Japan International Cooperation Agency (JICA)

No.

Ministry of Electric Power
Myanma Electric Power Enterprise
Union of Myanmar

The Study on Introduction of Renewable Energies in Rural Areas in Myanmar

Final Report

Volume 2 Main Report

Study Outlines

September 2003

Nippon Koei Co., Ltd.
Institute of Energy Economics Japan

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MYANMA ELECTRIC POWER ENTERPRISE
MINISTRY OF ELECTRIC POWER
UNION OF MYANMAR

THE STUDY ON INTRODUCTION OF RENEWABLE ENERGIES IN RURAL AREAS IN MYANMAR

FINAL REPORT

VOLUME 2

MAIN REPORT
STUDY OUTLINES

SEPTEMBER 2003

JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD.
INSTITUTE OF ENERGY ECONOMICS, JAPAN

PREFACE

In response to a request from the Government of the Union of Myanmar, the Government of Japan decided to conduct the Study on Introduction of Renewable Energies in Rural Areas in Myanmar and entrusted the Study to the Japan International Cooperation Agency (JICA).

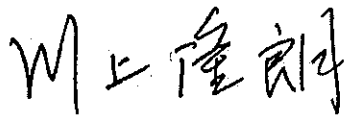
JICA dispatched a study team to the Union of Myanmar organized by NIPPON KOEI Co., Ltd. (NK) and the Institute of Energy Economics, Japan. The team was headed by Mr. Akio KATAYAMA of NK and visited Myanmar nine times from January 2001 through to August 2003.

The study team held a series of discussions with the officials concerned of the Government of the Union of Myanmar and, in conjunction with counterparts from the Myanma Electric Power Enterprise (MEPE), conducted field surveys and monitoring of an existing small MEPE hydropower station. The study team also carried out studies in Japan and compiled the final results in this Final Report.

I hope this report will contribute to improving the level of rural electrification and thereby contribute to alleviating poverty and reducing the urban-rural divide in Myanmar, and also to enhancing the amity between our two countries.

I express my sincere appreciation to the officials concerned of the Government of the Union of Myanmar for the cooperation they extended to the study team throughout the study.

September 2003



Takao KAWAKAMI
President
Japan International Cooperation Agency

NIPPON KOEI CO.,LTD.

Consulting Engineers

September 2003

To Mr. Takao KAWAKAMI
President
Japan International Cooperation Agency (JICA)
Tokyo, JAPAN

Dear Sir,

Letter of Transmittal

We are pleased to submit herewith the Final Report of the Study on Introduction of Renewable Energies in Rural Areas in Myanmar. The report reflects opinions and views of the Myanma Electric Power Enterprise and other organizations concerned in Myanmar, as well as Japanese government organizations concerned.

In view of the power supply conditions in Myanmar—severe shortages have been experienced even in the capital city Yangon—we propose in our conclusions that renewable energy be extensively introduced in the rural areas by utilizing local technology existing and available in Myanmar. We hope and believe these *Guidelines*, *Manuals*, *Development Plans*, and *Database* will be useful and employed in the implementation, operation and maintenance of rural electrification projects, both *Government Schemes* and *Village Schemes*, for sustainable improvement of the level of rural electrification that would contribute to rural poverty alleviation and reduction of the urban-rural divide in Myanmar.

We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs, and the Ministry of Economy, Trade and Industry, Japan for extensive support and cooperation.

We also wish to express our deep gratitude to the Ministry of Electric Power, Department of Electric Power, and Myanma Electric Power Enterprise for the cooperation extended to our study team throughout the field surveys and studies in Myanmar.

Very truly yours,

Akio KATAYAMA, Team Leader
The Study on Introduction of Renewable Energy in Rural Areas in Myanmar

Nippon Koei Co., Ltd.
Institute of Energy Economics, Japan

THE STUDY ON INTRODUCTION OF RENEWABLE ENERGIES
IN RURAL AREAS IN MYANMAR

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Source of [*2]: JICA Study Team

Source of [*3]: MEPE

ABBREVIATIONS

Organizations

DEP, DOEP	Department of Electric Power of MOEP
DHP	Department of Hydroelectric Power of MOEP
GOM/SPDC	Government of Myanmar/State Peace and Development Council
GOJ	Government of Japan
ID	Irrigation Department of Myanmar
ITC	Irrigation Technology Center, Irrigation Department
JETRO	Japan External Trade Organization
JICA	Japan International Cooperation Agency
MADB	Myanma Agricultural Development Bank
MCS	Mother and Children Society
MEC	Myanmar Economic Commission
MELC	Myanma Electric Light Co-operative Society Ltd.
MEPE	Myanma Electric Power Enterprise
MPBANRDA	Ministry for Progress of Border Areas and National Races and Development Affairs
MOC	Ministry of Cooperatives
MOE	Ministry of Energy
MOEP	Ministry of Electric Power
MOST	Ministry of Science and Technology
NEDO	New Energy & Industrial Technology Development Organization, Japan
SPICL	Sein Pann Industrial Production Co-operative Limited
USDA	Union Solidarity and Development Association (an NGO)
VEC	Village Electrification Committee
VFA	Village Fire Association
VPDC	Village Peace and Development Council
VPA	Village Police Association
VWSDC	Village Water Supply Distribution Committee
YCDC	Yangon City Development Council
YIE	Yangon Institute of Economics

YIT	Yangon Institute of Technology

Economics, Finance

ATP	Ability to Pay
GDP	Gross Domestic Product
GRDP	Gross Regional Domestic Product
IRR	Internal Rate of Return
WTP	Willingness to Pay

Unit

kWh	kilo-Watt-hour
MWh	Mega-Watt-hour (10^3 kWh)
K	Currency unit of Myanmar (Kyat)
toe	Tons of Oil Equivalent (10^7 kcal)
US$, $	Currency unit of USA (US dollar)
¥	Currency unit of Japan (Yen)

Others

BCS	Battery Charging Station
FS	Feasibility Study
HRD	Human Resources Development
IPP	Independent Power Producer
MP	Master Plan
NGO	Non Governmental Organization
OJT	On-the-Job-Training
O&M	Operation and Maintenance
R&D	Research and Development
RE	Rural Electrification
SHS	Solar Home System
TA	Technical Assistance

Exchange Rates

US$ 1.00 = K500 = JPY 120（May 2001）

US$ 1.00 = K1,000 = JPY 120（May 2003）

unless otherwise specifically noted

CHAPTER 1 INTRODUCTION

1.1 General

This Main Report: Study Outlines describes the outline of the Study on the Introduction of Renewable Energy in the Rural Areas in Myanmar, which consists of (i) Introduction, (ii) The Works Performed, (iii) Brief Explanation of Report, and (iv) Conclusions and Recommendations. The study took some 33 months from January 2001 to September 2003 to be completed and the work was carried out in both Myanmar and Japan. Various organizations and experts have been involved in both Phases -I and -II of the study. Also, the study was successfully completed through the mutual understanding and close cooperation between the teams from Myanmar and Japan for the whole period of the study.

1.2 Objectives and Scope of the Study

1.2.1 Objectives of the study

The study focused on rural electrification (RE) using renewable energies to serve rural villages in Myanmar. The objectives were as follows:

- Preparation of Guidelines for the introduction of renewable energy;
- Formulation of Development Plans;
- Preparation of a Manual through monitoring of an existing small hydro scheme to facilitate efficient future O&M (operation and maintenance) and development of such schemes; and
- Preparation of a Database for compiling all the RE information and data collected throughout the Study in a manner that facilitates easy reference and updating by the Counterpart Team.

Another important objective was the transfer of technology and know-how that was not limited to engineering, but also included other aspects such as organisational and institutional issues, tariff systems and RE scheme management/maintenance. This activity continued throughout the Study and was facilitated through close cooperation between the Teams from Japan and Myanmar.

1.2.2 Scope of the study

This study was carried out in accordance with the Scope of Work (S/W) (refer to Annex-1.2.1) and Minutes of Meetings (M/M) (refer to Annex-1.2.2) that were signed by the Ministry of Electric Power of Myanmar (MOEP), Myanmar Electric Power Enterprise (MEPE) and Japan International Cooperation Agency (JICA). The study covered a period of four fiscal years and consisted of two phases:

- The first phase: Phase I covered the first and second fiscal years and the main tasks were to create the Guidelines and prepare the Development Plans.

- The second phase: Phase II covered the third and fourth fiscal years and the main tasks were to monitor an existing small hydro power station and to prepare the Manual*[1.]

Note; *[1] : The monitoring of an existing small hydropower station was introduced replace the implementation of a pilot project in accordance with the Minutes of Meeting agreed and concluded between the Japan side and the Myanmar side on August 23, 2002 (refer to Annex-2.2.1 and Sub-Section 3.1.4)

The Study comprised the following main works and outputs:

1) Preparation of the Guidelines
2) Selection of development sites and assessment of priorities
3) Preparation of Development Plans for renewable energy
4) Monitoring of an existing small hydro scheme
5) Technology and know-how transfer
6) Preparation of the Manual
7) Preparation of the Database of collected data and the results of the investigations and analyses.

The assignment schedule is shown in Figure 1.2.1 and the Study Team consisted of 12 team members with respective counterparts.

1.2.3 Counterpart agency and executive body

The counterpart agency on the Myanmar side for the Study was the Ministry of Electric Power (MOEP). The Myanmar Electric Power Enterprise (MEPE) performed the role of the executing body for the Study.

If investigations were required in the border areas, the Study Team communicated with the Ministry of Progress of Border Areas and National Races and Development Affairs. Other related agencies were the Ministry of Agriculture and Irrigation, and the Department of Meteorology and Hydrology (in the Ministry of Transport and Communications). The counterpart agency coordinated communications and discussions with such agencies.

1.3 Background

Myanmar is located in the northwest of the Indochina Peninsula. It covers an area of 680,000 km^2 and has a length of 2,000 km from north to south and width of 1,000 km from east to west. Although Myanmar is in the monsoon region, the northern one-third of the country ranges from subtropical to temperate. The southern two-third are classified as a tropical with high temperature and humidity. The precipitation differs by region and altitude. The central dry region has the lowest precipitation, while the nearby mountain range and plateau have higher precipitation. Generally the wind speed is not high; however, Rakhine Province, which lies under the influence of the monsoon and sea currents, experiences winds of relatively high speed. The quantity of solar radiation is high in the plains area, but is low in mountainous areas because

of the formation of clouds.

