No.

Japan International Cooperation Agency (JICA)

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 7 Supporting Report

Institutional/Socio-Economics

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

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

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List of Volumes

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
IOE	Institute of Economics of Myanmar
ITC	Irrigation Technology Centre, Irrigation Department
JICA	Japan International Cooperation Agency
MADB	Myanma Agricultural Development Bank
MAPT	Ministry of Agricultural Products and Trade
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
MSTRD	Myanma Scientific and Technological Research Department
NCEA	National Commission for Environmental Affairs
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
VPDC	Village Peace and Development Council
YIE	Yangon Institute of Economics
YIT	Yangon Institute of Technology

Government Administration

Division/State

Township

Quarter

Village Tract

Village

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

kVA	kilo Volt ampere
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)
Yen	Currency unit of Japan (Yen)

Others

BCS	Battery Charging Station
FS	Feasibility Study
HRD	Human Resource 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

Exchange Rates

US$ 1.00 = K500 = Yen 120 (May 2001)
US$ 1.00 = K1,000 = Yen 120 (May 2003)
unless otherwise specifically noted

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Part 7-1	**Institutional Study**
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Chapter 1 Introduction

This report covers the work of the Institutional Expert over the period January 2001 to August 2003. Over this period a total of seven assignments were made in Myanmar and two inputs were made in the home office in Tokyo. Details of the input schedule are given in the table below:

Table 1 Project Inputs by the Institutional Expert

Dates	Location of input	Main work
6 - 21/1/01	Home office (Japan)	Document review and meetings with JICA
22/1 – 6/3/01	Myanmar	Data collection, meetings Yangon, field trips, social survey, documenting findings
6/6 – 5/7/01	Myanmar	Field trips, meetings Yangon, data analysis, conceptualising Guidelines
29/9 – 10/10/01	Myanmar	Drafting Guidelines. Preparing for and participating in Workshop with MEPE
11 – 21/10/01	Home office (Japan)	Supporting Report A. Progress Report 1
4 – 15/3/02	Myanmar	Field trips to biogas schemes. Preparing for and participating in Workshop with MEPE
31/1 – 1/3/03	Myanmar	Field trip to monitoring project. Conceptualising Manual. Progress Report 2
17/5 – 21/6/03	Myanmar	Preparation of the Manual and updating / finalisation of the Guidelines and Supporting Report (Institutional)
3 – 9/8/03	Myanmar	Final workshops / presentations to MEPE.

The input commenced with the project preparation task which was carried out in association with other team members in Tokyo and included meetings with JICA.

A summary of all of the work undertaken to date follows.

Preparatory work in Tokyo

Review of project documents, assistance with completion of the Inception Report and drafting of the initial presentation to the client on the Inception Report / study implementation concept.

Data collection in Yangon and related meetings

Data has been collected on existing legislation and the relevant organisations considered to be stakeholders or part of the main institutional framework linked to the project's objectives.

A list of documents collected and referred to is included in Annex 1.

The studies have involved meetings with officers and staff from:

- Ministry of Electric Power (MOEP):
  - Myanmar Electric Power Enterprise (MEPE)
  - Department of Electric Power (DEP)
- Ministry of Agriculture and Irrigation (MOAI)
- Ministry of Progress of Border Areas and National Races and Development Areas (MPBANRDA)
  - Department of Progress of Border Areas and National Races (PBANRD)
  - Department of Development Affairs (DDA)
- Ministry of Energy (MOE)
- Ministry of Science and Technology (MOST)
  - Yangon Institute of Technology
- Ministry of Cooperatives (MOC)
  - Cooperative Department
  - Cottage Industries Department
- Ministry of Forestry (MOF)
- Ministry of Foreign Affairs (MOFA) – National Commission for Environmental Affairs (NCEA)
- Peace and Development Council (at Township level)
- Myanmar Agricultural Produce trading (MAPT)
- Renewable Energy Association Myanmar (REAM)
- Myanmar Electric Light Cooperative Society Ltd. (MELCS)
- Myanmar Inventors Cooperative Ltd. (MICL)
- Alatchaung Trading Cooperative Ltd. (also acts as a Village Electrification Association)

All meetings have been formally recorded.

Main tasks

Study tasks have included: conceptualising the key document deliverables from the studies (the Guidelines and the Manual), drafting and making presentations to the Client / counterparts of the proposals for same, developing and drafting the institutional component of the Guidelines following interviews and data collection in Yangon and on field trips, developing and drafting the institutional component of the Manual and preparing the Supporting Report (Institutional).

Presentations prepared by the Institutional expert comprised:

- Jan 01 – Inception Report
- Feb 01 – Role of the Guidelines and Manual
- Jun 01 – Status of the institutional task

- Oct 01 – Organisational and institutional aspects of RE
- Mar 02 – Updated presentation on the Guidelines and the Manual
- Feb 03 – Institutional and financial aspects at the end of the 7^{th} Field Assignment
- Jun 03 – Key issues related to the institutional aspects
- Jun 03 – Organisational aspects of the manual
- Aug 03 – Summary of the institutional findings and recommendations

Field trips

5 field trips were participated in as follows:

1. North Shan State from 7^{th} to 12^{th} February 2001

Participated in the Team tasks comprising:

- 4 village surveys, interviews of 4 MEPE Township Engineers,
- inspection of 3 MEPE diesel powered generating stations,
- brief inspection of 2 potential mini hydro-power project sites,
- interview of one VEC
- interview of a successful cooperative syndicate representing 8 primary cooperatives (together with the responsible regional officers from the Ministry of Cooperatives).

2. South Shan State from 25^{th} Feb. to 2^{nd} March 2001

Participated in the team tasks comprising:

- 5 village surveys,
- interviews of 5 MEPE Engineers (representing State, Division, Township and Village level organisations),
- inspection of 2 potential mini hydro-power project sites,
- interview of one VEC,
- interview of a successful cooperative.

3. Ayeyarwaddy Division on 12 June 2001

Inspection of a village electrification systems using a rice gasifier as the power source and interviews of VEC representatives.

4. Central Dry Zone + South Shan State from 21 to 25^{th} June 2001

Participated in Team tasks comprising:

- 3 village surveys,
- interview of 5 VECs,
- interview of TPDC,
- interviews of 4 MEPE Engineers (representing State and Township level)
- inspection of 3 existing micro hydro-power village electrification schemes,
- inspection of existing village electrification scheme using solar power plus two solar powered drinking water supply pumping schemes.

5. *Kalay town, Sagaing Division - Monitoring of Zi Chaung hydro from 16th to18th of February 2003.*

Assessment of the institutional and organisational situation regarding this existing MEPE small hydro and the additional operational responsibilities of the MEPE Township Engineer.

Findings from the field trips and investigations

The key findings from these field trips are included in Annexes 2 and 3.

The findings from all of the initial investigations referred to above are set out in the subsequent sections of this report and form the basis of the institutional proposals included in the draft Guidelines and the Manual.

Chapter 2 Existing institutional and legal framework

2.1 Overview

The Union of Myanmar is composed of 7 states in the border areas (total population* 13 million) and 7 divisions in the central area (total population* 33.5 million).

Table 2 Approximate Populations in the States and Divisions

Name of State	Population* (millions)	Name of Division	Population* (millions)
Kachin	1.20	Bago	4.85
Kayah	0.24	Sagaing	5.18
Kayin	1.40	Tanintharyi	1.27
Chin	0.46	Manadalay	6.19
Mon	2.34	Yangon	5.30
Rakhine	2.61	Ayeyarwady	6.44
Shan	4.63	Magway	4.30

* 1997 figures from CSO's 2000 report

There are some 324 townships in the states and divisions. The State Law and Order Restoration Council (SLORC) has held all executive powers for the Union of Myanmar since 1988. In 1997 the SLORC was renamed the State Peace and Development Council (SPDC).

The Head of State is the Chairman of the SPDC. The other main members are the Vice-chairman and 3 Secretaries. The SPDC controls all organs of state power.

Each township has its own Township Peace and Development Committee.

There are many ministers, the Prime Minister and Minister of Defence, three Deputy Prime Ministers, the Office of the SPDC Chairman and a total of 32 Ministries in the Myanmar Government (see Table 2 overleaf).

Table 3 List of Ministries in Myanmar

	Name of Ministry
1	Ministry of Defence
2	Ministry of Military Affairs
3	Ministry of Agricultural and Irrigation*
4	Ministry of Industry (1)
5	Ministry of Industry (2)
6	Ministry of Foreign Affairs*
7	Ministry of National Planning and Economic Development
8	Ministry of Transport
9	Ministry of Labour
10	Ministry of Co-operative*
11	Ministry of Rail Transportation
12	Ministry of Energy*
13	Ministry of Education
14	Ministry of Health
15	Ministry of Commerce and Trade
16	Ministry of Hotel and Tourism
17	Ministry of Communications, Posts and Telegraphs
18	Ministry of Finance and Revenue
19	Ministry of Religious Affairs
20	Ministry of Construction
21	Ministry of Science and Technology*
22	Ministry of Culture
23	Ministry of Immigration and Population
24	Ministry of Information
25	Ministry of Progress of Border Areas and National Races and Development Affairs*
26	Ministry of Electric Power*
27	Ministry of Sports
28	Ministry of Forest*
29	Ministry of Homes Affairs
30	Ministry of Mine
31	Ministry of Social Welfare, Relief and Resettlement
32	Ministry of Livestock Breeding and Fisheries
33	Ministry of Chairman Office of S.P.D.C
34	Ministry of Prime Minister
35	Attorney General's Office

* Ministries currently having some involvement with renewable energy applications and / or rural electrification

Myanmar (where 75% of the population live in rural areas) has the lowest % of village populations with access to electricity in SE Asia.

