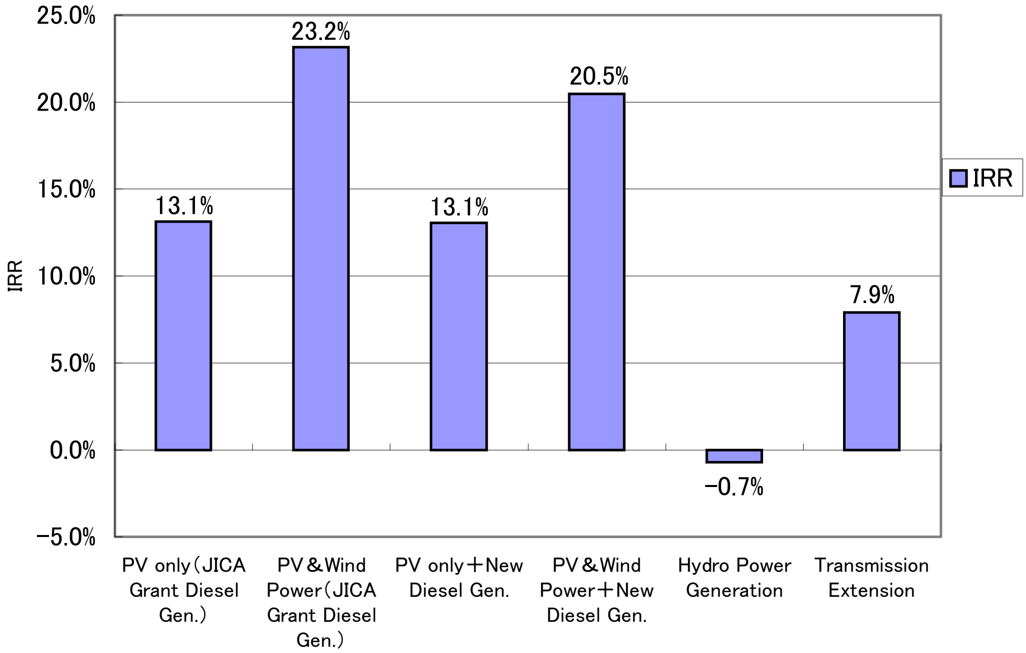


Figure I.13-3 Least Cost Evaluation For Year 2005

13.2 Evaluation By Stage

Three types of evaluation methods are conducted for the Study. They are economic, financial and least cost analysis. The economic evaluation analyzes the project in view of the contribution to the national economy. The assessment of BHN and environmental contributions come to play a critical role in the economic evaluation. The financial analysis looks at the efficiency of capital invested into the project from the view of the investor. The benefits of the project in the economic evaluation are measured in terms of the realized welfare to the beneficiaries. As the third measure, the cost of power generation is compared to the alternative system, in this case, diesel systems.

As FigureI.13-4 shows, the economic and financial feasibility is low in the near future, but still is superior to the alternative system of diesel engine for the rural areas of Mongolia.