The GDP per capita was estimated at US$270 for fiscal year 1997/98. The inflation rate was high (at 29.7%) for the same fiscal year. The economic growth rate was stated to be 5.7% in fiscal year 1999/2000.

In Myanmar's power sector, MOEP formulates electric power development plans and supervises electric power supply. MOEP consists of the Department of Electric Power (DEP) and MEPE.

The role of MEPE (the executive body for the Study) is:

Electric Power Development and electric power system construction,

Power generation and power transmission,

Power distribution, and

Rural electrification for the whole country.

In addition and in relation to the introduction of renewable energy into agricultural villages, the Ministry for Progress of Border Areas and National Races and Development Affairs (PBANRDA), which has jurisdiction over the development of the border areas, plays an important role. It will also be necessary to ensure cooperation with the Ministry of Agriculture and Irrigation, which supervises the construction of irrigation dams.

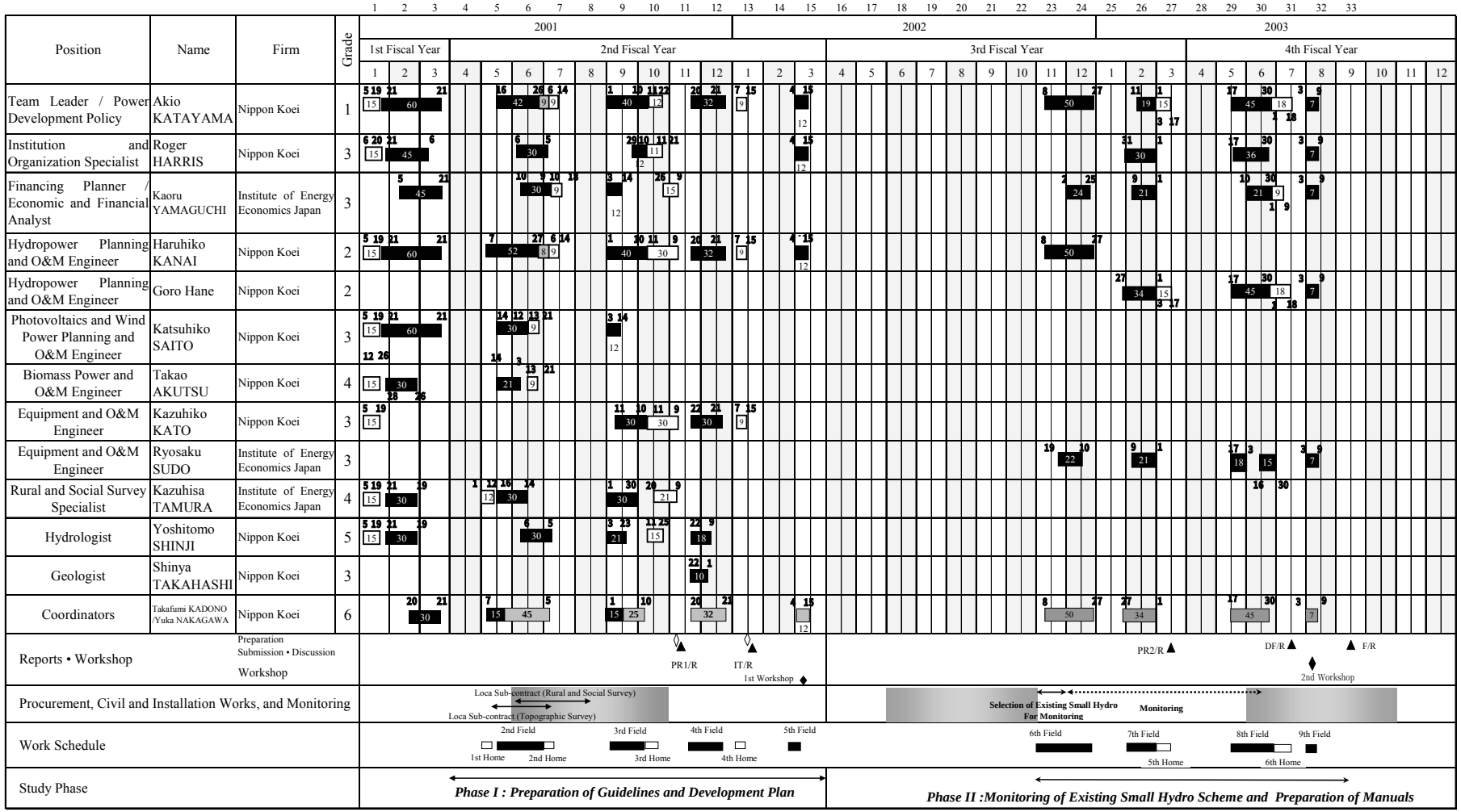
The total installed generation capacity in Myanmar in fiscal year 1996/97 was 1,028 MW, and the per capita power generation was as low as 0.022 kW/person. Even the capital of Yangon, where about 70% of the electric power is consumed, and the urban part of Mandalay suffer from a chronic shortage of electricity. Similarly, the power supply in local cities where the supply is from an independent power system (i.e. they are not served by the Interconnected Power System), is limited to a few hours in the morning and evening. The situation is worse in the rural areas where the electrification rate is 7.6%.

In the rural areas, it is inefficient to extend the distribution network from the Interconnected Power System (IPS) because the population density is low and the demand sites are dispersed and far from the IPS. In the Electric Power Development Plan prepared by MOEP, the capital investment priority is given to a central electric power system for city areas and industrial areas. Rural electrification in Myanmar is awaiting implementation.

Some 75% of the total population resides in the rural areas. Rural electrification is therefore important for poverty reduction and the stability of public life. The expected beneficial effects of rural electrification are:

- Improvement of living standards through home electrification (use of electric lamp/appliances and electronic products);
- Improvement of the educational environment through school and home electrification and the introduction of telecommunications;

- Improvement of the health environment through the introduction of modern medical equipment to electrified clinics / hospitals;
- Improvement in hygienic conditions through the pumped supply of groundwater; and
- Activation of the rural economy by supplying electric power to small-scale farm product processing facilities.



Source: JICA Study Team

Figure 1.2.1 Assignment Schedule

CHAPTER 2 THE WORKS PERFORMED

2.1 The Works Performed in Phase I

2.1.1 Home Office Input and Field Investigations

The works of home office inputs and field investigations in Phase I were conducted as shown in the following table:

Work	From	To	Period	Main Work Item
Home Office Preparatory Works	5 Jan 01	19 Jan 01	15 days	1) Data collection 2) Preparation of Inception Report 3) Study of specification for social survey
1st Field Investigation	21 Jan 01	21 Mar 01	60 days	1) Discussion of Inception Report 2) Basic design concept of Guidelines & Manuals 3) Data collection 4) Selection of potential sites 5) Field reconnaissance 6) Preparation of specification for social survey
1st Home Office Input	1 May 01	12 May 01	12 days	1) Approval of specification for field investigations by local subcontractors
2nd Field Investigation	7 May 01	5 Jul 01	60 days	1) Contracting of field investigations by local subcontractors 2) Field reconnaissance 3)Discussion of concept of Guidelines 4) Data collection and analysis 5) Identification of candidates for Development Plan
2nd Home Office Input	6 Jul 01	14 Jul 01	9 days	1) Study of Guidelines
3rd Field Investigation	1 Sep 01	10 Oct 01	40 days	1) Analysis of rural social survey 2) Study of Guidelines 3) Preparation of Development Plans
3rd Home Office Input	11 Oct 01	9 Nov 01	30 days	1) Preparation of Guidelines 2) Preparation of Development Plans 3) Selection of candidate for Pilot Project 4) Preparation of Progress Report-1
4th Field Investigation	20Nov.01	21 Dec.01	32 days	1) Discussion on Progress Report-1 2) Determination of Pilot Project 3) Additional field investigation 4) Execution of detailed design and

				preparation of specifications 5) Preparation of Workshop
4th Home Office Input	7 Jan. 02	15 Jan. 02	9 days	1) Preparation of Interim Report 2) Preparation for Workshop 3) Preparation of draft Manual
5th Field Investigation	4 Mar. 02	15 Mar.02	12days	1) Explanation of Interim Report

Source: JICA Study Team

2.1.2 Data Collection and Analysis

Each of the experts collected data concerning their corresponding fields of study during the field investigation in Myanmar through relevant organizations and field inspection. The collected data were analyzed during both field investigation and in Japan. The collected data and the results of the analysis are contained in the relevant appendices of the Supporting Report.

(1) Hydropower

For the planning of hydropower, monthly rainfall and hydrological data were acquired from the Irrigation Department and Department of Meteorology and Hydrology (DOMH). A list of potential small hydropower sites was given by MEPE and various project reports on these sites were also acquired. Based on these data, field inspection sites were selected and many site reconnaissance inspections were conducted as shown in Sub-Section 2.1.3. In addition, topographic survey, discharge measurements and test pitting of two potential sites were conducted as shown in Sub-Section 2.1.4. Factory inspection and interviews were conducted during the field assignment to collect information on local manufacturers and their costs.

(2) Photovoltaic and Wind Power

Data acquired for the assessment of photovoltaic (PV) and wind power were mainly global radiation, monthly mean wind speed, and wind direction. Most of these data were acquired from the Department of Meteorology and Hydrology (DOMH), but information available was limited. Since DOMH did not have data on global radiation, the values of monthly mean sunshine hours were converted and used for the analysis. Data from a computer software METONORM (version 4.0) was also used to conduct analysis on PV and wind power potentials in Myanmar. Information on present use of solar power was also collected.

Field inspection trips were conducted in seven (7) States / Divisions as shown in Sub-Section 2.1.3 to survey existing PV facilities and evaluate potential for PV and wind power. During the field trips, the use of battery charging stations (BCS) and recycling of batteries were also investigated.