Table 4 Level of Electrification in Rural Areas – SE Asian Countries

Country	% of total electrified villages	% of total rural population with access to electricity
Bangladesh	23	9
India	87	83
Iran	52	N/A
Laos	13	2
Myanmar	**<10**	**N/A**
Pakistan	50	37
Philippines	68	N/A
Sri Lanka	36	20

Source: ESCAP 1995-6 N/A =Not available

There is limited private sector involvement in the sector in Myanmar, there is no central regulatory body and there are no consumer representative groups. In the context of promoting rural electrification using renewable energy sources (e.g. mini hydro, biomass, solar and wind power) the main stakeholders are perceived to be:

- Rural communities / Consumers
- Various ministries
- Cooperatives
- NGOs
- Private sector
- Funding agencies
- Local banks
- Contractors / fabricators
- Village Electrification Committees (VECs)
- Research and development organisations
- External advisors / Consultants

From an "institutional" point of view the key organisations within these stakeholders can be reviewed as 3 main groups i.e.:

- Ministries and their associated enterprises
- NGOs and Cooperatives
- VECs

These 3 groups are therefore discussed further in the following sub-sections.

2.2 Ministerial involvement in RE / renewable energy

Many ministries are involved in the 4 renewable energy sub-sectors under consideration by our study as shown in 2.1. The main ministries / enterprises organisations currently having some involvement with rural electrification and / or the promotion of the use of renewable energy sources in Myanmar are:

- Ministry of Electric Power (MOEP)
  - DEP
  - MEPE (the Executive body for this Study)
- Ministry of Progress of Border Areas & National Races & Dev't Areas (MPBANRDA)
  - PBANRD
  - DDA
- Ministry of Cooperatives
- Ministry of Agriculture and Irrigation
- Ministry of Energy
- Ministry of Science and Technology
- Ministry of Forestry
- Ministry of Commerce and Trade
- Ministry of Foreign Affairs / National Commission for Environmental Affairs

Of these, the main ones involved are MOEP (through MEPE) and MPBANRDA. The two ministries have already been jointly involved on several projects in the border areas. The funding for these projects has come from MPBANRDA, while MEPE has provided the engineering / O & M services.

A summary of the key aspects of the ministries listed above follows.

Ministry of Electric Power

Up until 2002 the Ministry of Electric Power (MOEP) consisted of the Department of Electric Power (DEP) and the Myanmar Electric Power Enterprise (MEPE). The structure of the Ministry was changed in 2002 following the creation of a new department – the Department of Hydro Power.

The revised departmental structure of the MOEP is shown in Figure 1:

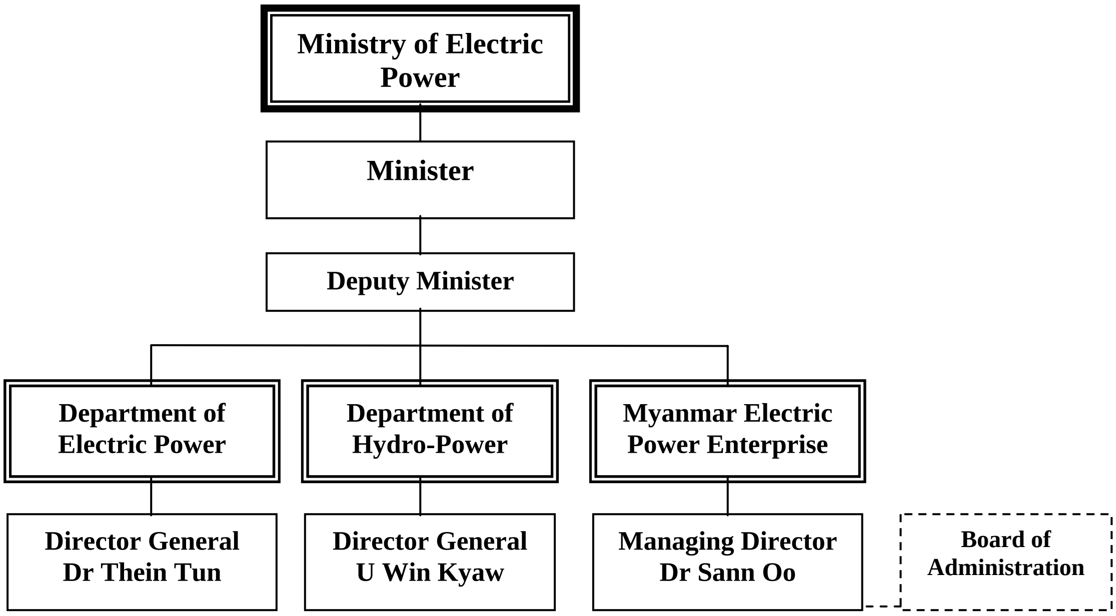


Figure 1 Ministry of Electric Power – Departmental structure (post 2002)

MOEP was established following Government reorganisation in November 1997 when MEPE was transferred from the Ministry of Energy (MOE). The planning function previously carried out by MOE's Energy Planning Department was split in two. The national energy planning function remained with MOE and the power planning function was transferred to DEP. MOEP / MEPE focus on power distribution only.

DEP

DEP carries out all normal functions of a ministry department and also has a key planning role. The departmental structure is shown Figure 2.

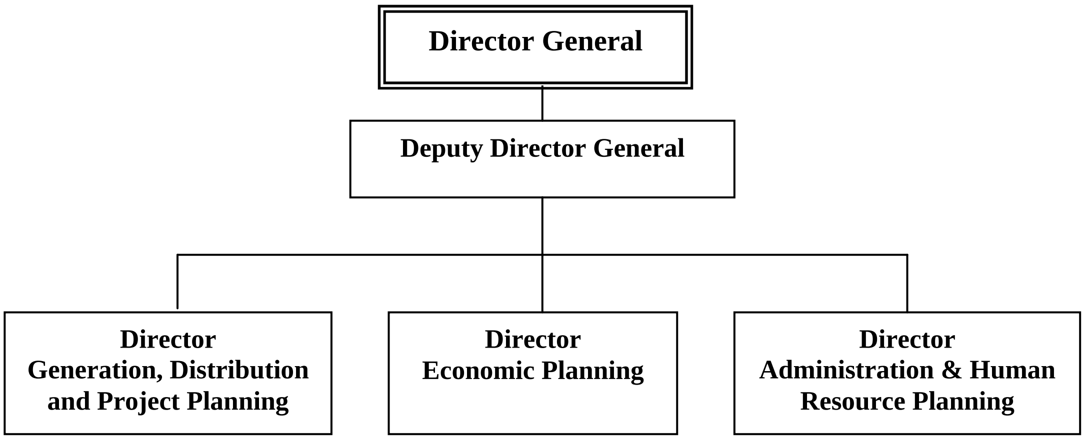


Figure 2 DEP – Departmental Structure Showing Directorates

It was relevant to the study to clarify the role of DEP in relation to Independent Power Producers (IPPs) and the linkage with Myanmar Investment Commission (MIC) in the approval process for such schemes.

Early in the study, two IPPs were being processed by the DEP. One was in the Golden Triangle in East Shan State - a steam powered plant of 12 MW total capacity (2 x 6MW units). This proposal had been approved in principle. The other was in Kachin State and was the first hydro power IPP proposal - a 6MW scheme at Don Ban Chaung. The private sector company involved intends to supply both industry and the township.

The government is concerned about the affordability aspects of IPP schemes on the part of the consumers since they often use diesel as the fuel source and the relatively high cost of this fuel has to be recovered. The government tries to ensure tariffs are close to the national norm and this is a problem to achieve given the foregoing.

There about 8 to 10 IPPs already in operation nation wide and often the tariff for these has not been approved by DEP. It has, instead, been approved by the Town Council.

An IPP proposal / application must first be submitted to the DEP for comment / approval on technical and tariff grounds. According to the State Owned Enterprise Law the application can then go to the Cabinet direct. However the cabinet may wish the Myanmar Investment Commission (MIC) to review and approve the appplication.

MEPE

MEPE was established 1989 and is managed by a board of 9 directors. The total number of employees was 16,526 in 2000. MEPE was restructured in 2002 in parallel with the restructuring of MOEP. The original and revised structures are shown overleaf in Figure 4 and Figure 5. There are now seven departments in MEPE as follows:

- Administration
- Finance
- Materials Planning
- Planning
- Thermal power stations
- Hydro electric power stations
- Transmission and distribution

In addition there is the Managing Director's Office. MEPE is responsible for generation, transmission, distribution, billing and collection, planning and implementation of electricity for the whole of the country. MEPE is also the Executive body for this study.

MEPE has 17 regional offices, 8 in the Divisions and 9 in the States.

The MEPE regional structure is shown in Figure 3.