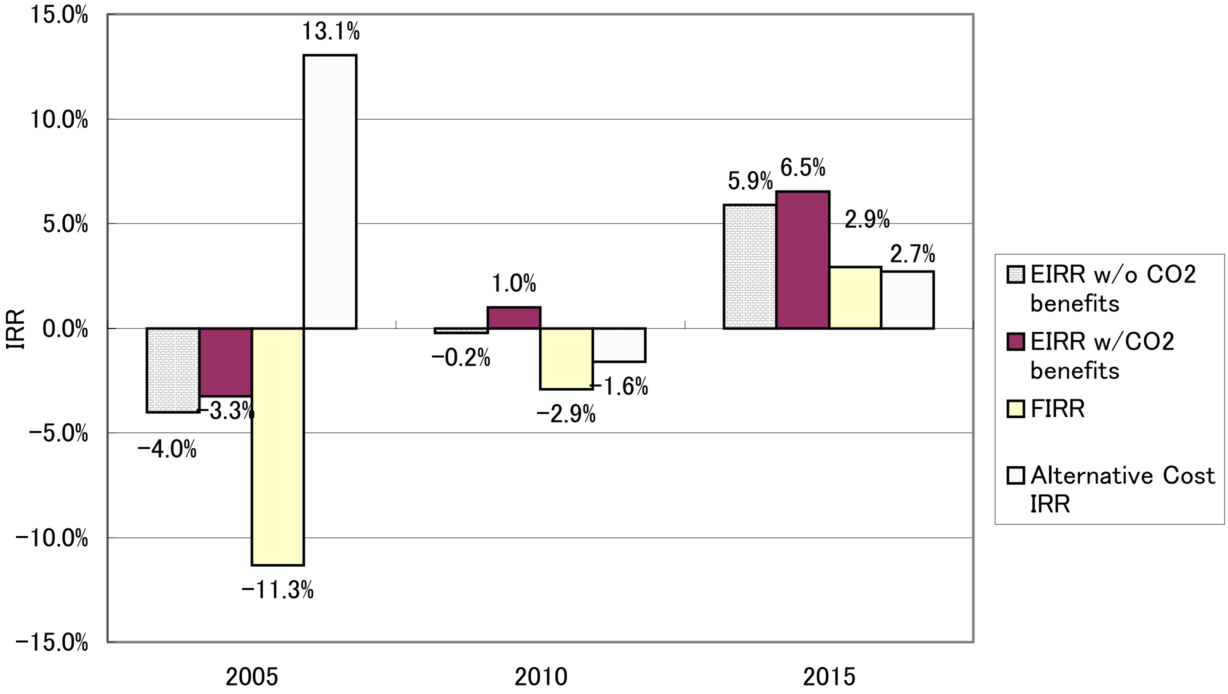


Figure I.13-4 Stage Based Evaluation

14. Financing Option and Recommendation

(1) BOT

It is difficult to believe that any single enterprise would undertake a business of providing isolated power supply systems in the vast rural land of Mongolia where users are located far. Another possibility of every Sum taking it into their own hands has a very limited possibility due to a large financial requirement at the start. For the sake of exercise, the results are shown under the assumption that a single ownership takes over the project. The current power tariff in the Sum center ranges around 100 Tg / kWh. It is deemed very difficult to assume that the same price is achievable as assumed for the pure analysis by a private firm with all the Sum centers after political negotiations[1]. With an assumption that a BOT will attain the price level 80% of 240 Tg/kWh, i.e.,184 Tg/kWh, the transfer takes place at the end of 21 year period.

[1] It needs to be reminded that the prevailing power tariff in the major cities and Aimag is 40 Tg/kWh.

Year	FIRR
2005	-18.9%
2010	-5.5%
2015	＋0.6%

(2) Soft Loan for Environmental Project

The Japanese government offers a special purpose loan tied to global environmental improvements to developing countries. With this scheme in mind the following assumptions are adopted for a soft loan based evaluation. The interest rate is set at 0.75% with the grace period of 10 years and repayment period of 30 years. Self financing covers 1/3 of the initial investment and the remaining 2/3 is financed by the assumed soft loan scheme. In general, the longevity of renewable energy systems and the long payment period of the soft loan correspond well with each other.

Year	FIRR
2005	-21.4%
2010	＋2.6%
2015	＋15.9%

15. Conclusion and Recommendation

The Study for the formulation of a master plan of the rural power supply by renewable energy in Mongolia was conducted over 2 years between October 1998 and September 2000 by the Japanese study team consisting of 6 experts. For the realization of the project for rural power supply by renewable energy, the optimum power supply plan was recommended in conjunction with Japan's grant aid projects of diesel power supply and in coordination with other foreign assistance projects.

■ **Social Impact**

Social evaluation was made in terms of improvement of social services and welfare, and impacts on the poor, and the results are as follows:

At present, most Sum centers can afford to generate electricity only during the night time in the winter due to financial difficulty. So Sum hospitals are forced to conduct emergency operation and delivery service during the night time under the flame of a candle. In addition, Sum schools cannot utilize audio-visual facilities for language classes, machine tools for technical education and computers, due to the lack of a power supply during the daytime. Thus the shortage of electricity is severely hindering education in Sum Centers. If Sum hospitals and schools can receive stable power supply by 2005, it will improve the quality of social services and satisfy local people's needs. It will also minimize the negative effects on the poor and the disadvantaged caused by the transition from socialism to a market economy and by natural disasters such as the heavy snow. In this way, a power supply will play the key role in maintaining the basic social services (basic human needs) for the poor.

There are some issues for the future: 1) introduction of incentives (such as privileged taxation and subsidy) to promote the use of renewable energy, which is environmentally very clean and 2) the support for the poor households (such as the discounted electricity tariff).

■ PV and Wind Energy Potential and the Development Plan

Renewable energy, PV and Wind energies have high potential in the eastern and southeastern parts of Mongolia. The renewable energy potential for the power development is estimated at 300 GWh/year. Most of the regions with high renewable energy potential have not been developed yet, but are under the same study as this master plan. It is possible to generate electricity 1.195 GWh / year at 2005, 9.8 GWh / year at 2010 and 34.7 GWh / year at 2015 under this plan. In addition, the amount of fossil fuel consumption for power generation will be reduced by this plan. Moreover, the amount of exhausted gas from diesel generator such as CO_2 or NO_X will be kept at low levels and will be an effective means of preventing the global warming.

In the first stage of this plan, by the year 2005, installation of the power supply systems to public facilities is planned considering Basic Human Needs. In the second stage, by the year 2010, installation of the power supply system that operates synchronized with diesel generators of isolated grid in Sum centers is planned. In the third stage, by the year 2015, electricity that is generated by a renewable energy source to low renewable energy potential regions by using fuel cell will be supplied.

■ Hydro Energy Potential and Development Plan

Hydro energy is one of the natural clean energies and there are rich hydro power potentials in the north and northwestern region of Mongolia. Available power output is assumed as 1,793 MW in total. The hydropower potential sites are located at the opposite sites of the solar and wind potential sites. Most of the hydropower potentials have not been developed yet, but the survey is in progress. The development study of the hydropower plant was completed on the 5-hydropower plants and the following 2 hydropower plants met the requirements of the rural power supply. Therefore, these hydropower plants are planned to be included in the Master Plan.