(3) Biomass Power

Data acquired included those on agricultural activities in Myanmar and the use of refuse, as well as information on the biomass gas engines acquired through the Ministry of Agriculture & Irrigation and other relevant organizations. Information on a rice husk gas engine was acquired through the manufacturer and their first installation in Younetalin Village (Ayeyarwady Division) was inspected.

Other field inspection trips were conducted in Yangon Division, Bago Division, Mandalay Division and Sagaing Division. During the field inspection, existing sugar mills, timber mills, rice mills, and rubber plantations were inspected. Large scale biomass gas engines installed in the rice mills were also inspected.

(4) Financial and Economic Analysis

For the study of financial and economic analysis, the data required included macroeconomic indicators, various MEPE data including tariff and financial statements, economic and financial value of electricity in the rural areas, prices of alternative energies/fuels in the rural areas, international prices of fuels, and cost estimates of various technologies for renewable energy.

The macroeconomic indicators were collected from the publications of the Government of Myanmar, the International Monetary Fund, and the World Bank. Various data were collected from MEPE. Economic and financial values of electricity and the prices of alternative energies/fuels in the rural areas were surveyed through field investigations. International prices of fuels were collected from the publications of the International Energy Agency (IEA). The cost estimate of various types of technologies for RE was made by the Study Team members.

Five field trips were conducted in the rural areas of Myanmar. The surveys were conducted by means of interview survey principally with village leaders and villagers to investigate the following:

1) willingness to pay (WTP) for electricity
2) present expenditure for fuel and lighting
3) examples of RE based on renewable energy and their costs
4) financial options for the community
5) functions of the village electrification committee (VEC)
6) involvement of MEPE in RE
7) accounting, billing, and O&M by the community and VEC

(5) Rural and Social Survey

In the field of rural and social survey, the following types of data were collected from reference materials acquired through MEPE and other relevant organizations:

1) general information on society in Myanmar;

2) population, number of households, ratio of electrified households, household demand for electricity and income of various townships;
3) type and number of public facilities (medical, education, etc.), industries and their demand for electricity in various townships;
4) tariff, tariff collecting system, and willingness to pay (WTP) for electricity.

Furthermore, detailed interview surveys with village leaders and villagers were conducted in Kachin State, Northern and Southern Shan and Yangon Division, focusing especially on the daytime and nighttime demand for electricity and the WTP of the villagers.

In addition, village society survey was subcontracted to acquire detailed information of the villages and townships in Kachin State and Northern and Southern Shan as shown in Sub-Section 2.1.4. At the same time, basic information on the villages and townships was collected with the cooperation of an NGO as shown in Sub-Section 2.1.7.

(6) Institution and Organization

Data were collected on legislation and the relevant organizations considered to be stakeholders or part of the main institutional framework linked to the objectives of RE.

Furthermore, numerous meetings and interview sessions with officers and staff from the various ministries and organizations were conducted throughout the Study. A list of organizations interviewed is shown in Table 2.1.1. Field inspection trips were also conducted to investigate the organization of MEPE at division and township level, as well as the existing VECs in some of the villages.

Table 2.1.1 List of Organizations Interviewed

	Organization	Date
1	Ministry of Electric Power (MOEP)	
	a. Myanma Electric Power Enterprise (MEPE)	almost daily liaison
	b. Department of Electric Power (DEP)	19 Feb, 14 Jun, 4 Oct 2001
2	Ministry of Agriculture and Irrigation (MOAI)	5 Feb 2001
3	Ministry of Progress of Border Areas and National Races and Development Areas (MPBANRDA)	
	a. Department of Progress of Border Areas & National Races (PBANRD)	21 Feb 2001
	b. Department of Development Affairs (DDA)	14 Jun 2001
4	Ministry of Energy (MOE)	22 Feb 2001
5	Ministry of Science and Technology (MOST)	23 Feb 2001
	a. Yangon Institute of Technology	27 Jun 2001
6	Ministry of Cooperatives (MOC)	
	a. Cooperative Department	6 Feb, 15 Feb, 4 Jul 2001
	b. Cottage Industries Department	14 Feb 2001
7	Ministry of Forestry (MOF)	14 Jun 2001
8	Ministry of Foreign Affairs (MOFA)	
	a. National Commission for Environmental Affairs (NCEA)	14 Jun 2001
9	Peace and Development Council (at Township level)	23 Jun 2001
10	Myanma Agricultural Produce Trading (MAPT)	20 Jan 2001
11	Renewable Association Myanmar (REAM)	21 Jan, 8 Jun + field trip x 4
12	Myanmar Electric Light Cooperative Society Ltd. (MELCS)	5 Feb 2001
13	Myanmar Inventors Cooperative Ltd. (MICL)	15 Feb 2001
14	Alatchaung Trading Cooperative Ltd. (also acts as VEC)	20 Jun 2001

Source: JICA Study Team

2.1.3 Field Inspection

(1) Hydropower Potential Sites

	Potential Site	State/Division	Scale (kW)	Date
1st Assignment	Namlan (1)	Northern Shan	320	8 Feb 01
	Parhe Falls	Northern Shan	340	10-11 Feb 01
	Heho Falls (1)	Southern Shan	8,000	28 Feb 01
	Ngot Chanug	Southern Shan	600	27 Feb 01
2nd Assignment	Namlan (2)	Northern Shan	320	19-20 May 01
	Heho Falls (2)	Southern Shan	8,000	22-23 May 01
	Nam Uon	Eastern Shan	530-800	30 May 01
	Chaung	Eastern Shan	2,000	1 Jun 01
	Nam Hkun	Magway	1,200	6-7 Jun 01
	Chaung	Northern Shan	320	19-20 Jun 01
	Zahaw Chaung	Southern Shan	8,000	22-23 Jun 01
	Namlan (3)			
	Heho Falls (3)			
3rd Assignment	Namlan (4)	Northern Shan	320	16-17 Sep 01
	Heho Falls (4)	Southern Shan	8,000	19- 20 Sep 01
4th Assignment	Heho Falls (4)	Southern Shan	8,000	23-24 Nov.01
	Namlan (4)	Northern Shan	320	26-28 Nov.01

Source: JICA Study Team

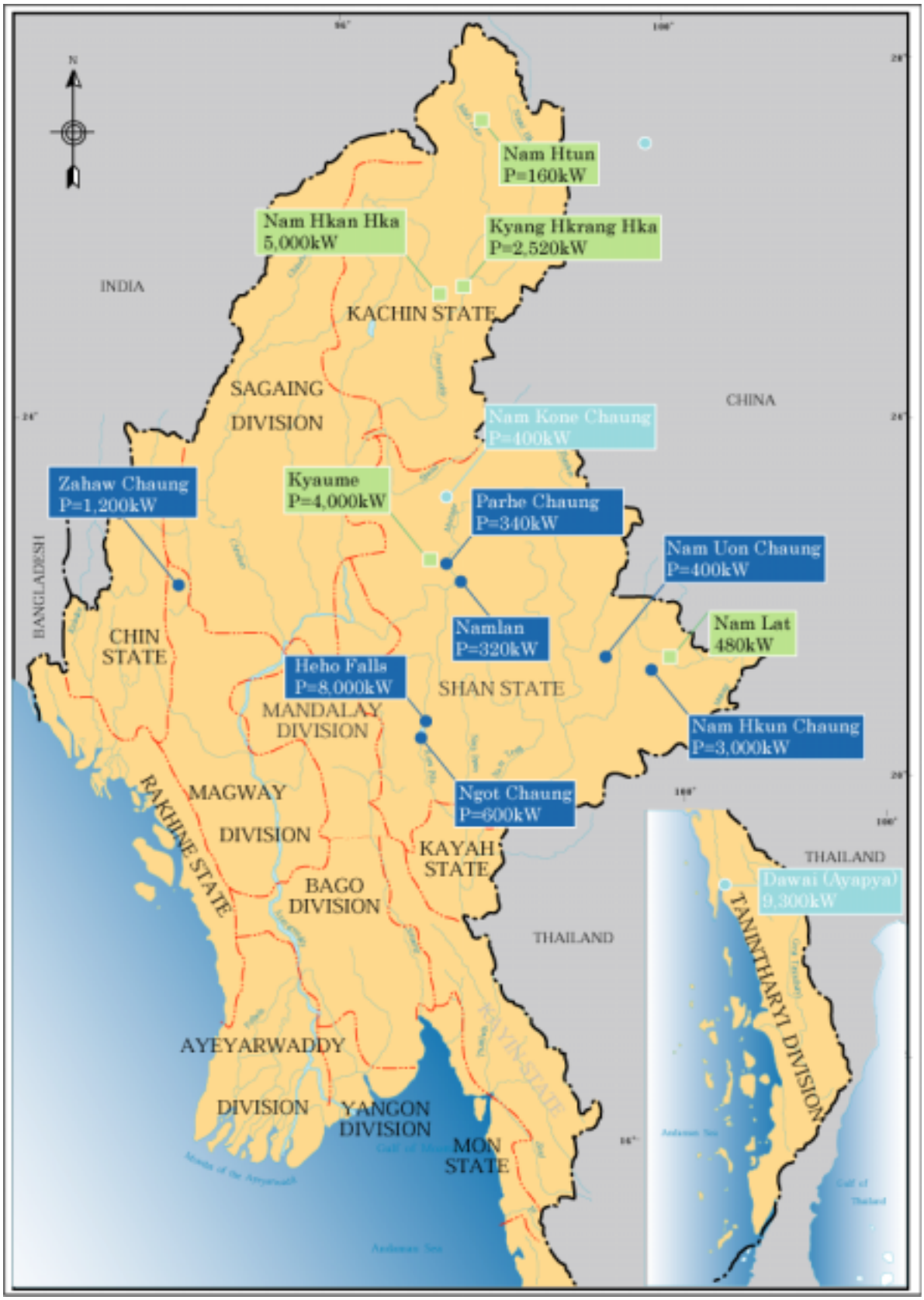
The locations of the hydropower potential sites inspected are shown in Figure 2.1.1.

(2) Existing Hydropower Stations Insepcted

	Existing Plants	State/Division	Scale (kW)	Date
1st Assignment	Kyaukme	Northern Shan	4,000	9 Feb 01
	Kyang Hkrang	Kachin	2,520	9 Mar 01
	Hka	Kachin	5,000	10 Mar 01
	Nam Hkam	Kachin	160	12 Mar 01
	Hka			
	Putao			
2nd Assignment	Nam Latt	Eastern Shan	480	28 May 01

Source: JICA Study Team

The locations of the existing hydropower stations inspected are shown in Figure 2.1.1.