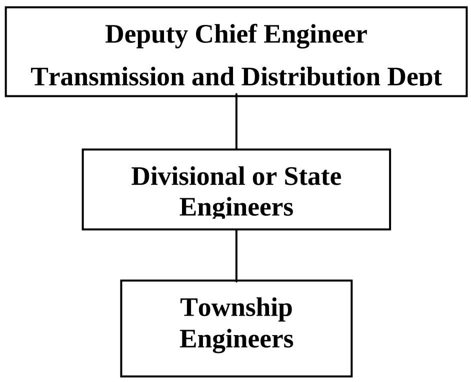


Figure 3 MEPE – Regional Structure

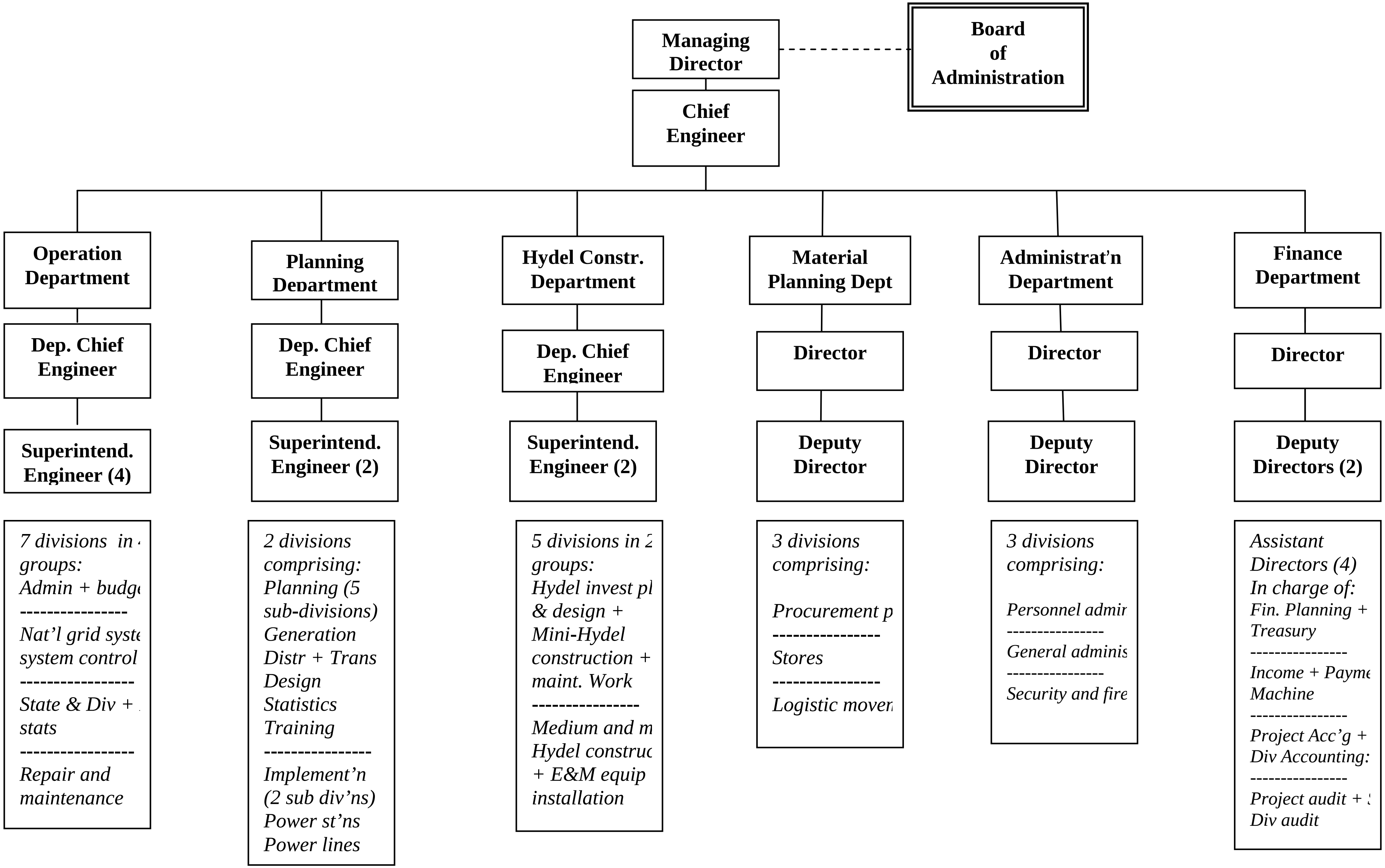


Figure 4 MEPE organisational structure up to 2002

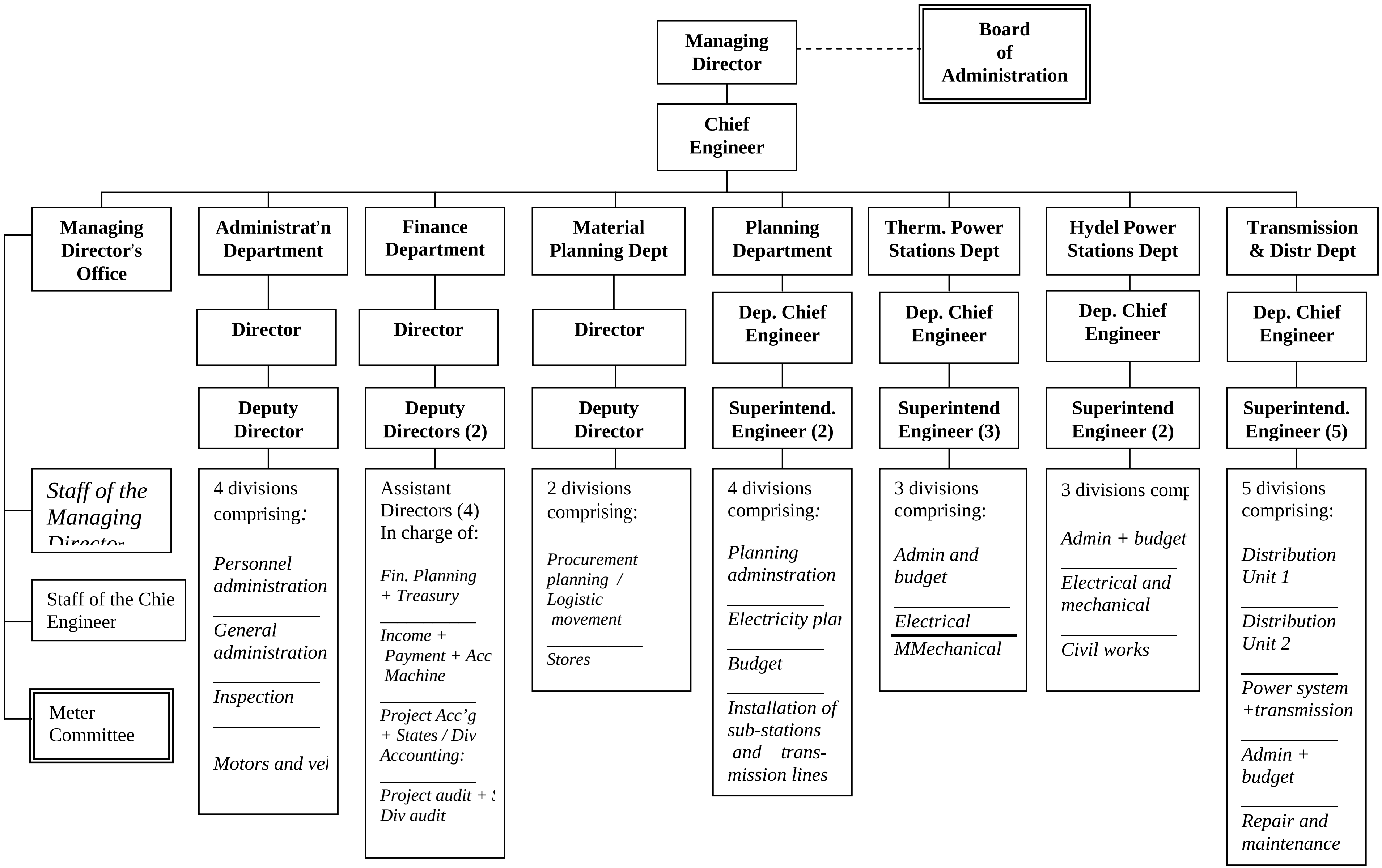


Figure 5 MEPE latest organisational structure following restructuring in 2002

The 8 MEPE regional offices in the Divisions are located at:

- Ayeyarwady
- Bago
- Bago S
- Magway
- Mandalay
- Sagaing
- Tanintharyi
- Yangon

The 9 MEPE regional offices in the States are located at:

- Chin
- East Shan State
- Kachin
- Kayah
- Kayin
- Mon
- Rakhine
- Shan (1)
- Shan (2)

The organisational structure of a typical MEPE regional office is shown in Figure 6.

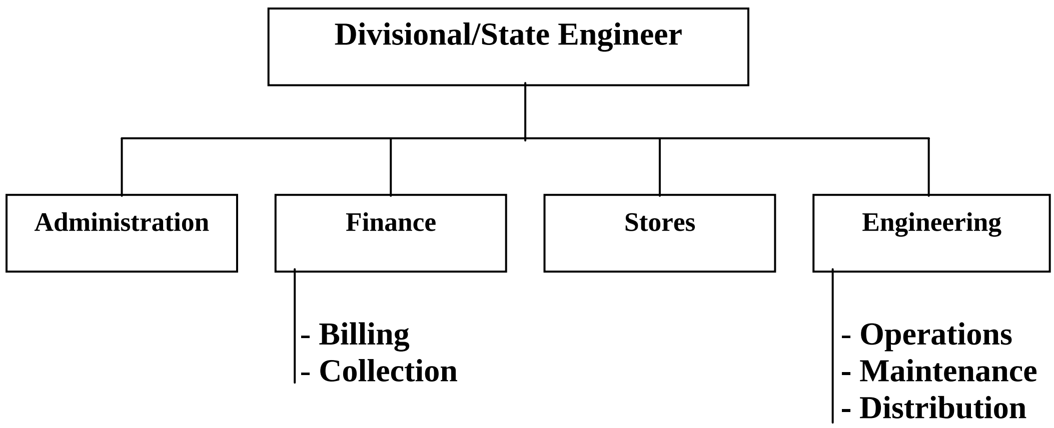


Figure 6 MEPE – Typical Regional Office Structure

MEPE currently has a small team at their HQ in Yangon dealing with a minor programme of small scale Village RE projects (usually diesel powered) in the Border Areas. Project funding is provided by MPBANRD. MEPE normally carries out the operation and maintenance work.