(a) Monkhairkhan mini-hydro: 2 sets x 75 kW (0.6 MWh/year)
(b) Baruunturuun mini-hydro: 2 sets x 100 kW (0.6 MWh/year)

(5) Power Distribution Plan

There are lots of problems in the existing power distribution systems in the Sum centers so the systems should be improved. These are caused by the deterioration of the facilities, insufficient operation and maintenance, unstable power supply without balance of supply and demand, large power losses, etc. Modernization of the power distribution system was recommended as the optimum power distribution plan in the Master Plan improving the system. The recommended plan was included in the whole improvement plan of the existing power distribution system facilities. This plan contributes to the positive impacts of the stable power supply, application of appropriate power rate to consumers, reduction of power losses, etc.

■ Establishment of Operation and Maintenance Organization

Organizational evaluation was made in terms of the organizational system for maintenance and organization's management capacity, and results are as follows:

Because the system in 2005 is a comparatively small-scale renewable energy system targeting mainly public facilities such as hospitals and a schools, it is quite possible for Sum offices to become accustomed with necessary technologies to operate and maintain the system, and to establish an operation and maintenance organization for it. Since the system in 2010 will supply electricity for all users in Sums including households, it is necessary for Sum offices to strengthen the management capacity which will be established by 2005. But a Sum office can cope with this challenge, if the system is expanded gradually according to a Sum office's management capacity. The system in 2015 will include new technologies such as hydrogen storage and a fuel cell, but a Sum office can master them with the technical and managerial capacity that has been accumulated by that time.

■ Economic Impacts

It is not possible to maintain a standard quality of medical and educational services at the Sum centers without a basic power supply. The economic analyses conducted are based on the cash affordability of the nomads living in the rural areas. Therefore, the economic benefits measured in monetary value is somewhat limited. The nature of medical services also works negatively to the evaluation as well. The needs for medical services are often unpredictable to the users. When medical emergencies arise at a Sum center, it is often the case that the hospital cannot provide adequate medical treatment due to the lack of a power supply. The expected cost (probability times the associated cost) is small to each person Ex Ante. However, Ex Post, people are usually willing to pay a much larger Sum for proper treatment in most cases. In other words, the measurement of the willingness-to-pay in the form of insurance in preparation of emergency poses a difficult problem in detecting a true willingness. It is common sense that a public body needs to serve a wide reaching insurance mechanism to meet emergency medical needs. With these above issues in mind, the economic analyses conducted are more biased toward conservative results.

Another issue that requires a policy deliberation is the gap in power tariffs between urban and rural areas. Currently, the rural people are paying close to five times higher price for electricity than the urban residents pay in Mongolia. The rural areas of Mongolia are the backbone of the country which serves the supply of vital foodstuffs and also serve as a shelter at the time of economic crises. In consideration of these interlinkages that the rural areas have, it is quite reasonable to provide a certain level of assistance to these hard stricken areas.

The direct implication of the economic and financial analyses is that it is not possible to operate power supply operations financially under a pure market regime. It is clear that the returns on investment for the year 2005 program are negative. However, if power supply to the rural areas is to be continued, there is no clear alternative method. The diesel engine powered power generation system that was compared as the alternative method is not economically superior to the proposed systems. Lack of financial viability is forcing the current practice of severe power rationings. The proposed systems are financially more viable with the assumption of a 24 hour power supply.

There is a societal question of how to divide the limited resources available between urban and rural areas to maintain the Basic Human Needs services, and also a question of how far economic efficiency needs to be pursued in the basis social services.

There is an important caveat in the implementation of the project. There are large costs that are not described in economic analyses, i.e. administrative costs. If the central authority is to control the whole stand-alone system centrally, the operation will incur a formidable administrative cost. The same should apply to the operation under BOT. It is beyond a mere side cost to establish the contractual agreements with 167 Sum centers alone. A few years ago, attempts to privatize the power supply operation at Sum centers all failed without exception within 1-2 years showing that privation is no panacea for economic viability. However, the alternate stringent central control is not a possibility. It is necessary to establish responsible management in each Sum center to effectively and efficiently manage power supply operation.

■ Project Benefits and Recommendation

Execution of the project recommended above would have many important benefits to 167 Sum centers (direct beneficiaries in 2005 are 180 thousand people, 200 thousand people in 2010, 220 thousand people in 2015 and indirect beneficiaries including such users as hospitals and schools, etc. are 580 thousand people) and as stated below.

- Stable power supply is available (24 hour services).
- Economic power supply system without the use of fossil fuel oil is secured.
- Reduction of fuel oil and CO_2 emission would occur as shown below.

	2005	2010	2015
Reduction of fuel oil	1,815 kl/year	4,965 kl/year	6,850 kl/year
Reduction of CO_2 emission	1,336 ton-CO_2/year	3,654 ton-CO_2/year	5,042 ton-CO_2/year

- 24-hour power supply is available for public facilities.
- Power distribution loss would be reduced (from about 30% to within 5%).
- Smooth and effective power operation would be expectable (reduction of personnel expenses).

These benefits are contributed to the people in the Sum centers indirectly on the following points.

- Adequacy of BHN
- People's stable life and enhancement of living level
- Improvement of various public services such as medical care, welfare, education, etc.

In addition to the above, the recommended plans should indirectly contribute to the protection of global environmental issues and regional development by the rehabilitation of infrastructures.

As mentioned above, the recommended plans meet the Mongolian requirements in combination with the Japan grant aid projects and other donors.

Consequently, Stage 1 project (targeted year 2005) is the most important and urgent project for the adequacy of BHN considering the current situation that power supply by diesel generators is sometimes obliged to stop because of steep rises in fuel oil price. It is concluded that the Stage 1 project would be appropriate urgently by cooperation in the form of grant aid on humane grounds.