Source: JICA Study Team

Figure 2.1.1 Location of Hydropower Potential Sites and Existing Hydropower Stations Inspected

(3) Photovoltaics and Wind Power Potential Sites

	Location	Date
1st Assignment	Bago, Mandalay, Sagaing Rakhine (Thandwe, Taung-gok) Kachin (Mythyina, Putao)	12-16 Feb 01 26 Feb – 1 Mar 01 9-14 Mar 01
2nd Assignment	Ayeyarwady (Pathein, Chaung Tha) Sagaing (Monywa), Magway (Poppa) Kachin (Putao, Machambau)	18 May 01 17-31 May 01 4-6 Jun 01

Source: JICA Study Team

The locations of the photovoltaics and wind power potential sites inspected are shown in Figure 2.1.2.

(4) Biomass Power Potential Sites

	Location	Date
1st Assignment	Yangon area (Khanaungtoe, Helgu) Yangon Area Bago, Mandalay (Pyinmana), Sagaing	31 Jan – 2 Feb 01 8 Feb 01 12-16 Feb 01
2nd Assignment	Ayeyarwady (Pathein) Bago Mandalay area Ayeyarwady (Hinthada)	18-20 May 01 22 May 01 24-26 May 01 12 Jun 01
3rd Assignment	Yangon area (Kayin Seik, Banbwe Kone)	22, 26 Sep 01
4th Assignment	Yangon area (Kayin Seik, Sarmalauk)	7, 8, 10, 14 Dec 01

Source: JICA Study Team

The locations of the biomass potential sites inspected are shown in Figure 2.1.2

(5) Institution and Organization

	Task	Location	Date
1st Assignment	Village survey Inspection of existing power plants Interview with VEC/Cooperatives	Northern Shan	7-12 Feb 01
		Southern Shan	25 Feb – 2 Mar 01
2nd Assignment	Interview with VEC	Ayeyarwady	12 Jun 01
	Village survey Inspection of existing solar/hydro Interview with VEC/TPDC	Central Dry Zone Southern Shan	12-25 Jun 01

Source: JICA Study Team

In addition, experts in the fields of economic/financial planning and rural and social survey accompanied most of the major field inspection trips.

Source: JICA Study Team

Figure 2.1.2 Location of Biomass, Solar and Wind Power Potential Sites Inspected

2.1.4 Field Surveys Subcontracted

During the 2nd Field Investigation, three field surveys, 1) Village Society Survey, 2) Topographic Survey, and 3) Discharge Measurements & Test Pitting were conducted at the locations shown in Figure 2.1.3.

(1) Village Society Survey

1)	Specification of Work	- Survey locations - Survey items	-Kachin State, Northern Shan, Southern Shan -1050 Un-electrified Households 240 Electrified Households 75 Village Leaders
2)	Procedures and Progress of subcontract	-Approval of spec. -Tender evaluation -Approval of subcontractor -Contract - Site work - Receiving of report - Final Payment	- 2 May 01 - 3-5 May 01 - 11 May 01 - 17 May 01 - 18 May-10 Aug 01 - 14 Aug 01 - 14 Aug 01
3)	Contractor	- Professor Myat Thein and Associates, Yangon Institute of Economics	

Source: JICA Study Team

(2) Topographic Survey

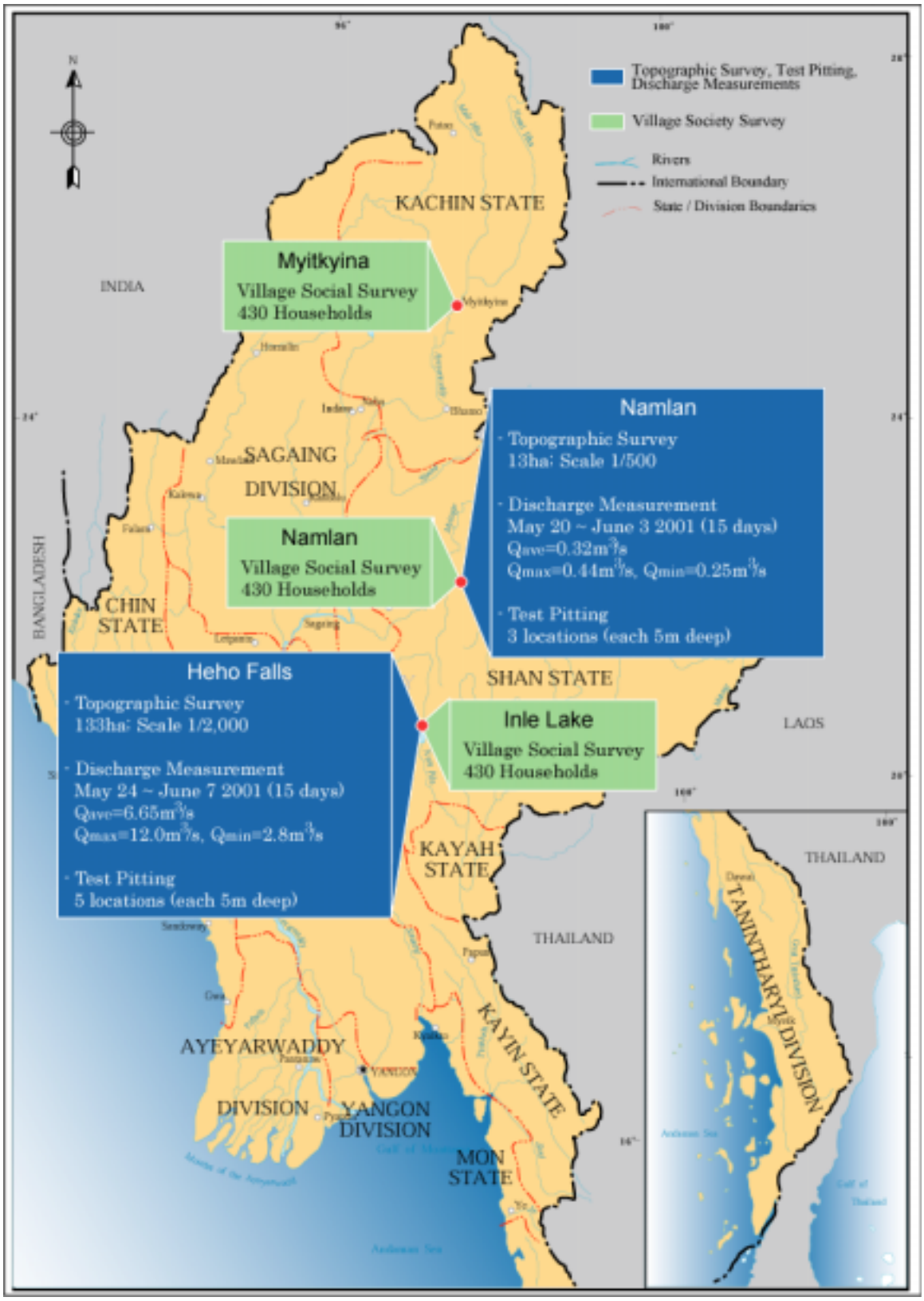
1)	Specification for Heho Small Hydro	- Scale - Contour interval - Survey area - Control points	- 1/2,000 - 2 m - 133 ha - 3 points
2)	Specification for Namlan Micro Hydro	- Scale - Contour interval Survey area - Control points	- 1/500 - 1 m - 9 ha - 3 points
3)	Procedures and progress of subcontract	- Approval of spec. - Tender evaluation -Approval of subcontractor - Contract - Site work - Receiving of maps - Final Payment	- 2 May 01 - 4-10 May 01 - 11 May 01 - 17 May 01 - 19 May-27 June 01 - 27 June 01 - 27 June 01
4)	Contractor	- Concordia International Ltd.	

Source: JICA Study Team

(3) Discharge Measurements & Test Pitting

1)	Specification for Heho Small Hydro	- Discharge measurement - Measurement point - Test pitting	- 15 days from mid May - Negya Chaung - 5 m deep x 5 points
2)	Specification for Nam Lan Mini Hydro	- Discharge measurement - Measurement point - Test pitting	- 15 days from mid May - Ho Sant Chaung - 5 m deep x 3 points
3)	Procedures and progress of subcontract	- Approval of spec. - Tender evaluation - Approval of subcontractor - Contract - Site work - Receiving of maps - Final Payment	- 2 May 01 - 8-10 May 01 - 11 May 01 - 17 May 01 - 19 May-25 June 01 - 25 June 01 - 25 June 01
4)	Contractor	- Aung Pyitun Construction Ltd	

Source: JICA Study Team



Source: JICA Study Team

Figure 2.1.3 Location of Field Surveys Conducted

2.1.5 Discussion with Agencies Concerned on the Priority Development Projects

(1) Meeting with MPBANRDA on Priority Projects

On 22 June 2001, the Study Team and their MEPE counterparts held a meeting at the Ministry of Progress of Border Areas and National Races and Development Affairs (MPBANRDA) to explain the selection of the Priority Development Plans. Out of the three schemes, SH-02: The Namlan Rural Electrification Project in Northern Shan was welcomed since the project is located within the administration of MPBANRDA. Similarly, the east bank of Inle Lake included in SH-01: The Inle Lakeshore Rural Electrification Project in Southern Shan is also under the administration of MPBANRDA in an area named Special Region No.6, where the Pao tribes reside.

In return, MPBANRDA requested the Study Team to conduct three additional studies on hydropower schemes and consider the dispatching of a biogas expert. It was concluded that the three hydropower schemes presented were not adequate candidates for the Study. However, it does seem worthwhile to consider supplying biogas to the scattered farmhouses within the areas under MPBANRDA as fuel for gas lamp and cooking. The dispatching of a biogas expert is desirable.