It is recommended that the team’s work should be integrated within the proposed RE Section in MEPE (described later) and a strategy followed to seek more use of renewable energy as the power source for future schemes.

Ministry for Progress of Border Areas and National Races and Development Areas

The Ministry promotes the development of rural areas through two departments:

- Progress of Border Areas and National Races Department (PBANRD)
- Department of Development Affairs (DDA)

PBANRD co-ordinates all development in the Border Areas which cover 7 States and 2 divisions. DDA covers 284 Townships. The areas that are outside of the remit of the two departments are those covered by YCDC and MCDC (the development committees for the cities of Yangon and Mandalay which comprise 31 and 5 townships respectively).

PBANRD has a budget allocated to it, whilst DDA runs on its own budget which it raises from taxes on the Townships. PBANRD manages 18 sub committees (which normally meet quarterly) dealing with different sectors including energy. The sub-committees are chaired by the Deputy Minister of the relevant line Ministry. The energy sub-committee has the MD of MEPE as the secretary.

PBANRD has implemented power generation / rural electrification schemes using diesel engines and MEPE implemented them on their behalf (funded from PBANRD's budget).

This Ministry is a key component of the institutional framework that relates to the implementation of rural electrification schemes in the rural areas and particularly so in the case of the Border Areas.

The organisational structure of this Ministry is shown in Figure 7 overleaf.

Ministry of Agriculture and Irrigation

The Ministry structure includes 5 enterprises and a bank (which gives seasonal credits to farmers plus medium term loans for buying implements) as well as various ministry departments. Myanmar Agriculture Service is effectively the "Department of Agriculture" in normal ministry terms.

The Agricultural Mechanisation Department is already involved in some relevant technology transfer e.g. the improved efficiency stoves, solar power and biogas.

The Ministry have been involved in some integrated rural development but the focus was on improving agricultural productivity and did not include infrastructure development. The Ministry has a network of regional offices down to village level.

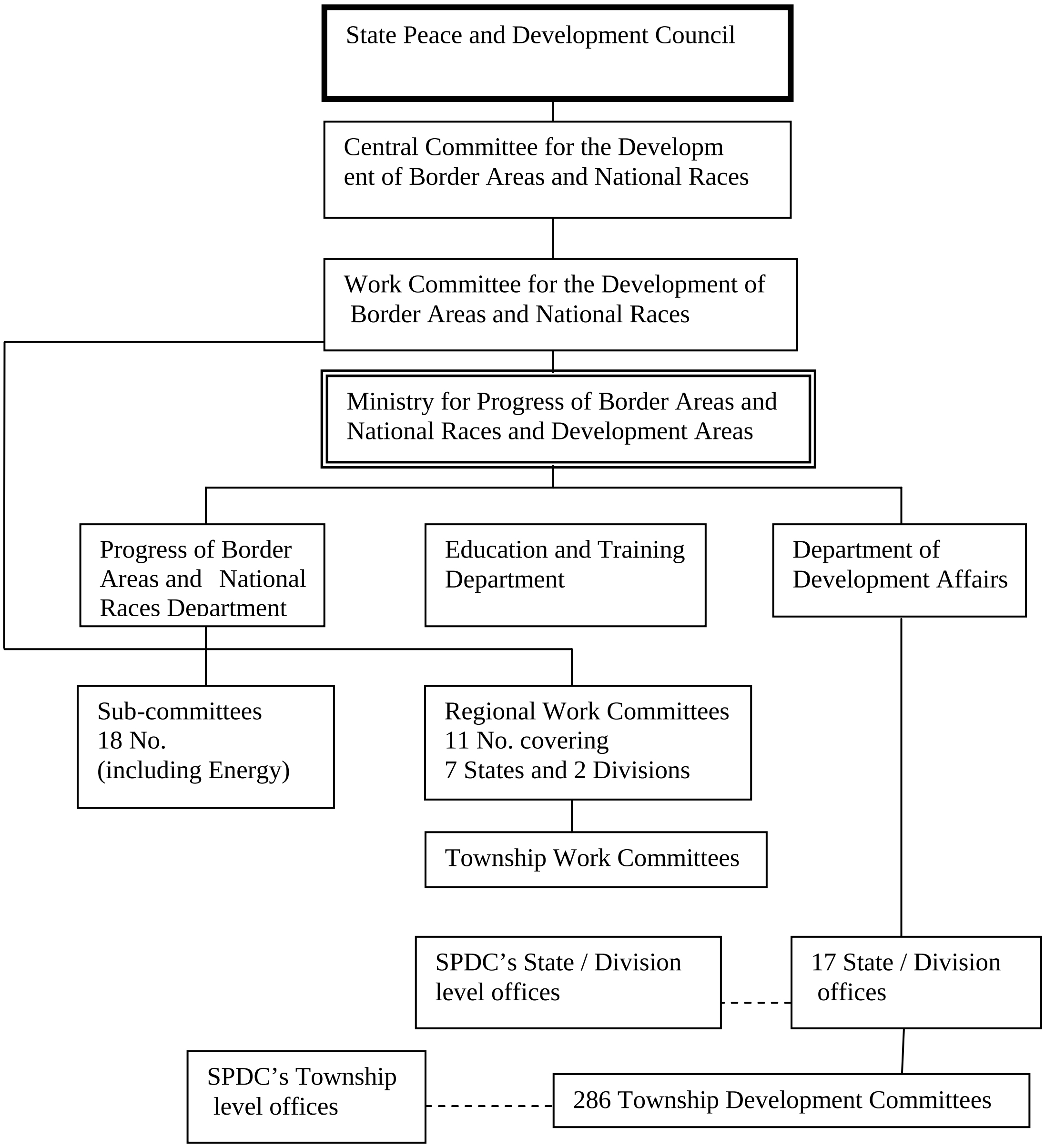


Figure 7 MPBANRDA organisational diagram

Ministry of Energy

The Ministry of Energy manages oil and gas and has one department and 3 enterprises as follows.

- Energy Planning Department (EPD)
- Myanmar Oil and Gas Enterprise (MOGE)
- Myanmar Petroleum Enterprise (MPE)
- Myanmar Petroleum Products Enterprise (MPPE)

MOE sits on 2 important international committees related to energy, one of these is for ASEAN energy sector cooperation. This committee has been working in 6 sectors including renewable energy and currently wants to identify projects to implement in the member countries.

MOE has a central role regarding all forms of energy and act as a data depository and in future could provide feedback on the development and outcome of work on renewable energy to the committee for ASEAN energy sector cooperation.

Ministry of Science and Technology

The Ministry of Science and Technology (MOST) were the counterpart agency for the United Nations ESCAP project on the commercialisation of renewable energy. MOST has 5 main departments. The Ministry is based in Yangon and carries out any work in the regions through the technical institutes.

There are 9 research departments under the Myanma Scientific and Technological Research Department (MSTRD).

The Physics and Engineering Research Department (PERD) is the main research department and they have been involved in wind and solar energy work.

For biomass they developed and tested a gasifier that worked with paddy husk and distributed it to farmers. PERD's work on solar energy goes back 20 years and includes solar cookers, dryers, water heaters and distillation plants.

The departmental structure of this Ministry is shown in Figure 8 overleaf.

*Ministry of Forest*ry

The Ministry of Forestry are strongly promoting fuel wood substitution and were doing research on using biomass for power generation but have now ceased these research activities and have no plans to restart them.