■ Additional Survey Items

Following surveys are required for the execution of the projects additionally.

- Establishment of management, operation and maintenance organization
- Establishment of power tariff system and collection system
- Review of power demand forecast (for each Sum center)
- Transportation plan of equipment and materials
- Study on installation of equipment and construction work (including land acquisition)
- Review of economic and financial assessment in detail
- Review of implementation program in detail
- Detailed design and preparation of tender documents

■ Future Important Problems

The following important problems for the Government should be settled for the promotion of renewable energy development in the country, that the renewable energy power plant brings positive impacts on the global environment.

- Policy making on Long-term Development Plan (restraint of outflow of foreign money by fuel oil import, energy security measures, positive impacts against greenhouse effect and so on)
- Reformation of Consciousness of Consumers (Saving energy and fuel resources, demand side management, efficiency enhancement of management, operation and maintenance and so on)
- Legal Favorable Provisions for Promotion of Development (tax deduction measures, subsidy, power tariff discount and so on)
- Reduction in the price gaps between power tariffs between urban and rural users
- Institutional building for operation and maintenance organizations and adequate allocation of the financial resources for rural power supply.

PART II PILOT PLANT

PART II PILOT PLANT

1. Pilot Plant Installation

In this master plan, pilot plants that consist of PV-Wind hybrid generation systems and meteorological monitoring units such as a pyranometer and anemometer are installed at three Sum centers for the pilot test. The generated electricity is being supplied to a hospital in Adaatsag Sum of Dundgovi Aimag and Tariat Sum of Arkhangai Aimag, and to a hospital and school dormitory in Bayan-Undur Sum of Uvurkhangai Aimag. Figure II.1-1 shows a diagram of the pilot plant. Table II.1-1 shows the list of data that was collected at the pilot plant. Installation work of the pilot plant began on 20 May 1999 and was completed on 28 June 1999. Through the experience of the pilot plant installation work, their technical level, feature of their work and problems for the work are clarified. The problems or subjects that were found through the installation work will be improved when the project is implemented. Furthermore, the experience of the pilot plant installation work shows that it is possible to install the plant by Mongolian engineers under the supervision of Japanese experts.

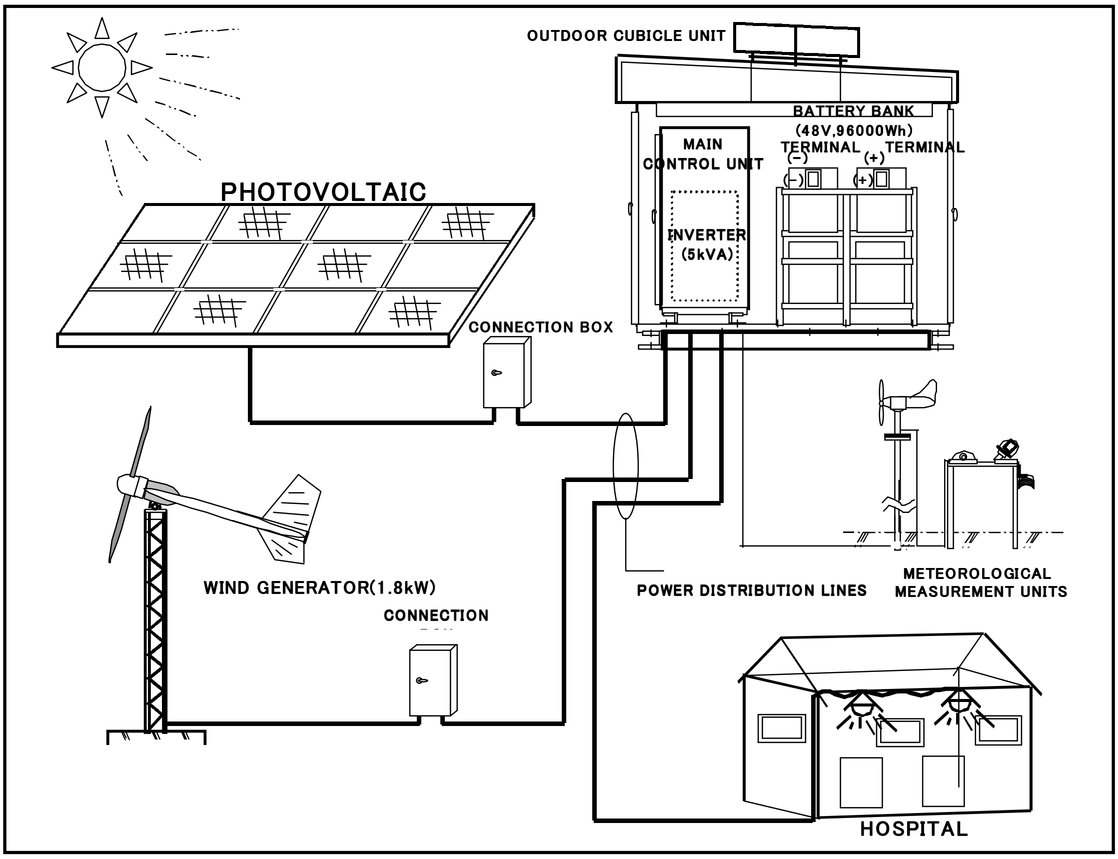


Figure II.1-1 Diagram of pilot plant

Table II.1-1 List of Collected DATA at Pilot Plants

No.	Meteorological Data	No.	Meteorological Data	No.	System Data
1	Solar radiation	6	Maximum wind speed	9	PV power output
2	Sunshine hours	7	Ambient Temperature	10	WG power output
3	Atmospheric pressure	8	Temperature (in cubicle)	11	Battery charge/discharge
4	Wind direction			12	AC loads
5	Wind speed			13	DC loads