(2) Meeting with MEPE on Three Priority Projects

On 29 June 2001, an official meeting was held between the Study Team and MEPE, and the Study Team presented the progress of the Study. After thorough discussion, MEPE agreed to the three schemes proposed by the Study Team to be the Priority Development Projects, as presented in the Minutes of Meeting (refer to Annex-1.2.4). MEPE stated that in the short term, it would be the executing body responsible for O&M of all schemes, but in the long run, it would like to consider a transfer to VECs. The long term O&M organization for rural electrification by small hydropower needs further discussion between the Study Team and MEPE counterparts.

(3) Meeting with MEPE on Pilot Project

The Study Team proposed the Nam Lan Mini Hydro Scheme (320 kW) in Northern Shan as the Pilot Project to be implemented in FY-2002, and the Counterpart Team agreed on it as described in the Minutes of Meeting on 22 Nov. 2001 (refer to Annex-1.2.6). The minutes of meetings stated that the agreement would be officially finalized after getting approval from the Minister of MOEP.

2.1.6 Formulation of the Development Plan and Detailed Design of Pilot Project

For SH-01: The Inle Lakeshore Rural Electrification Project in Southern Shan and SH-02: The Namlan Rural Electrification Project in Northern Shan, basic design was conducted during the 3rd Assignment in Myanmar based on the data from

topographic survey, discharge measurements and test pitting. Further economic/financial analysis and social survey for determination of the electricity demand and WTP were conducted based on data acquired from the subcontracted village social survey.

For BH-01 BM-01: The Model Villages for Rural Electrification with Rice Husk Gas Engine and Battery Charging Stations (BCS), the exact location of the project site was selected through additional field inspections trips. A Development Plan was formulated including the funding plan for the project in the 3rd Assignment in Myanmar.

The additional field investigation and detailed design for the Nam Lan Mini Hydro Project were executed and the specifications were prepared during the 4th field assignment from 20 Nov. 2001 to 21 Dec. 2001.

In the 4th Home Office Input from 7 Jan. 2002 to 15 Jan. 2002, preparation of the Work Shop for the Pilot Project scheduled in Mar. 2002, preparation of the draft Manuals, and modification of draft Guidelines were conducted. The Interim Report consisting of the progress, the Guidelines and the Priority Development Projects was submitted and explained to the team of Myanmar in the 5th field assignment from 4 Mar. 2002 to 15 Mar. 2002.

2.1.7 Problems Encountered and Countermeasures Taken

(1) Field Surveys During Rainy Season

During the 2nd Field Investigation (May-June 2001) subcontracted work consisting of Social Survey, Topographic Survey, Discharge Measurements & Test Pitting was conducted. The rainy season in Myanmar usually begins in mid May and continues until the end of October. In order to avoid the risk of delay anticipated during this season, it was necessary to contract during May and immediately begin the works.

After evaluation of the tenders, the contracting was completed on 17 May 2001 and work was started the next day on 18 May 2001. In June, the region centering Mandalay suffered heavy rain and flooding said to be the worst in 70 years. This affected all subcontracted works, especially the topographic survey team, who had no access to the site due to flood water blocking the only road leading to the site. It was feared that the topographic survey would have to be interrupted until November, but the survey team was able to recommence the survey work and submit their final output on 27 June 2001.

Although no serious effect resulted, the inundation around the plains around Mandalay caused cancellation of some field trips scheduled by the Study Team during this period and prevented access to regions that were to be surveyed.

(2) Assistance by NGO in Field Inspection

Due to the limitation of time and/or security reasons, the Study Team did not have the opportunity to visit all states and divisions in Myanmar. To compensate for this disadvantage, the Study Team was able to receive cooperation from Renewable Energy Association Myanmar (REAM), an NGO specializing in RE by the use of renewable energies. On behalf of the Study Team, REAM conducted field surveys in Chin State, Sagaing Division, Magway Division, Mandalay Division and Rakhine State to acquire basic information about villages needed to formulate the master plan on rural electrification by renewable energies. The collected information included:

- population, number of households and rate of electrification;
- present use of electricity in households and number of appliances;
- number and types of public facilities, industries and agricultural activities and their demand for electricity; and
- existing sources of energy and their cost, and potential for introduction of renewable energies.

The information acquired through this field survey allowed the Study Team to understand better the situation of the rural regions not yet visited. The location of the villages inspected are shown in Figure 2.1.4.

Source: JICA Study Team

Figure 2.1.4 Village Location Inspected by REAM

2.2 The Woks Performed in Phase II

2.2.1 Field Investigation and Home Office Input

The field investigations and home office inputs conducted in Phase II were as follows:

Inputs	From	To	Period	Work Details
6th Field Investigation	8 Nov 02	27 Dec 02	54 days	1) Discussions to identify candidate schemes for monitoring 2) Inspection of candidate schemes 3) Selection of the small hydro power scheme for monitoring 4) Monitoring (dry season) 5) Drafting of the Manual 6) Preparation of the Database
7th Field Investigation	27 Jan 03	1 Mar 03	34 days	1) Monitoring (early irrigation season) 2) Drafting of the Manual 3) Preparation of the Database
5th Home Office Input	3Mar 03	17 Mar 03	15 days	1) Preparation of Progress Report 2
8th Field Investigation	17May03	30 June 03	45 days	1) Monitoring 2) Carrying Monitoring Equipment in Myanmar 3) Completion of Database 4) Preparation for Overall Workshop 5) Guidance on Usage of Monitoring Equipment
6th Home Office Input	1 July 03	18 July 03	18 days	1) Completion of Manuals and revision of Guidelines based on results of monitoring, if necessary. 2) Preparation of Draft Final Report 3) Preparation of documents for Overall Workshop
9th Field Investigation	3 Aug. 03	9 Aug. 03	9 days	1) Final Workshop to discuss about Draft Final Report

Source: JICA Study Team

2.2.2 Inspection of Existing Small Hydros for Site Selection

As shown in Figure 2.2.1, and as part of the process of site selection for monitoring purposes, the Study Team inspected the following three small hydro schemes of MEPE from 24 to 30 November 2002:

- Hopin (630 kW x 2 = 1,260 kW), Hopin, Kachin State
- Nam Khan Kha (1,250 kW x 4 = 5,000 kW), Moe Gaung, Kachin State

- Zi Chaung (630 kW x 2 = 1,260 kW), Kalaymyo, Sagaing Division

The results of these inspections are presented in Memos-1 and 2 of Part 8-3 / Vol. 8 Supporting Report: Renewable Energy.

The Study Team had previously inspected four other small hydro schemes in Phase I of the Study. These sites are listed below and are also shown in Figure 2.2.1 and outlined in Annex-2.2.1:

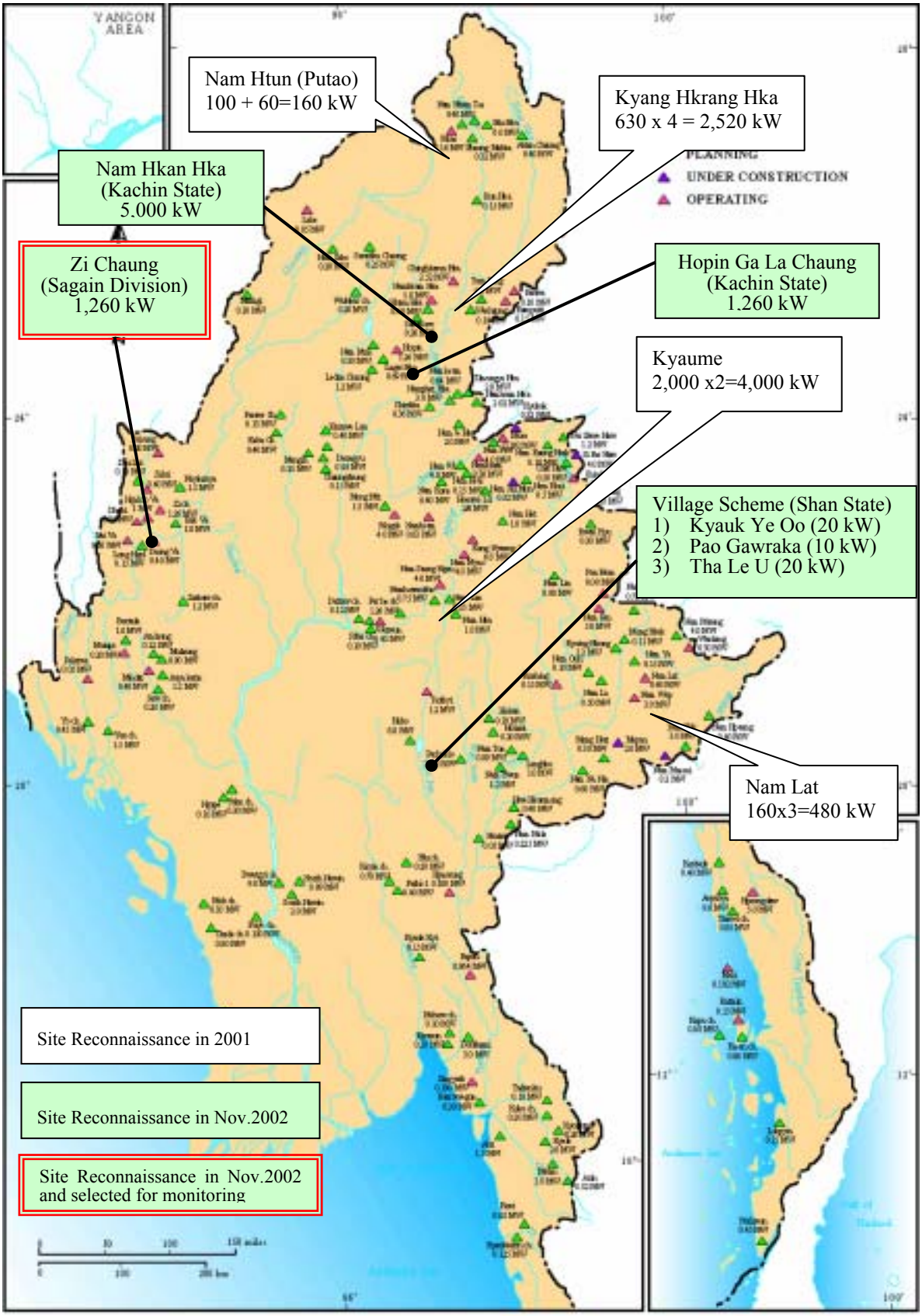
- Kyaume (2,000 kW x 2 = 4,000 kW), Shan State
- Kyaung Hkrang Hka (630 kW x 4 = 2,520 kW), Kahin State
- Nam Htun, Putao (100 + 60 = 160 kW), Kachin State
- Nam Lat (160 kW x 3 = 480 kW), Eastern Shan

2.2.3 Selection of a Suitable Small Hydro Scheme for Monitoring Purposes

The target users of the Manual are MEPE engineers and administrators while potential users would include independent hydro electricity experts, NGOs, and villagers who are interested and engaged in survey, planning, design, and operation and maintenance of small hydros (<10 MW).