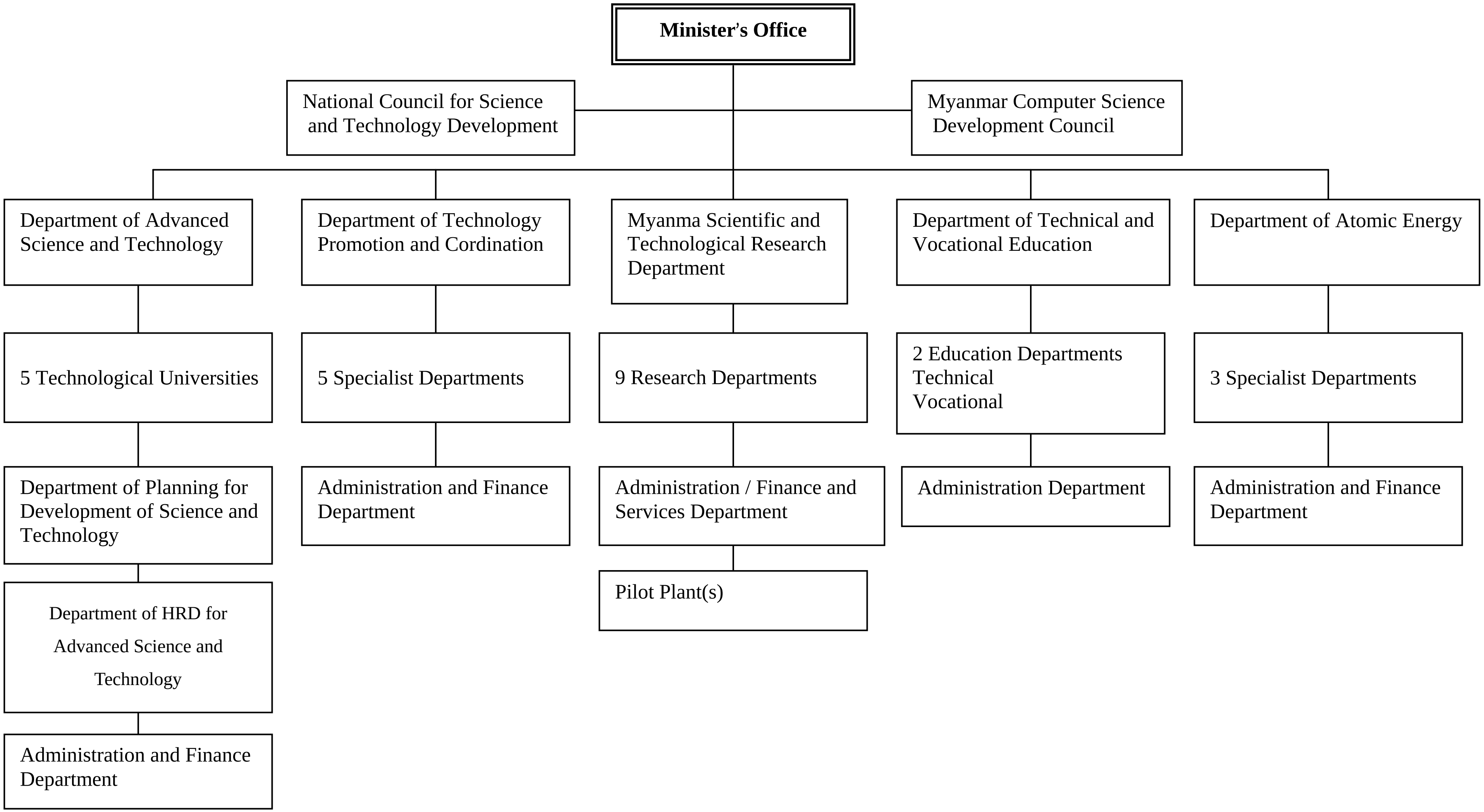
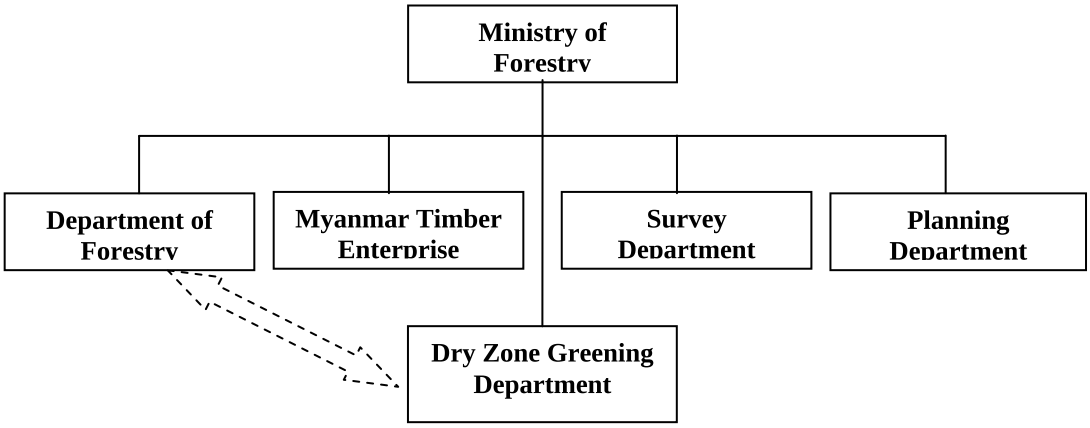


Figure 8 MOST – Departmental structure

The departmental structure of the Ministry of Forestry is shown in Figure 9 below.



(Staff come from Department of Forestry)

Figure 9 Ministry of Forestry – Departmental Structure

Ministry of Commerce and Trade / Myanmar Agricultural Produce Trading

Myanmar Agricultural Produce Trading (MAPT) is a state owned enterprise under the Ministry of Commerce and Trade and is the only enterprise under this Ministry. There are also 2 departments under the Ministry.

MAPT's 67 mills produce 5071 tons of rice per day. Nationwide there are in addition 499 privately owned mills that are contracted with MAPT and another 1035 privately owned mills (total = 1601). The total production of all the mills in the country is 16,727 tons per day. In other words the 67 MAPT mills represent approximately 30% of the national production capacity whilst they own only 4% of the actual total number of mills in the country.

9 of MAPT's 67 rice mills have Power Generation Units (PGUs). All PGUs develop power for the sole use of the mill complex and this can include the staff quarters within the compound. The 9 mills with PGUs are mostly in lower Burma (because this region is the "rice bowl"). Current power production is only sufficient to meet the mill's own needs but it was agreed that if the efficiency of the PGUs could be increased then the surplus power could be "exported" (e.g. sold to the national grid or to nearby households / premises).

Ministry of Foreign Affairs / National Commission for Environmental Affairs

The main responsibility for the environment is with the Commission on Environmental Affairs which comes under the Ministry of Foreign Affairs. Environmental law is currently spread across many acts but it is planned to be consolidated under a new Environmental Law. There are also proposals to establish a Ministry of Environmental Affairs in the near future. A key document on environmental matters is Agenda 21.

Ministry of Cooperatives

This is an old Ministry (the first cooperatives were established in 1904) and has 25,000 staff nationwide. The new cooperative law was introduced in 1992. It was more market orientated and left behind the socialist ideals.

Government subsidies to cooperatives with soft loans ceased. They now have to rely on their shareholders alone. There are some 18,000 cooperatives in Myanmar.

The Ministry has a Cottage Industry Department which has upper and lower Burma offices (in Mandalay and Yangon). This department provides technical assistance to the cooperatives / NGOs and has had links with JICA.

The departmental structure of the Ministry is shown in Figure 10 and the main functions of cooperatives is shown in Figure 11.