The data of the pilot plants have been collected by a local consultant. In the pilot test, not only was data collected by automatic data logging system but also the operator records log sheets of daily operation and maintenance and battery voltage. The troubles and problems of the pilot plants have been clarified by the collected data. The most difficult point for the renewable energy generation system operation is load control. The load pattern should match meteorological conditions. All of the pilot plants have the experience of down of the system because of over discharge of the battery. The problems and countermeasure of the pilot plants are explained at technology transfer seminars that are held at pilot Sums. At the end of meteorological observations, the pattern of wind and solar radiation of the site is clarified. The meteorological data that was monitored by the pilot plant is compared with that of the meteorological agency of Mongolia to correct the margin of monitoring error and the results have been used for Master Plan planning.

2. Operation and Maintenance System

Based on the experiences of the pilot plants, the following points were recommended for a better operational and maintenance organization:

- The most important thing is that all the Sum residents recognize the importance of pilot plants and develop an awareness of keeping the plant by themselves. Sum Offices need to appeal to the residents including the children to understand the importance of the plant and their responsibility to keep the plant in good condition. Especially for children, the Office should teach them not to throw stones at the plant out of mischief.

- Sum Offices should appoint a "person in charge" of daily maintenance and management jobs, who should be familiar with electricity and machinery.

- Sum should establish a new system that the officials at Sum Office ("supervisor") can supervise and train the "person in charge" of maintenance and management on a regular basis, in cooperation with representatives of electricity users such as hospitals and schools.

To describe the system in detail, the "person in charge" keeps the "work record" shown in Table II.5.1-1 and the "supervisor" checks the record every day. Once a month, the "person in charge", the "supervisor", and the "representative of electricity users" gather and hold a monthly meeting to discuss if they have any problems concerning maintenance and management.

3. The generalization of the Pilot Plant

It was conformed that all three pilot plants were being operated smoothly under the adequate supervision, despite the fact that these were the first systems of their kind at those sites. At all three pilot plants, a problem occurred related to the charge/discharge control of the storage battery. Under the guidance and explanation by the member of the master plan, local consultant's correspondence and through the technology transfer seminar, the importance of regulating the load, thinking about the balance of the amount of the stored power was explained to the person in charge, the operation staff, and so on. Because the amount of power generation from renewable energy resources is greatly effected by the local weather.

In the case of solar irradiation, as a result of comparing obtained data between pilot plants and with that of the Mongolian Meteorological Agency, the recorded value at pilot plants is beyond the recorded value of the Mongolian Meteorological Agency. Even though all three pilot plants were installed according to the area classification, it was discovered that the monthly average solar irradiation does not differ much during the summer season. Also in the case of wind energy, data on the Meteorological Agency were different from data of pilot plant. Together with this, the night conditions of the wind became obvious for the first time, and it confirmed that it could be used by the place. The observation results and data were feedback to the master plan and considered introducing the meteorological data observation devices in the year 2005, collecting data and feeding back these data to conform and compensate the selected Sum centers, equipment and designed system for the years 2010 and 2015.

4. Technology Transfer Results

Through each technology transfer seminar, an explanation was given to solve the technical problem of power supply management that occurred at the pilot plant installed site. Such as the load, the amount of generating electricity and the solution plan should balance with the stored electric power and power utilization pattern based on the record data. The operation pattern that was better for the daily operation was found from the technical side and was requested to be adopted. The analysis and an explanation of the recorded data of each pilot plant were done to an operation staff, the person in charge and users and so on, to make an effort to understand the needs of the pilot plant and the importance of it to establish the master plan. These kinds of efforts made concerned local people understand the need of demand side management and made it possible to be carried out and also be appreciated. As for the daily operation of the system, it was found out that it could cope with it fully by local operators. However, Japan engineers' advice was necessary when a problem occurred. Due to this reason it can be said that the technical training and local people's rearing are necessary at the level of execution of this master plan.

Technology Transfer of Technological Aspect

- Pilot plants installation
- Operation and Maintenance of the pilot plants
- Analysis of data at pilot plants
- Comparison of meteorological agency data and pilot plants data
- Selection criteria for Sums suitable for renewable energy generation system installation
- Selection criteria for sites suitable for renewable energy generation system installation
- Current topics of renewable energy generation systems

Regarding Operation and Maintenance Organization:

- Desirable organization for operation and maintenance of the power plant (personnel, supervision and monitoring system, training)
- Establishment of the management principles (self-reliance, self-responsibility)
- Keeping accounting records, operation records and maintenance records
- Financial management (maintenance fund, the yearly diminishing value of the machine)

Regarding Maintenance System:

- Technical maintenance
- Saving the fund for the maintenance cost
- Maintenance system (personal, organization, linkage with the Central and Aimag Government)