The Manual was prepared with reference to the findings from the monitoring of one of the existing small hydro schemes of MEPE. The key criteria for selecting a suitable small hydro scheme were:

- The installed capacity had to be in the order of 100 kW to MW class.
- The scheme was not to be connected to the nationwide grid of MEPE.
- The scheme had to be in operation.
- There had to be no security issues.
- The scheme should have experienced issues in design and O&M that would be common to many of the small hydro schemes in Myanmar.



Source: JICA Study Team

Figure 2.2.1 Location Map of Candidates for Existing Power Stations as Monitoring Sites

Table 2.2.1 Comparison of Three Small Hydros of MEPE

No.	Items	Unit	Hopin	Nam Khan Kha	Zi Chaung
1.	Location		Hopin, Kachin	Moe Gaung, Kachin	Kalaymyo, Sagaing
2.	Installed capacity	kW	1,260	1,250 x 4	1,260
3.	Specifications	-	Horizontal axis Pelton turbine with 1 nozzle, H = 190.5 m, Q = 0.4 m^3/s per turbine	Horizontal axis Francis turbine, H = 128 m, Q = 1.35 m^3/s per turbine	Horizontal axis Francis turbine, H = 41.0 m, Q = 2.12 m^3/s per turbine
4.	Commissioned in	year	September 1991	September 1996	July 1996
5.	Diesel generators if any	kVA	None	None	320, 860 & 608 kVA, 1 unit each These are operated only for evening 3 hours, separately to each other also independently from Zi Chaung hydro.
6.	Peak supply capacity	kW	1,260 kW	2,500 kW at max. since Unit 3 requires spare parts for thirister and Unit 4 have been out of order for more than 1 year.	900 kW at Zi Chaung hydro only. 1,300 kW including 3 diesel generators
7.	Nos. of consumers	h.h.	3,147	3,100	3,000
8.	Peak load	kW	1,300	1,400 kW at 18:15 on 26.11.2002	900 kW on 7 August 2002 1,800 kW in potential load
9.	Present conditions		● Unit 1 in automatic operation while Unit 2 in manual operation.	● Units 1 & 2 are in manual operation. Units 3 & 4 are out of order.	● Unit 1 turbine has water leakage from casing.
10.	Remarks		● Inspected on 26.11.2002 ● 6 hour driving from Mitkyina	● Inspected on 10.3.2001 and 26.11.2002 ● 3 hour driving from Mitkyina	● Inspected on 28-29.11.2002 ● 1 hour driving from Kalaymyo
11.	Judgement		● Civil works are in good conditions. ● Governors need some modifications.	● Intake and desander need design review to prevent sediment inflow. ● Rehabilitation of turbine-generators by manufacturer is needed.	● Intake and desander need design review in relation to sedimentation around intake. ● Turbines need rehabilitation.

Source: JICA Study Team

Through comparison of the three sites (Hopin, Nam Khan Kha, and Zi Chaung) as presented in Table 2.2.1, the JICA Study Team and MEPE Counterpart Team jointly selected the Zi Chaung Hydro for monitoring and preparing the Manual. The Zi Chaung Hydro has the following issues relating to operation and maintenance:

- The intake needs a design review to reduce sediment inflow;
- The headtank needs a water level gauge for peak power generation during the dry season;
- The governors need some adjustments and improvement; and
- Parallel operation with diesel generators is needed and essential to save fuel consumption while reinforcing the supply capacity.

The first three issues are common to most of the small hydroelectric power plants in Myanmar, as observed and identified through the inspection of seven small hydroelectric power plants of MEPE since January 2001. The last issue was also observed in many places in Myanmar and will, if achieved, reduce fuel expenditure of MEPE for rural electrification.

As the conclusion, the following was suggested to MEPE as the power station to be monitored:

- Zi Chaung Small Hydro (1,260 kW) in Kalaymyo, Sagaing Division

2.2.4 MEPE Concurrence on the Site Selection

As presented in Annex-2.2.2, the site selection above was agreed between the JICA Study Team and the MEPE Counterpart Team. MEPE's concurrence on the site selection was officially confirmed by letter which is presented in Annex-2.2.3.

2.2.5 Monitoring of Zi Chaung Power Station

(1) Monitoring in December 2002

The Zi Chaung Power Station was first monitored on the 12th and 13th December 2002. The issues found and possible countermeasures conceived were contained in Manual for Sustainable Small Hydros in Vol. 4.

(2) Monitoring in February 2003

The Zi Chaung Power Station was monitored from 16th to 21st February 2003, i.e. during the dry season. The results are reflected in the Manual for Sustainable Small Hydros in Vol. 4.

(3) Monitoring in May 2003

The Zi Chaung Power Station was monitored prior to the start of the rainy season. The monitoring period was the 21st to 31st May 2003. The major monitoring activities were as follows:

- Cutting down bushes and provision of temporary bamboo bridges and handrails at the existing footpath to enable the inspection of the headrace canal.
- Inspection of the headrace canal during watering and de-watering and a leveling survey to grasp both the structural and flow conditions of the headrace canal.
- Topographic survey for the upstream of the intake and preparation of countermeasures for sediment deposited upstream of the intake.
- Estimate of the overall efficiencies of hydraulic turbines and generators, measuring hydraulic turbine discharges by use of an acoustic flow meter, and carrying out a guidance relating to efficient reservoir operation inclusive of fabrication of an electric water level gauge.

The results were taken into account in preparing the Manual for Sustainable Small Hydros in Vol. 4.

(4) Monitoring Equipment

In advance of monitoring in May 2003 during the 8th Field inspection, the monitoring equipment were procured in Japan and carried to Myanmar.

Table 2.2.2 shows the overall list and usage purpose of the monitoring equipment as follows:

Table 2.2.2 Overall List and Usage Purpose of Monitoring Equipment

Item No.	Description	Supply Q'ty in Total	Supply Q'ty by 1st batch	Supply Q'ty by 2nd batch	Supply Q'ty by 3rd batch[*1]	Usage Purpose
1	**TEST AND MEASURING DEVICE**					
1.1	PORTABLE STANDARD METER (3-phases power meter: 1 unit, Direct current/ voltage meter: 1 unit, Alternate current/ voltage meter: 1 unit, Shant resister: 1 unit)	1	-	1	-	The standard meter to be useful for calibration of the meters in switchboards, various specific tests, etc.
1.2	MEGGER (1000V, 2000M ohm, DM-1527)	3	1	-	2	The meter to measure insulated resisters of high-voltage equipment.
1.3	MEGGER (500V, 1000 M ohm, DM-5257)	5	1	-	4	The meter to measure insulated resisters of low-voltage equipment.
1.4	UNIVERSAL CIRCUIT TESTER (Main body, CD-751: 1 unit, Probe: 2 units)	5	1	-	4	The universal tester to measure resister, voltage and current regarding circuits of various equipment.
1.5	CLAMP TESTER (DCM-2000R)	5	2	-	3	The device to measure currents by clamping instead of decomposition of circuits.
1.6	VIBRATION METER (1MV-VM-2001)	1	1	-	-	The device to measure vibrations of running parts such as a hydraulic turbine, a generator, a shaft bearing, a speed governor, etc. and predict risks during the maintenance and inspection.
1.7	THICKNESS METER (I&D AD-3253)	1	1	-	-	The meter to measure the thickness of the steel penstock..
1.8	DYE CHECK	5	-	-	5	To be useful for detection of fine surface cracks, an acceptance test of brand-new equipment and an ageing test of operational equipment, etc. , which are necessary for maintenance works.
1.9	DEFECT SOUNDER WITH MAGNETIC POWDER	1	-	-	1	To be applicable for non-destructive tests to examine inner cavities and inner cracks of casting iron, and invisible defects which may be in the hidden side of the parts forming complicated shapes

1.10	STOP WATCH	10	-	-	10	To be applicable for measurement of specific characteristics of movements, i.e. velocities of movable parts, surface velocities of water flow, etc. for hydroelectric facilities and equipment.
1.11	PRESSURE CALIBRATOR (Main body/ DGSN-125B: 1 unit, Attachments/ BG5-30:1 box, BG-80: 1 box, GPMZ-80: 1 box)	1	1	-	-	To be applicable for calibration of water pressure meters, pressure oil meters and pressure relays during maintenance.
1.12	PHOTO-VOLTAIC REVOLUTION METER (HIOKI 3403)	3	1	-	2	The revolution meter to measure revolution velocities of rotating parts, getting out of touch. It is a handy apparatus for measuring rotating velocities of governors, auxiliary equipment, etc. where are no installation of revolution meters.
1.13	ONE SET OF TOOLS	10	-	-	10	It consists of AMP instruments, fasting instruments for terminal points with a large scale to be pressed for joining, cutting instruments of cables, etc.
1.14	DIGITAL FREQUENCY METER (DA500)	2	1	-	1	The digital meter with an accurate reading at 1% at min., which is applicable for adjustment of specific characteristics .
2.	**MAINTENANCE TOOLS AND EQUIPMENT**					
2.1	ENGINE ELECTRIC WELDER (240 A, 20 Hp)	1	-	-	1	For the use of welding works which may be occurred during operation and maintenance.
2.2	GAS WELDER	1	-	-	1	For the use of cutting, heating and welding of a nonferrous metal during disassembling and assembling.
2.3	PORTABLE ELECTRIC DRILL (Main body/ DR DV-13C: 1 unit, Attached drill, straight: 8 ps.)	1	1	-	-	For the use of drilling holes in the field repair processing.
2.4	PORTABLE ELECTRIC GRINDER (Main body/ DGSN-125B: 1 unit, Attachments/ BG5-30: 1 box, BG-80: 1 box, GPMZ-80: 1 box)	1	1	-	-	For the use of surface grinder in the field repair processing.
2.5	MICROMETER CALIPER (Mitsutoyo production/ M110-25: 1 ps., M110-50: 1 ps., M110-75: 1 ps.)	1	1	-	-	To measure the outer diameter of part at an accuracy of 1/100 mm, which will be required during maintenance works of hydraulic turbine, governors, parts of oil pressure devices.