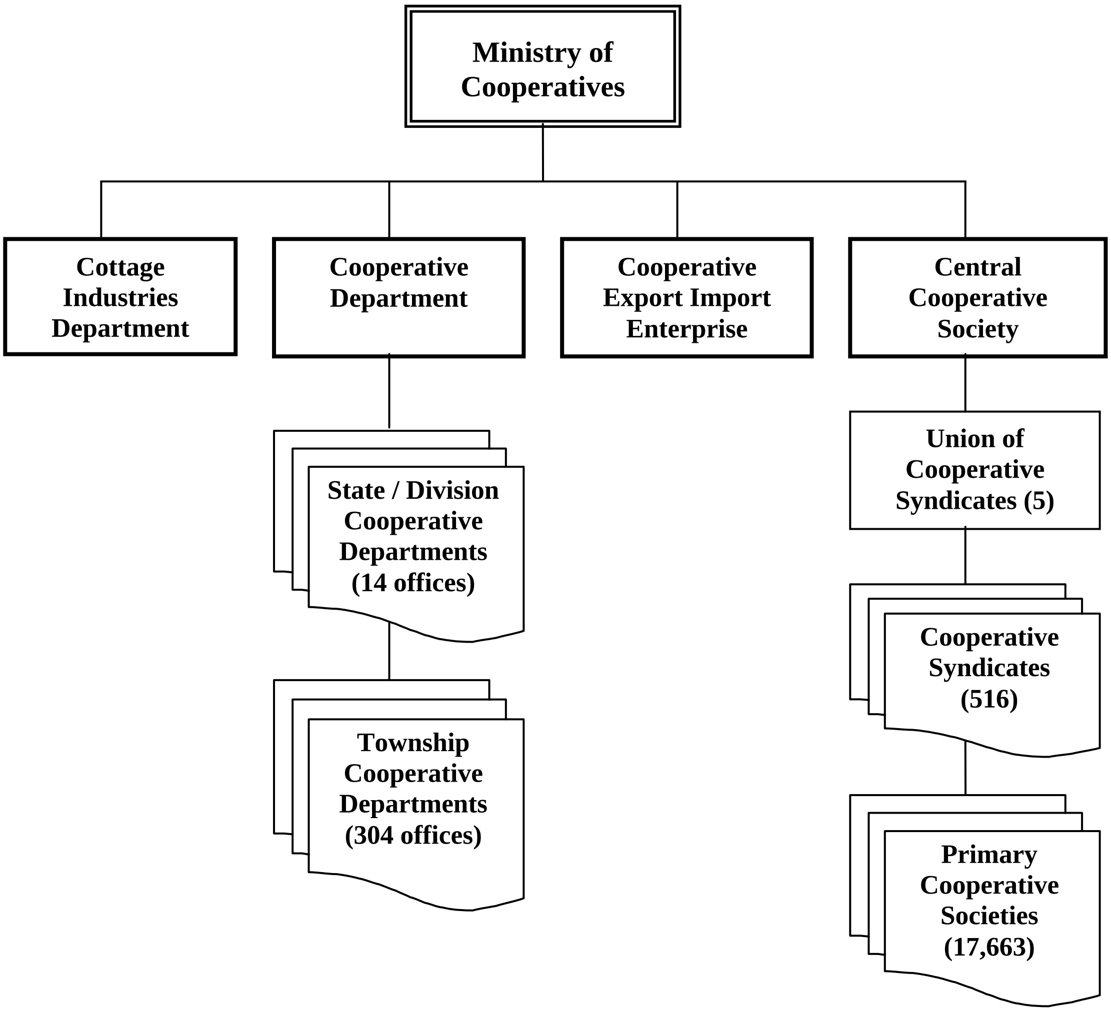


Figure 10 Ministry of Cooperatives – Departmental Structure

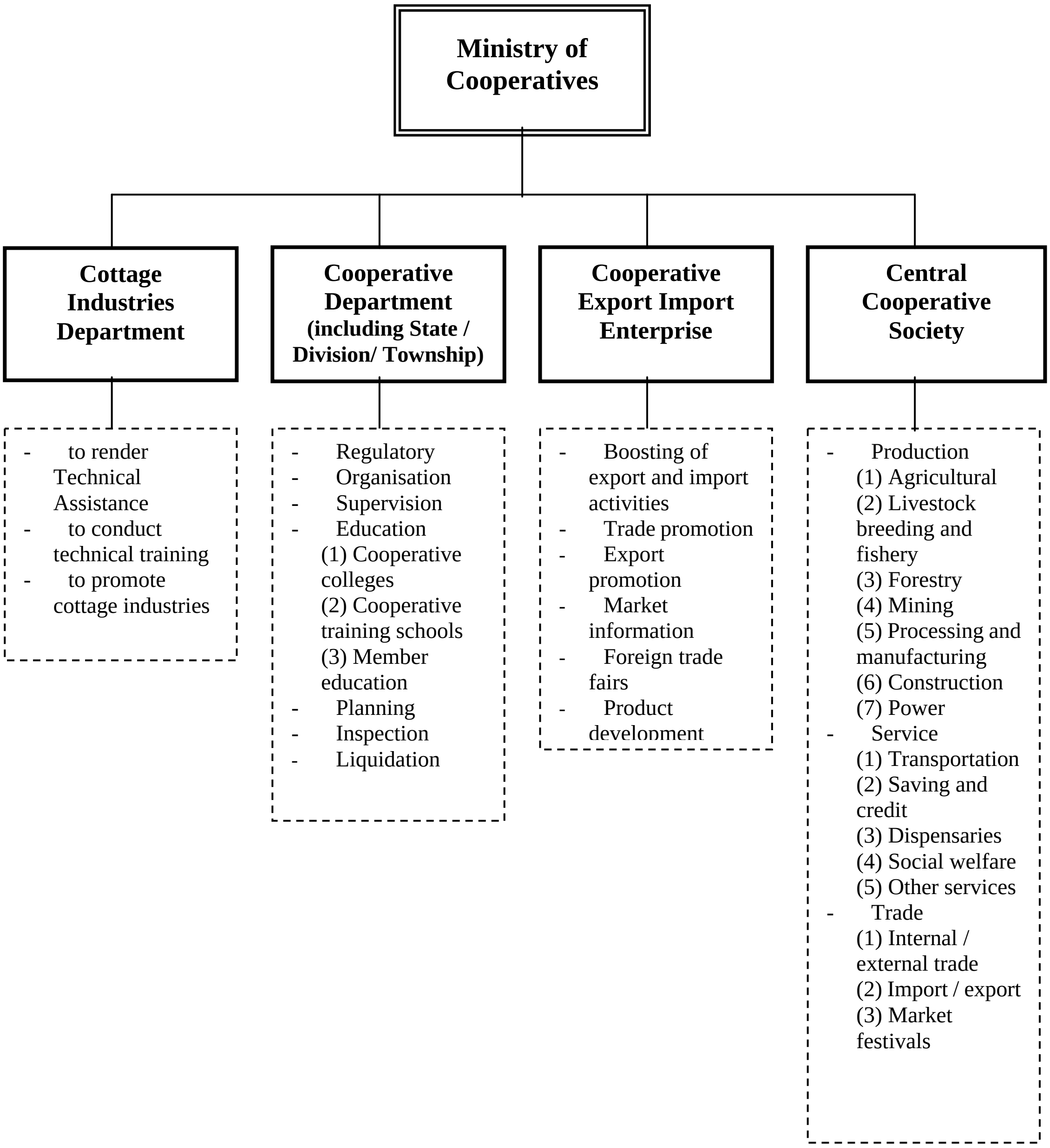


Figure 11 Main Functions of Cooperatives in Myanmar

2.3 NGOs and cooperatives

The only NGO found to be active in the sector is Renewable Energy Association Myanmar (REAM). Examples of cooperatives already active in the sector are:

- Myanmar Electric Light Co-operative Society (MELC)
- Myanmar Inventors Co-operative Ltd. (MICL)
- Sein Pann Industrial Co-operative Ltd. (SPICL)

MELC acts as a retailer of electrical goods and also carries out some small scale power supply installation services either as a sub-contractor to MEPE or independently. MICL and SPICL prefabricate components for renewable energy projects e.g. gasifier equipment (MICL), turbines & pipework (SPICL). A few VECs are cooperatives.

More details of the key organisations referred to here follow.

NGO – Renewable Energy Association Myanmar

In 1993 the Government started a programme to encourage people to find alternative sources of energy and reduce the use of fuel-wood and it subsequently became apparent that a central group was needed. The Renewable Energy Association Myanmar (REAM) was therefore established but although it purports to be an NGO it does not appear to have been formally registered with the Ministry of the Home Office in accordance with the Association Law of Myanmar.

REAM has been focussed in 3 areas:

- Reducing the energy problem in rural areas
- Conserving the environment
- Developing the rural areas

REAM has provided 3 main services in relation to renewable energy. These are as follows:

- Information collection / dissemination
- Education related to different technologies and their use
- Communication as a means of support during project implementation

REAM claims to have 38 individual members and 6 company members. REAM have were recently involved in a “hybrid wind / solar power” project and a micro-hydro scheme (5kW) in the dry zone in central Myanmar with community participation. REAM facilitated the establishment of a co-operative. The windmill / generator used in the former project was locally made.

Three co-operatives have links with REAM: (1) Solar Energy Co-operative Ltd. (2) Emerald Green Co-operative Ltd. (3) Dry Land Development Co-operative Ltd.

When REAM worked on a solar project with UNDP / MOE a cooperative was also set up and a private bank was persuaded to lend to the cooperative (banks in Myanmar do not in principle lend to the poor without collateral.

REAM has produced several training packages. Training is normally carried out by their members. The organisational structure of REAM is shown in Figure 12

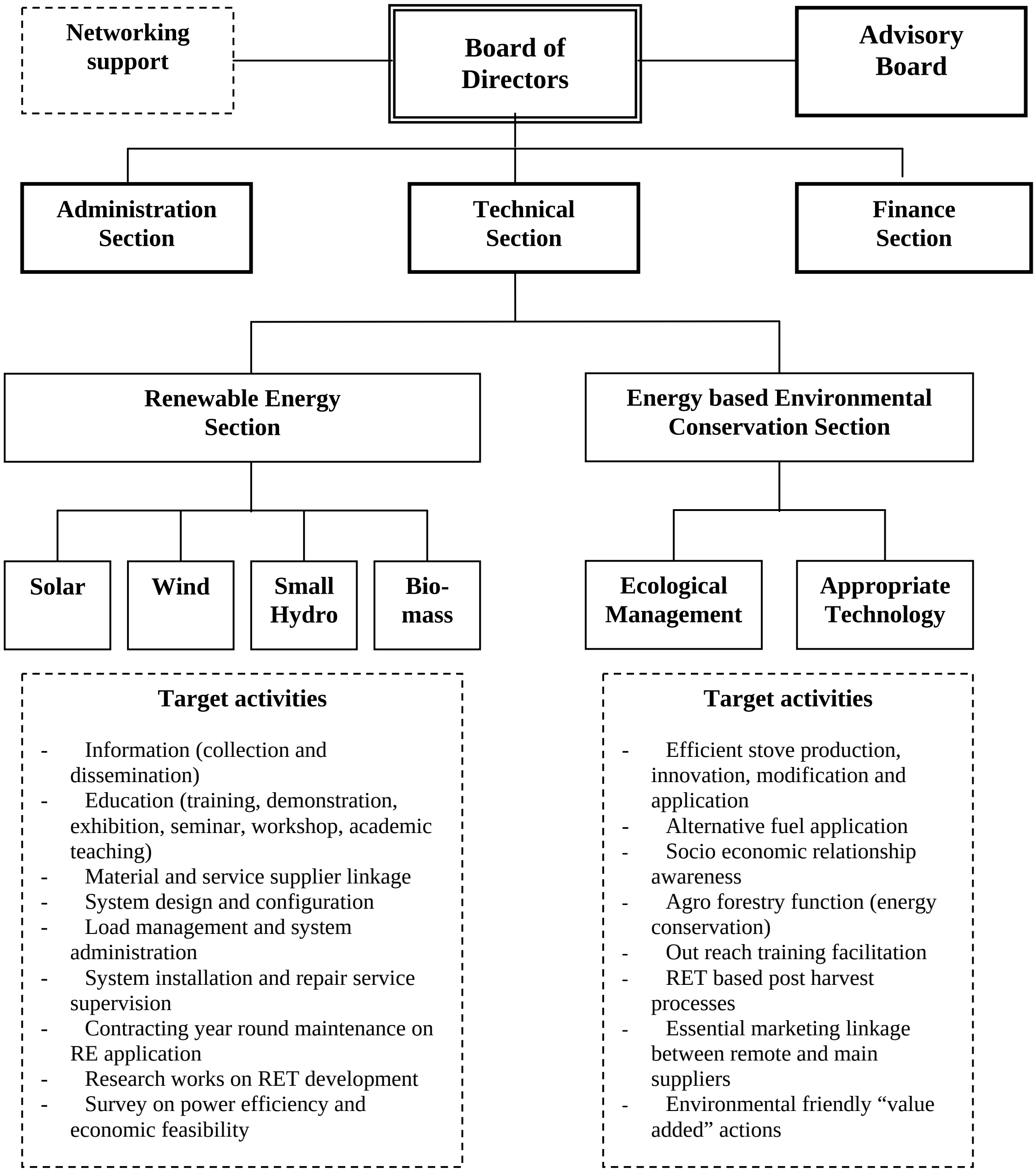


Figure 12 REAM Organisational Diagram Showing Main Activities

Myanmar Electrification Co-operative

MELC is the only cooperative of it's type currently operating in the power sector and was founded in 1994 for the benefit of MEPE staff. MELCs headquarters is located adjacent to MEPE's office in Yangon.

The Board of Directors has 15 members and there are 7,000 members / shareholders (99% are existing MEPE staff or pensioners). MELC has 50 permanent staff and made a profit of K100 million last year. The rest of the staff are temporary and hired on an "as needed" basis.