Table & Figure

Table I.10-8 Overall Implementation Schedule

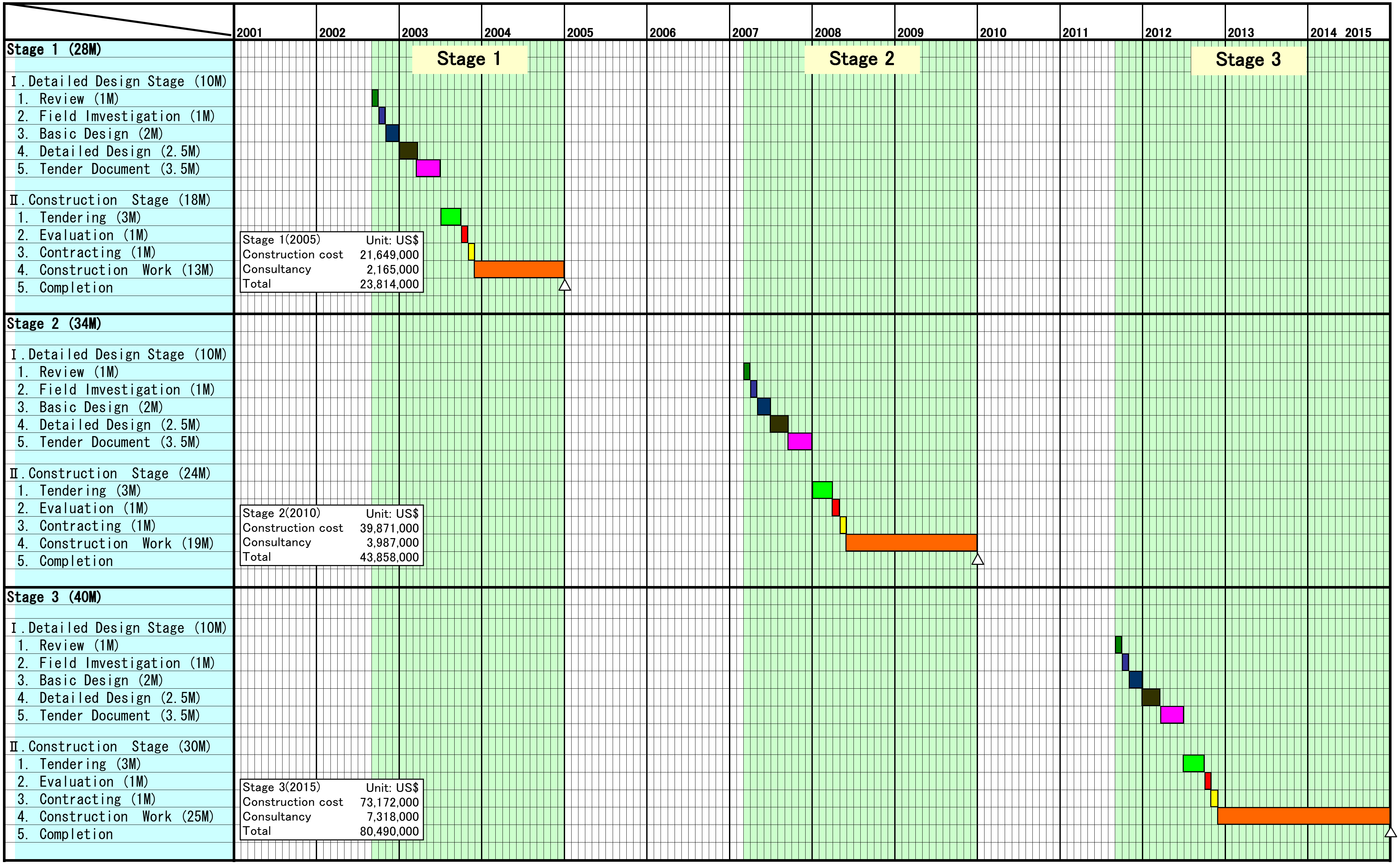


Table I.10-9 Breakdown of Project Costs

Serial No. ID. No. Item	Stage 2005	Stage 2010	Stage 2015
1 Diesel Generator System	8,310,000	0	0
2 Photovoltaic System	3,679,000	22,967,550	47,808,000
3 Wind Generator System	587,250	4,510,000	7,420,000
4 Inverter	262,000	1,534,680	2,795,100
5 Converter	603,000	0	0
6 Battery	1,245,000	5,904,000	0
7 Fuel Cell	0	0	4,927,650
8 Hydrogen Production System	0	0	8,463,000
9 Hydrogen Storage System	0	0	547,780
10 Hydrogen Transportation	0	0	460,000
11 Control House	1,230,000	3,731,114	320,000
12 Distribution System	1,648,200	0	227,788
13 Refurbishment of Indoor Wiring	516,600	835,000	0
14 Intelligent Management System			
For Sum Centers	1,002,000	317,000	167,000
For Aimag Centers, MOID & EA	80,000	72,000	36,000
15 Hydro Generating System	677,000	0	0
16 Meteorological Observation Unit	525,000	0	0
17 Transmission Line (35 kV)	1,284,000	0	0
Subtotal	21,649,050	39,871,344	73,172,318
18 Consultancy Services	2,164,905	3,987,134	7,317,232
Grand Total	23,814,000	43,858,000	80,490,000