2.6	EXTENSIBLE INSIDE MICROMETER (1 MZ 1500: 1 ps., Extensible bar: 1 set)	1	1	-	-	To measure the inner diameter of part at an accuracy of 1/100 mm for hydraulic turbine liners, shaft bearings and holes.
2.7	TOOLS FOR DRILLING SCREW HOLE (Tap drill set/ ND-21S: 2 sets, Tap drill set/ ND-21SPL: 1 set, Tap handle/ TH-19:1 ps., Dice/ RD-38, M8: 2 ps., Dice/ RD-38, M10: 2 ps., Dice/ RD-38, M12: 2 ps., Dice/ RD-38, M16: 2 ps., Dice handle/ DH-382: 1 ps.)	3	1	-	2	A set of instrument to process screws having 3-20 mm in diameter. in the field repair processing.
2.8	BOX SPANNER SET (Maeda Iron Industry production/ 700S)	3	1	-	2	For the use of fastening and unfastening the large sized bolts and nuts of M5-M20 where the common spanners are not applicable.
2.9	SPANNER SET (Tone Instrument production)	5	-	-	5	For the use of fastening and unfastening the bolts and nuts of M10-M50 which assembling and disassembling of equipment required.
2.10	DIAL INDICATOR WITH MAGNETIC STAND (1 set of Mitsutoyo production/ Dial indicator 2064F: 2 ps. Dial indicator 1033: 1 ps. Magnet stand MB-B: 2 ps. Magnet stand MB-PSL: 1 ps.)	5 sets	3 sets	-	2 sets	The instrument temporarily installed at the site for measurement of distortion of revolution parts, microscopic movements of driving parts, etc.
2.11	ENGINE GENERATOR (5 kW)	1	1	-	-	To be used in powerhouses during a power cut.
3	**ACOUSTIC FLOW METER, ETC.**					
3.1A	ACOUSTIC FLOW METER (Yokogawa electric company production- US300 PM-A21-2-N/ Main body: 1 unit, Trans juicer GCG: 1 unit, Couplement: 4 ps., Trans juicer US300 PT SCG: 1 unit, Fixing strap USPA001: 1 set)	1	1	-	-	The meter to estimate an overall efficiency of hydraulic turbines and generators by measuring hydraulic turbine discharges.
3.1B	THICKNESS MEASUREMENT PROBE (Yokogawa electric company production - USPA301)	1	1	-	-	The meter to determine characteristics constants by measuring thickness of both parts which sends and receives ultrasonic waves.
3.1C	PRESSURE CONVERTER (EJA430-DA	1	1	-	-	A part of Thickness Measurement Probe.

	S2B) INCL. DISTRIBUTER					
3.1D	CONNECTION CABLE (US300PC-A-020, 20 m)	1	-	1	-	A part of Thickness Measurement Probe.
3.2	ELECTRIC PREIS-TYPE CURRENT METER	1	1	-	-	A current meter to measure velocities of river flows.
3.3	LEVELING APPARATUS (SOKKIA/ Auto level B20: 1 unit, Tripod CSA1: 1 unit, Staff gauge K53-IIW: 2 units)	1	-	-	1	The leveling apparatus is necessary for operational staffs of power stations for their operation and maintenance purposes.
3.4	AIR-PUMP FOR PNEUMATIC WATER LEVEL GAUGE (MITSUVAC MF-10) INCL. TRANSFORMER FOR 100V	1	1	-	-	For the use of the air-activated water level gauge which JICA Study Team installed in the Zi Chaung powerhouse in his 7th Field Investigation.
3.5	ELECTRIC WATER LEVEL GAUGE (This item contains 2 sets of water level gauge including some extras/ Dai-ichi electronics production: 3 ps., Potentiometer CP-6: 3 ps. Potentiometer CP-10: 3 ps. Fixed resister 10 k Ω , 20 k Ω , 40 k Ω , 50 k Ω : each 10 nos., DC power for 6V: 3 ps., V pulley A-Ø224: 2ps., V pulley A-Ø160: 2ps., Float Ø240: 2 ps., Plummet 2 kg (Ø60x 100): 2 ps., Gear SS1.5-20: 2 ps. Gear SS1.5-120: 2 ps. Pillow block UP002: 8 ps., Axis: 4 ps., Base: 2 sheets, Cover: 2 ps., Wire Ø2: 20 m, Mech-rock: MA15x29: 6 ps., Coupling NB-08-6X6: 2 ps., Attached screws: 1 set)	1	1	-	-	This water level gauge would be installed in the locations where water level controls are indispensable, i.e. intakes, de-silting basins, head ponds, etc. In particulars, it should be installed in the case when the head pond is far from the powerhouse.
3.6	ENGINE-PUMP (MSW-71K)	1	1	-	-	This would be useful for Saxophone and Flute sediment flushing devices through breaking sediment layers hardened by aging.

Source: JICA Study Team

Note;
*1: The 3rd batch will be procured by JICA Head Office and their specifications and or quantities would be subject to modification depending on the tendering results.

2.2.6 Interviews and Data Collection

Interviews and data collection to collect basic information and data necessary for preparation of the Manual were also carried out in Phase II. The agencies and organisations interviewed are listed in Table 2.2.3.

Table 2.2.3 List of Interview and Hearing

Date	Counterpart	Objectives/Contents
04/12/2002	Ministry of Cooperatives (U Kyaw Thein, Director; U Min Lwin, Asst. Director; U Pe Kyi, Asst. Director)	- Position and Approach of Ministry of Cooperatives towards RE - Option of financial assist from Cooperatives' Banks for RE
07/12/2002	U Tun Myat, Chief Engineer of the project	- Prospects and problems of RE: Example through Japan Grass Root Grant
10/12/2002	UNDP (Mr. Bishnu B Silwal, Project Manager of Micro-Finance, U Hla Phyu Chit)	- Prospects and problems of UN micro-credit for the purpose of rural electrification
10-11/12/2002	U Khun Kyaw, Microhydro Expert	- Prospects and problems of RE: Example through VEC self funding and local micro-hydro expert
13/12/2002	Tokyo Mitsubishi Yangon Office (Telephone Interview with local staff)	- Prospects and problems of financial options from private banks for the purpose of RE (not possible)
2003/02/16-17	MEPE Kalaymyo Office & ZiChaung Power House (U Aung Thit, MEPE Kalay Township Head Officer)	- MEPE Kalymyo Office Financial Aspects
20/02/2003	Mr. Kitamura (JICA Myanmar Economic Restructuring Program Coordinator)	- View and proposals of JICA Economic Restructuring Program on financial options of villagers and MEPE tariff/Power Sector restructuring
24/02/2003	U Kyaw Aye (DyCE, Operation Dpt. of MEPE)	- Sedimentation of Nam Wop Hydropower Station
24/02/2003	Mr. Ebashi (JICA Myanmar Economic Restructuring Program Coordinator)	- Economic condition of Myanmar, Electricity, tariff system of MEPE, and Rural electrification
28/02/2003	U Soe Tint Aung, MIC	- Load adjustment and operation of Rice Husk Gas Engine

Source: JICA Study Team

2.2.7 Technology and Know-how Transfer

(1) Seminar Held on 7 December 2002

A seminar was held on 7 December 2002 on the following themes:

1. Time 8:00 to 12:00 a.m. on 7th December, 2002 (Saturday)
2. Place Lecture Room, Main Gate Building 1st Floor

3. Agenda 8:00-8:10 a.m. ····· Opening by DyCE U Soe Myint Lwin

8:10-8:40 a.m. ····· Rural Electrification Policy by Mr. A. Katayama

8:40-9:10 a.m. ····· Site Selection for Monitoring by Mr. H. Kanai

9:10-12:00 a.m. ···· Governor by Mr. R. Sudo

(2) Lecture on Design of Crossflow Turbine

Mr. Sudo presented a lecture on the basic design of the Crossflow turbine in Taunggyi on 23 Nov. 2002 and in Yangon on 9 Dec. 2002.

(3) Seminar Held on 26 December 2002

Another seminar was held on 26 December 2002 on the following themes:

1. Time 13:00 to 15:00 p.m. on 26th December, 2002 (Thursday)
2. Place Office of JICA Study Team, MEPE 1st Floor
3. Agenda 13:00-14:30 ····· Issues on O&M of Zi Chaung Power Station, including video for introduction of new method of sand flushing presented by Mr. A. Katayama & H. Kanai

14:30-14:50 ····· Outline of Manual presented by Mr. A. Katayama

14:50-15:00 ····· Outline of Database presented by Ms. Y. Nakagawa

(4) Joint Meeting Held on 26 February 2003

A joint meeting of findings of the second monitoring of Zi Chaung Power Station was carried out on 26th February 2003 on the themes shown below:

1. Time 10:00 to 12:00 a.m. on 26th February, 2003 (Wednesday)
2. Place LDC Meeting Room
3. Agenda 10:00-10:20 ····· Agenda and introduction of the Study by Mr. A. Katavama

10:20-10:50 ····· Monitoring of generating equipments (O&M manual, air activated water level gauge, Water leakage from turbine casing, pressure oil unit, and organization for O&M) by Mr. A Katayama

10:50-11:20 ····· Monitoring of waterways (intake, leveling and hydraulics around intake, discharge measurements, and sand flushing using Saxophone) by Mr. G. Hane

11:20-11:40 ····· Summary of the institutional aspects by Mr. R. Harris

11:40-12:00 ····· Financial Aspects by Mr. K. Yamaguchi

(5) Joint Meeting Held on 24 June 2003

A joint meeting of findings of the third monitoring of Zi Chaung Power Station was carried out on 24th June 2003 on the themes shown below:

1. Time 10:00 a.m. to 14:30 p.m. on 24th June, 2003 (Tuesday)
2. Place LDC Meeting Room
3. Agenda
   - 10:00-10:20 ····· Opening Speech by Dr. Sann Oo
   - 10:20-10:40 ····· Proposed RE policy & issues by Mr. A. Katayama
   - 10:40-11:00 ····· Institution and Organization by Mr. K. Yamaguchi
   - 11:00-11:30 ····· Outline of Manual by Mr. A. Katayama
   - 13:00-13:20 ····· Turbine Efficiency Test by Ms. Y. Nakagawa
   - 13:20-13:50 ····· Waterway System by Mr. G. Hane
   - 13:50-14:10 ····· Financial Aspects by Mr. K. Yamaguchi
   - 14:10-14:30 ····· Database by Ms. Y. Nakagawa

2.2.8 Final Workshop to Present Draft Final Report

The Final Workshop was held to present the Draft Final Report on August 5, 2003. The counterpart team appreciated the Study inclusive of the Guideline and the Manual as presented in the Minutes of Meeting (refer to Annex-2.2.6) and the themes are shown below:

1. Time 10:00 a.m. to 16:00 p.m. on 5th August, 2003 (Tuesday)
2. Place Mindon Room, 2F, Sedona Hotel, Yangon
3. Agenda
   - 10:00-10:20 ····· Opening Address by Dr. Thein Tun (DEP), Dr. Sann Oo (MEPE), Mr. Y. Iwata (EOJ) and Mr. T. Sasaki (JICA)
   - 10:20-11:20 ····· Study Outline by Mr. A. Katayama
   - 11:20-11:40 ····· Institutional Aspects by Mr. R. Harris
   - 11:40-12:00 ····· Social and Financial Aspects by Mr. K. Yamaguchi
   - 13:30-13:45 ····· Outline of Manuals by Mr. A. Katayama
   - 13:45-14:00 ····· Monitoring and Manual of Waterway by Mr. G. Hane
   - 14:00-14:45 ····· Visual Guide by Mr. A. Katayama incl. experience of Myanmar expert
   - 15:00-15:40 ····· Development Projects by Mr. A. Katayama & Ms. Y. Nakagawa
   - 15:40-15:55 ····· Database by Ms. Y. Nakagawa
   - 15:55-16:00 ····· Closing Address by Mr. A. Katayama

It is noted that the counterpart team informed the Study team that it had no comments on the Draft Final Report by letter on 22nd August 2003 (refer to Annex-2.2.7), requesting the Study team for finalization of the Report.

CHAPTER 3 BRIEF EXPLANATION OF THE REPORTS

This chapter was prepared to present a brief overview to the Main Report, Supporting Report, Visual Guide, and Database, some of which are also multi-component.

3.1 Main Report

The main report consists of: (i) Study outlines, (ii) Guidelines for rural electrification, (iii) Manual for sustainable small hydros, and (iv) Development plan of priority projects.

3.1.1 Study Outlines

The Study outlines, the content is presented at the beginning of this report, i.e. in Sub-Section 1.1 General.

3.1.2 Guidelines for Rural Electrification

The guidelines for rural electrification in Myanmar were prepared to suggest necessary measures for how rural electrification in Myanmar can be proceeded.

First of all, the Guidelines describe the results of investigations on the present conditions of rural electrification in Myanmar, of which the major items are the electrification ratio of the urban area, that of the rural area, and the main sources of electric power in the rural areas.

The Guidelines then summarize the renewable energy potential and prospects for rural electrification in Myanmar. Based on such an understanding and the prospects for rural electrification as investigated and analyzed, it examined the minimum target for rural electrification that 166 village tracts with about 350,000 people be electrified for lighting purpose every year with renewable energy. This would improve the electrification level by 1.2% per year.

Further, the Guidelines present a strategy consisting of two basic approaches to rural electrification in Myanmar, i.e. (i) the Government Schemes that implement full scale rural electrification on a 24 hour basis by extending distribution lines from the interconnected and isolated grids, and (ii) Village Schemes that aim at providing lighting for 5 hours a day and that should be implemented on a self-help basis by villagers. Also, it presents the Social Schemes that provide battery lighting with solar or wind power to those villages in the remote areas that have little potential for hydro power or rice husk power and are situated far from the grid.

Finally, the Guidelines suggest the measures necessary for achieving rural electrification: (i) organizational measures such as establishment of a section of rural electrification (SRE) in MEPE, (ii) implementation of Government Schemes, (iii)

official recognition of Village Schemes, (iv) implementation of capacity building for construction, operation and management of rural electrification projects, and (v) financial support for Social Schemes.

3.1.3 Manual for Sustainable Small Hydros

The manuals were prepared through planning and designing the priority projects as well as monitoring the existing Zi Chaung small hydropower station, locating in Kalaymyo, Sagaing Division. The manuals consist of: (i) O&M manual for small hydros, (ii) Design manual for small hydros, (iii) Design manual for village hydros, and (iv) Institutional and financial aspects. A brief introduction to each manual follows:

(1) O&M manual for small hydros

This manual is dedicated to operators and maintenance staff of small MEPE hydropower stations. The scale of installed capacity for "small" hydropower stations is assumed at 50 kW to 1,000 kW per unit. The Manual covers (a) organization and rules, (b) operation manual, (c) inspection, maintenance and repair, and (d) maintenance and repair of civil works.

(2) Design manual for small hydros,

The design manual for small hydros is intended to serve engineers of MOEP and maintenance staff of small hydropower stations of MEPE. The station scale would be in a range of 50 kW to 10,000 kW. It presents (a) investigation and planning, (b) design of civil structures, and (d) design of hydro- and electro-mechanical equipment.

(3) Design manual for village hydros,

The design manual for village hydros is intended to serve those MEPE engineers who design and construct small Village Hydro electrification schemes having a unit capacity smaller than 50 kW. This design manual would be useful also to people and organizations in the private sector who support or undertake the design and construction of electrification schemes with Village Hydro.

(4) Institutional and financial aspects

It is prepared to illustrate the organizational structure and role of the proposed RE Section to be attached to the Transmission and Distribution Department of MEPE. It also contains procedures for the 16 tasks of the proposed RE Section.

3.1.4 Development plan of priority projects

The Development Plan for the priority projects was prepared to select the Pilot Project to be implemented and monitored as part of the Study.

The 14 identified schemes were evaluated according to the Selection Criteria proposed in the Guidelines and were composed of seven (7) hydropower schemes, four (4) biomass schemes, two (2) solar-wind BCS schemes and the rehabilitation of small hydropower plants. Eventually the following three schemes were selected as the Priority Development Projects:

- Electrification Plan of Nyaung Shwe Township by Heho Small Hydro
- Electrification Plan of Nam Lan Township by Mini Hydro
- Lighting of Sama Lauk Village by Rice Husk Gas Engine

Out of these three candidates, the Nam Lang scheme was jointly selected by the JICA team and the MEPE counterpart team as the Pilot Project to be implemented and monitored as part of the Study. However, it was finally decided not to implement the Nam Lang scheme as Nam Lang Township would be electrified in 2005 by extending transmission lines from Hsipaw where a new Grid substation will be erected connecting Shweli power station (200 MW) and Mandalay.

Accordingly, another Minutes of Meeting was exchanged between the JICA S/W mission and MOEP in August 2002 (refer to Annex-2.2.1). It was confirmed to select one of the existing small hydropower stations of MEPE and to monitor it for preparation of Operation and Maintenance Manual.

3.2 Supporting Reports

The Supporting Reports were prepared to supplement: (i) the manuals for sustainable small hydros; (ii) the subjects of institutional/socio-economics, and (iii) the subjects of renewable energy such as biomass power, solar and wind power**,** and inspection memos.

3.3 Visual Guide

A Visual Guide was prepared copture the essence of the guidelines and the design manual for village hydros targeting villagers who wish to electrify their villages on a self-help basis. It provides; (a) Selection of renewable energy sources suitable to villages, (b) What are Village Hydro, Rice Husk Gas Engine, Solar and Wind Power ?, (c) Visual manual for Village Hydro, and (d) Technical references.

3.4 Database for Rural Electrification Using Renewable Energy Sources

The Database for Rural Electrification using Renewable Energy Sources was established as part of the Study. It contains output of the Study such as guidelines, manuals, data and information collected through the Study that may be referred to in

promoting rural electrification using renewable energy such as project reports, references, and catalogues. It consists of electronic files, a search system, and a HTML viewer with hyper links to files.

CHAPTER 4 CONCLUSIONS AND RECOMMENDATIONS

The opportunity exists to make a significant improvement to the current low level of electrification in the rural areas of Myanmar by establishing the institutional capacity to promote, fund, implement, co-ordinate and monitor a long term RE programme comprising Government and Village RE schemes using appropriate sources of renewable energy. The Study provides several of the key tools needed to support such a programme.

Myanmar is blessed with abundant renewable energy of hydropower potential, biomass (rice husk, wood chips, etc.), and solar power. Moreover, Myanmar has its own unique technology such as manufacturing and construction of Village Hydros smaller than 50 kW, biomass gas engine, technology for battery lighting and market for battery recycling. These resources and technologies can be used to facilitate low cost Village Schemes that would be affordable to many of the villages in Myanmar.

It is recommended that the following measures be taken to accelerate and sustain the rural electrification in Myanmar:

- To appoint MEPE as ***Champion for Rural Electrification*** and establish a ***Section of Rural Electrification (SRE)*** attached to the Transmission and Distribution Department of MEPE;
- To rehabilitate existing small hydros and diesel generators owned and operated by MEPE;
- To implement, as *Government Schemes*, full scale rural electrification for 24 hour supply by (i) constructing new small hydros in remote areas, and (ii) extending distribution lines to areas nearby existing Grids after reinforcement of generating capacity by the ongoing generation expansion projects;
- To endorse and encourage *Village Schemes*;
- To study the establishment and management of a ***Rural Electrification Fund*** and ***Completion Guarantee System*** to support implementation of *Village Schemes*;
- To implement ***Capacity Building*** for the design, construction, operation and management of rural electrification projects;
- To financially support *Social Schemes*.