MELC are a trading and contracting entity e.g. they sell electrical goods, make RC posts and do all the same construction / installation work as MEPE (i.e. small / medium contract work for transmission / distribution) and provides design / planning services.

The work is for other Ministries and private sector. Sometimes MELC work with or as a sub contractor to MEPE.

MELC recently worked with TEPCO (from Japan) on a rural electrification project linked to a mini hydro plant (50kW) serving 450 households in Shan State. The project is nearly finished. MELC plan to do the O & M and billing / collection (in conjunction with the Village Council).

The structure of the heirachy of MELC is shown in Figure 13.

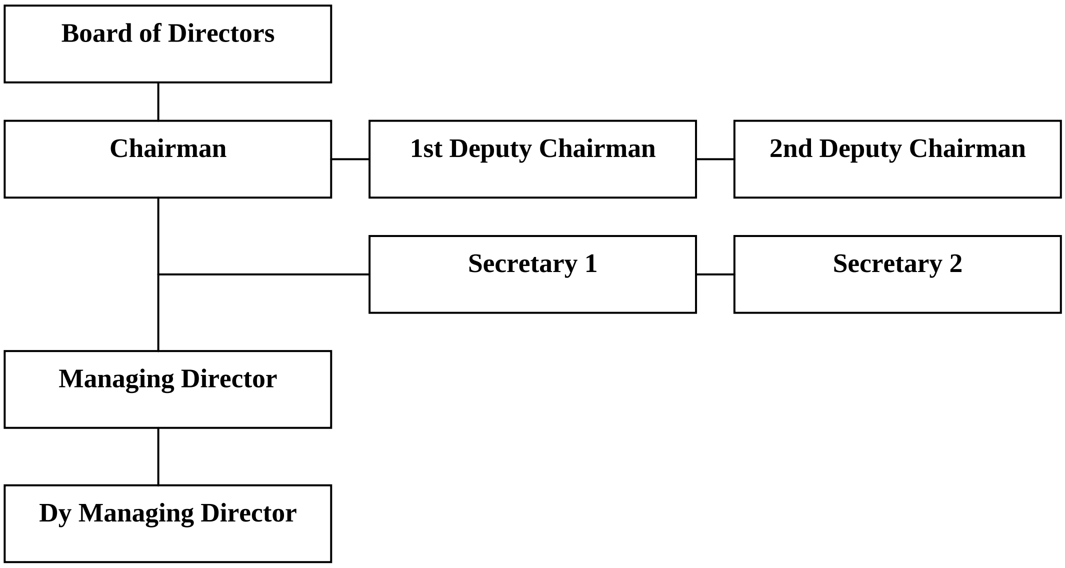


Figure 13 MELC – Senior Management Structure

Myanmar Inventors Cooperative Ltd.

MIC is a commodity production type of cooperative society. They are involved in an RE programme in Ayeyarwady Division and are supplying 30 power generation units. 2 units are allocated per township (15 No.) on a normal basis of one per village in the township. The area is 4 hours drive from Yangon.

Their units work on methane gas produced from rice husk. The units have Japanese engines and all other components are locally manufactured. Smallest unit of engine plus generator (20 KVA) costs K1 million. The largest costs K5.8 million.

100W is allowed per household. Villagers are raising the funds (K30,000 per household). There is said to be no problem in raising this sum and villagers appear willing to pay 2 times this amount. Villages are expected to set up committees to run the schemes. The charging structure was not finalised at the time of the inspection – there appeared to be an intent to charge K25 per unit.

2.4 Village Electrification Committees (VECs)

Many VECs already exist and are operating mini hydro, biomass and solar powered schemes (as well as schemes taking a bulk supply from the National Grid). Sometimes they are linked to the VPDC, some are cooperatives and others are just organised groups. Some common aspects can however be noted, i.e.:-

- No standard structure
- No standard rules and regulations (sometimes none)
- Generally able to establish equitable tariffs
- Committed to serve the community
- Most are voluntary staffed

VECs are the key organisations in respect of self-help RE schemes and the members of several were therefore interviewed. The findings are presented as case studies in Section 3.

Small scale applications of renewable energy to provide RE are already apparent in the many parts of Myanmar. The schemes include mini-hydro, biomass and solar power. They are mostly operated by VECs.

RE plays a key role in reducing / counteracting the “rural – urban divide”. The benefits explained during the interviews of the VECs are shown to be:

- Increased standard of living
- Improved security and hygiene
- Higher educational achievement
- Improved water supply through ability to pump
- Improved economic output from cottage industries (people able to work in the evenings)
- Cheaper than diesel generated power
- Environmentally friendly concept

2.5 Policies and plans

Policies

The State has laid down 12 political, economic and social objectives in its endeavours to establish a peaceful modern and developed nation. Three of the economic objectives are:

- Development of agriculture as the base and all round development of other sectors of the economy as well
- Proper evolution of the market-orientated economic system
- Development of the economy inviting participation in terms of technical know-how and investments from sources inside the country and abroad

The National Energy Policy is to:

- maintain the status of energy independence
- employ hydroelectric power as one vital source of energy sufficiency
- generate and distribute more electricity for economic development
- save non-renewable energy for the future energy sufficiency of our nation
- promote efficient utilisation of energy and impress on energy conservation
- prevent deforestation caused by excess use of fuel-wood and charcoal

MOEP's documented aims reflect the above and specifically include:

"promoting electricity production from new and renewable sources of energy".

Two of MOEP's objectives which are most relevant to this study are to:-

(a) To identify all the hydropower sources in Myanmar and conduct feasibility studies.

(b) To utilise internal expertise and equipment as well as imported machinery to develop mini hydropower.

Plans

The UN's ESCAP report "Commercialisation of renewable energy technologies for sustainable development", which involved MOST as the counterpart body, found that a cohesive national plan for research, development and implementation of renewable energy technologies did not appear to exist in Myanmar and neither did an integrated national energy planning programme.

An Energy Master Plan for Myanmar was prepared by ECFA / JGC Corporation in February 1998. The report is mainly focussed on petroleum and petroleum products but does contain some information on biomass / other forms of renewable energy and on energy policy of Myanmar. The report makes reference to an earlier ECFA report prepared in association with JDI in 1995 entitled "Comprehensive study on sustainable development for Myanmar". The latter covers many sectors including power and recommends the implementation of a number of projects across these sectors. One recommended project involved the updating of the power sector review carried out by the World Bank in 1992.

MOEP formulates electric power development plans through DEP. In the last Electric Power Development Plan the capital investment priority was given to the central electric power system for city and industrial areas.

Projects proposed by MEPE and the new Department of Hydro Power need approval by DEP and the overall process involved within MOEP is shown in Figure 14.

MOEP prepared a 20 year plan in 1995 but this is now superseded. A 5 year plan was prepared at the same time but did not included anything specifically for RE.. The latest 5year plan of DEP (2001 – 06) also does not include anything specifically for RE.

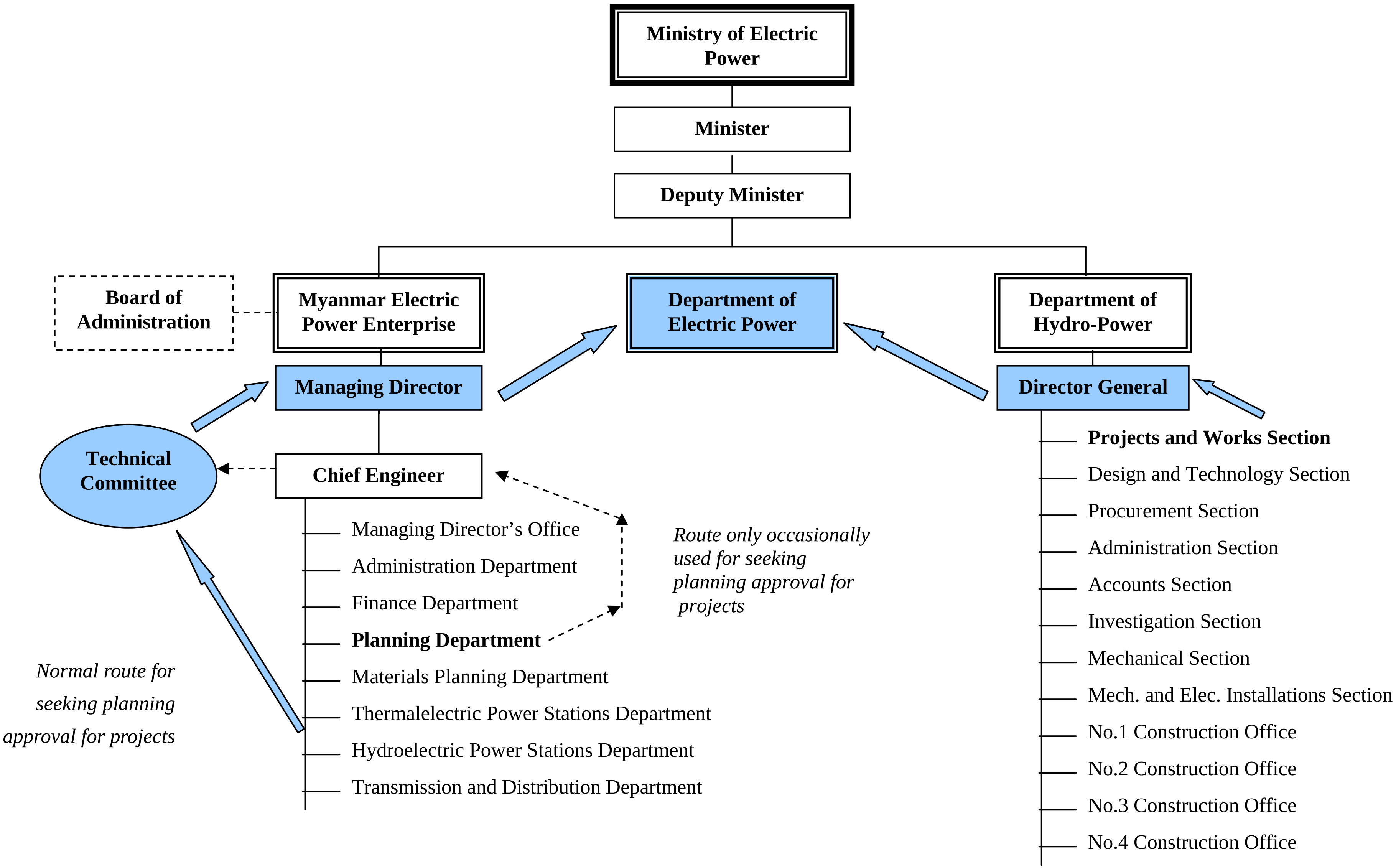


Figure 14 MOEP – project planning approval process

2.6 Training facilities

Existing training facilities and arrangements in the sector are as follows:

MEPE

Training within the MOEP is one of the responsibilities of the Planning Directorate in DEP. There is no training college or a department to serve MEPE and no HRD department. The training is carried out by DEP and MEPE staff in a large room at the rear of the compound dedicated to training.