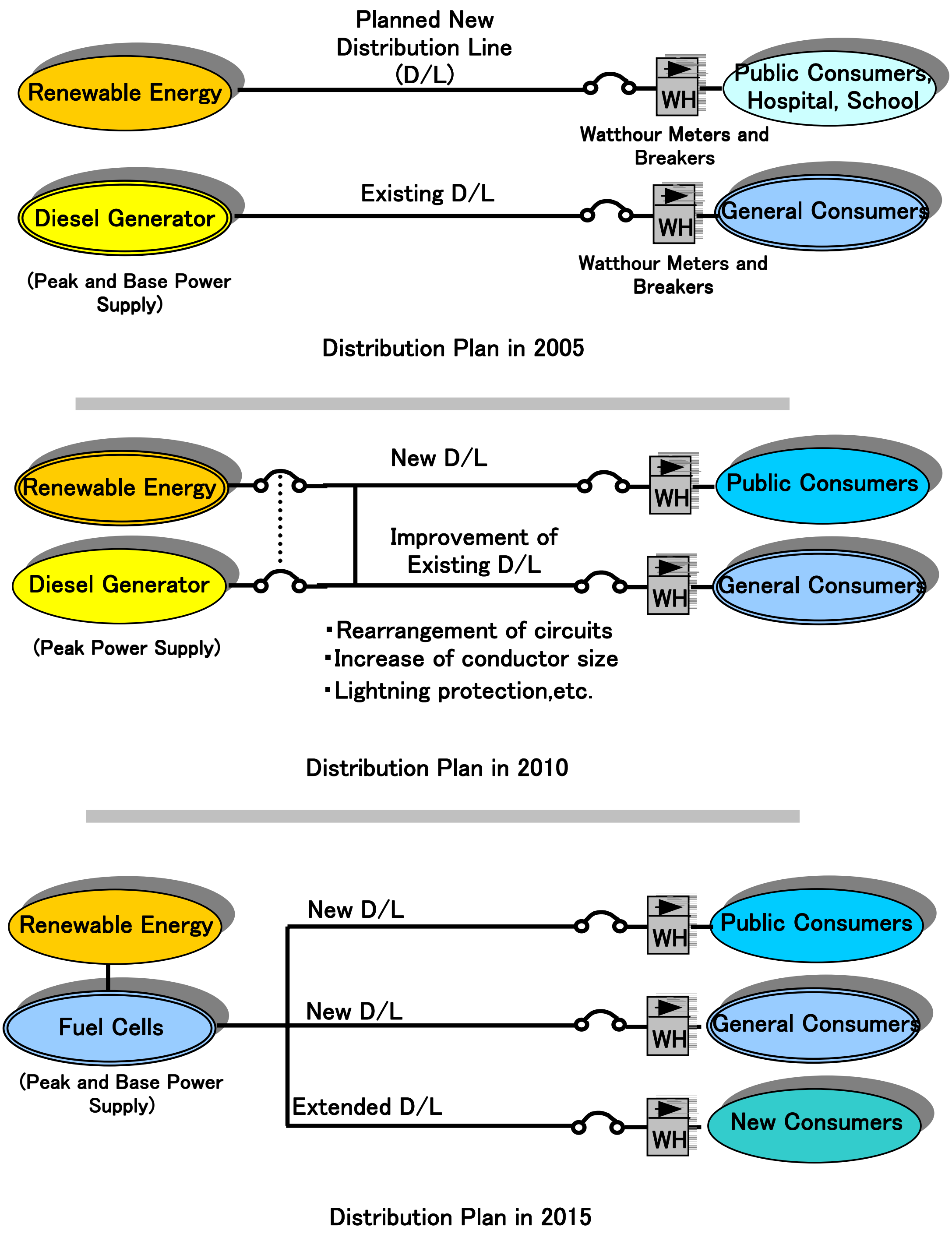


Figure I.10.1 Optimum Distribution Plan

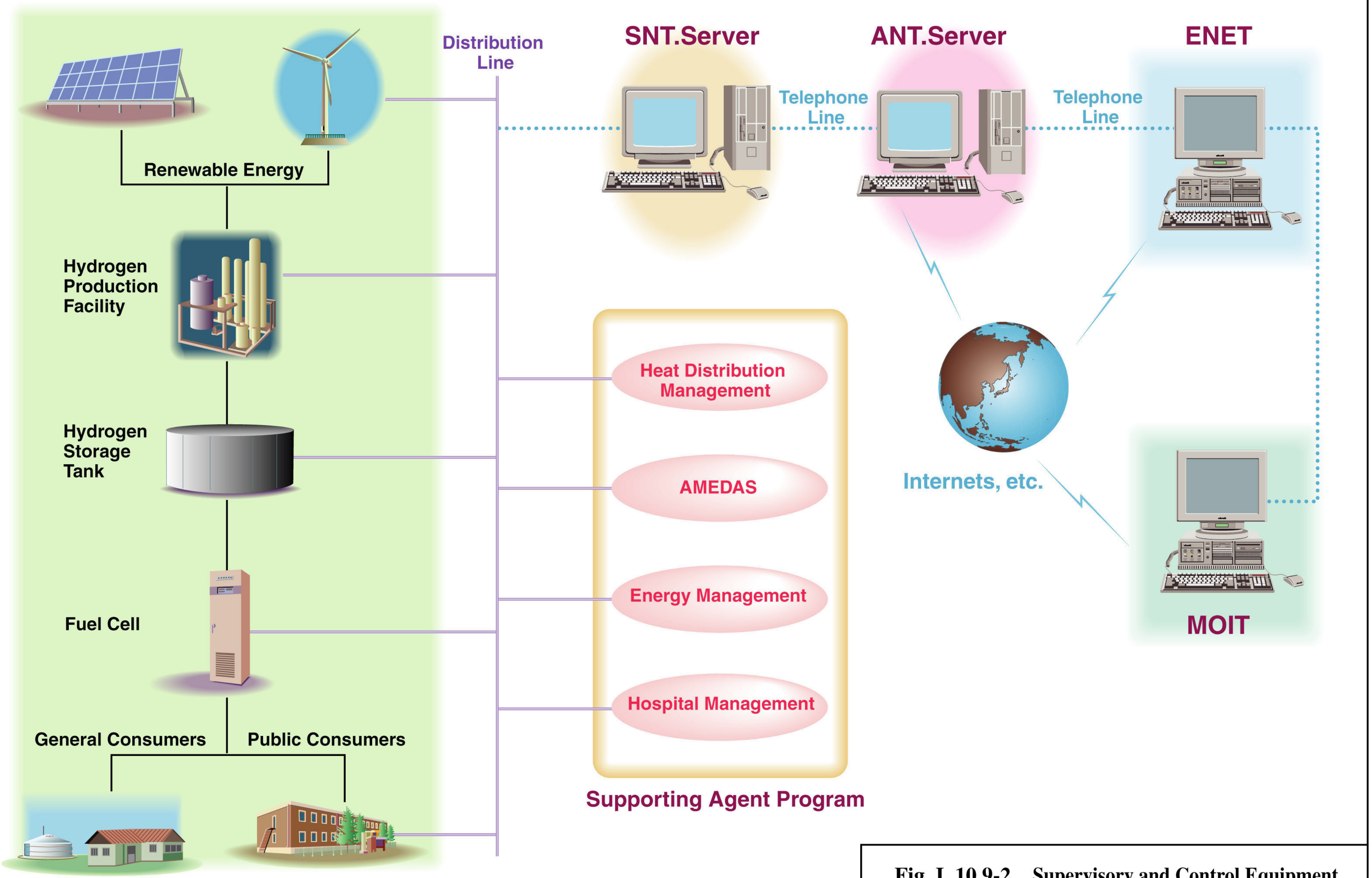


Fig. I. 10.9-2 Supervisory and Control Equipment

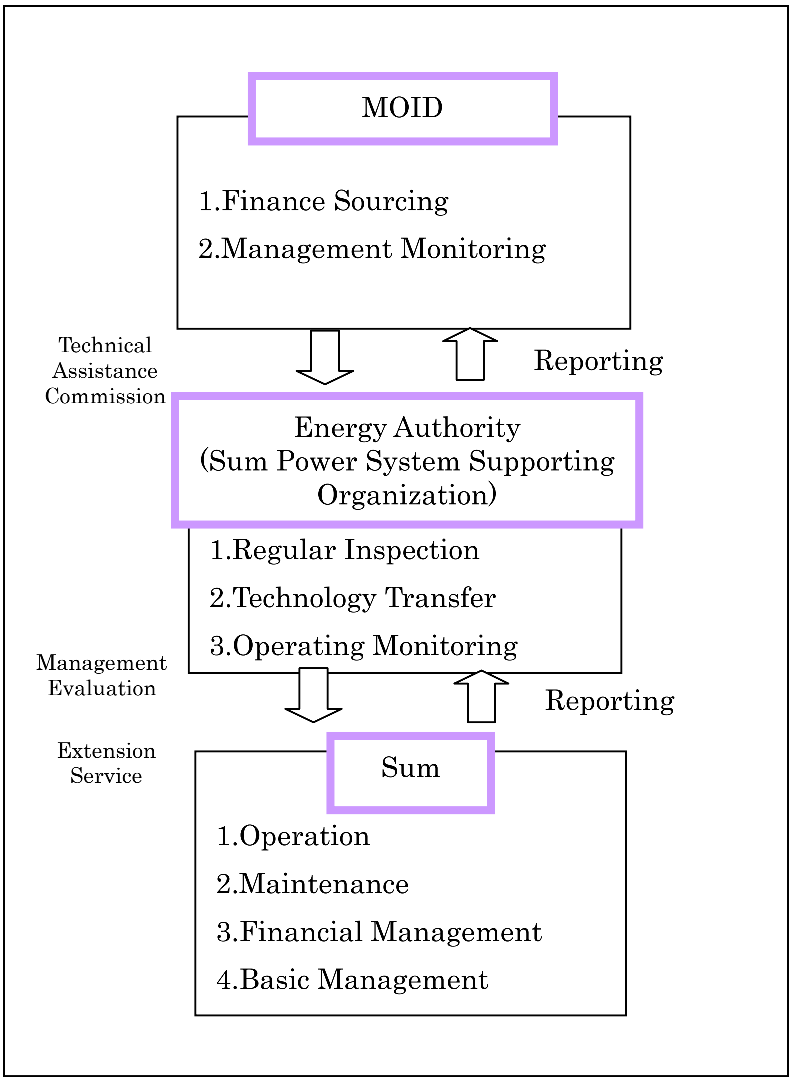


Figure I.12-1 Scheme of Management Organization