There are two “general orientation” training courses each year and it is for junior engineers and covers engineering, finance and management. Each course lasts for 3 months and is full time. Normally there are between 50-60 participants selected by the Divisional Engineers.

No training is given to finance staff (apart from induction training at the Government Staff College– see below).

Renewable Energy Association Myanmar (REAM)

REAM have produced several training packages. Areas covered by their training packages have included:

- Community education
- Solar panel systems
- Technician training
- Fire-wood substitute / fuel efficient stoves

MOST / MSTRD

This Ministry through one of their key R & D departments is able to offer “technology related” training.

Ministry of Cooperatives

Training is available from the Cottage Industries Department.

Universities

Most have HRD departments and provide courses for internal and external students.

Government Staff College / Phaung Gyi

Provides a form of induction training for government staff of different levels following their entry into government service. (One college is in Yangon and another in Mandalay). Courses are full-time and of 3 to 4 months duration.

All staff have to have attended this course which covers administration, finance, engineering, politics and government rules and regulations.

External (0ffshore) training arrangements / organisations

In addition to “in-house” training, many MEPE staff at different levels have gone abroad for training under sponsorship schemes (e.g. JICA).

Relevant courses for key managers are available regionally. An example of an institution offering these is The Asian Institute of Management (AIM) – Manila, Philippines.

The AIM offers degree and non-degree-training programs in development management which include subjects areas of special interest, such as strategic planning and development master planning.

One relevant module is the Program and Project Development and Management (PPDM), an intensive four-week course designed to develop the operational skills needed in each phase of the project cycle, as well at the strategic skills required to integrate and package projects into effective and sustainable programs.

The PPDM course sets out to develop effective managers by equipping them with skills, tools, and techniques needed to manage the cycle from conceptualization and design, to implementation and evaluation.

2.7 Existing legal framework

Legislation, regulations and bye-laws obtained (translated when required) and reviewed includes:

- The Electricity Law 1984
- The State-Owned Economic Enterprises Law 1989
- The Co-operative Society Law 1992
- Promotion of Cottage Industries Law 1991
- The Co-operative Society Rules 1998
- Co-operative Society Model Bye-law – For commodity production type of societies
- Co-operative Society Model Bye-law – For service type of societies
- Rules and regulations of VECs
- Myanmar Electric Light Co-operative Society Ltd. Bye-law

The only law / decree related to electric power supply is the Electricity Law 1984 which has remained unchanged since its enactment.

Environmental impact assessments should be made in conjunction with all infrastructure development including renewable energy projects. At the present time environmental law is spread across many acts but it is planned to be consolidated under a new Environmental Law (now in final draft form).

The main responsibility for the environment is currently with the National Commission on Environmental Affairs which comes under the Ministry of Foreign Affairs. There are proposals to establish a Ministry of Environmental Affairs in the near future.

A key document on environmental matters and the promotion of sustainable development is Agenda 21.

There are 2 types of regulations covering MEPE activities:

- Ministry of Industry’s regulations
- MEPE’s in house regulations

The Ministry of Industry’s regulations do not deal with the O & M aspects of the different power generation technologies related to the various forms of renewable energy usage now under study for RE applications.

The overall scope of the nine main sections of these regulations is as follows:

1. Definitions
2. Permits for power generation, transmission and generation
3. Procedures for operating power generation, transmission and generation systems
4. Procedures for operating in hazardous areas
5. Procedures related to lifts, escalators and electric vehicles
6. Procedures related to the qualifying and working arrangements of skilled electricians
7. Procedures for inspecting electrical equipment
8. Procedures for inspection staff
9. Dealing with compensation

Section 2, Chapter 3, Clause 18 of the Ministry of Industry's regulations covers the procedure for issuing permits for electricity generation. This is an important aspect in the context of isolated power supply systems in rural areas. Once issued these electricity production permits last for 4 years.

The specified limits of production are shown in Table 5:

Table 5 Electricity Production Limits for Various Types of Permit Holders

Type of permit holder	**Production limit**
MEPE	Unlimited kW
The Defense Units and Factories under Ministries	Unlimited kW
Cooperative Associations	750 kW
Private businesses	300 kW
Other associations	Up to 500 kW

In the past there were 3 books of in house regulations used by MEPE:

- Administration
- Engineering
- Finance

These regulations are also very old, sometimes not evident in regional offices, voluminous and in need of review, revision / updating and reissue.

In summary, the existing legal framework is shown in Figure 15.

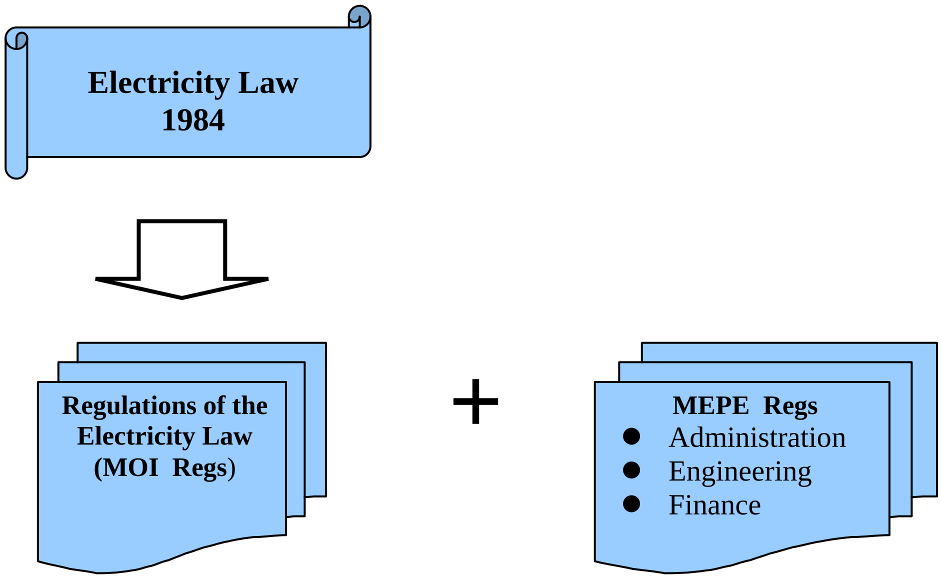


Figure 15 Existing Legal Framework

VECs are generally informal organisations formed to fulfil the local need linked to some form of RE scheme. Some have developed their own rules and regulations but there is no national model for same.

It should be noted that cooperatives are established in accordance with the The Co-operative Society Rules 1998 and the Co-operative Society Model Bye-laws. Very few of the existing VECs in Myanmar are formally established as cooperatives.

2.8 Strengths and weaknesses

Given the foregoing a summary of the strengths and weaknesses in the existing arrangements to provide rural electrification (RE) are:

Strengths

- Some work already ongoing (based on renewable energy sources) / benefits of RE evident
- Already examples of entrepreneurship innovation and private sector involvement (and funding)
- Willingness and ability to pay for the service
- Communities agreeable to participate / self fund
- Myanmar has abundant renewable energy resources
- Appropriate renewable energy technologies exist
- Skills to design and build systems exist
- Geography / topography / demography suited to isolated power supply systems
- Co-operative system exists and already involved in the sector

Weaknesses

- National Grid cannot meet existing demand and therefore cannot be extended to serve rural areas
- This situation is unlikely to change in the medium term
- No apparent ownership of the problems of meeting the RE need
- Many ministries / organisations involved but no central co-ordination
- No comprehensive RE policy / no targets or significant budget
- Lack of funding / credit facilities
- No champion for RE using renewable energy
- More research and development needed
- Many of the renewable energy project materials /equipment are not available in Myanmar
- Poor maintenance has affected sustainability of some existing renewable energy projects
- There is a lack of general awareness from grass roots through to government level of the potential of using renewable energy for RE
- Not enough publicity of achievements to date
- No formal structure for existing VECs

Chapter 3 Case studies

3.1 Existing small hydro power scheme of MEPE

Originally the project was going to focus all Phase 2 outputs on feedback / experience of implementing a pilot project. Owing to a change of plan the project outputs will be based on the monitoring of an existing (and representative) small hydro scheme of MEPE. After a selection procedure involving MEPE management, the scheme at Zi Chaung scheme serving Kalay town in Sagain Division.was chosen.

In order to review the institutional aspects related to this scheme, a field trip to Kalay town was made in February 2003. A detailed questionnaire was prepared by the Institutional Expert and progressively completed during the field trip following interviews with the MEPE Township Engineer and key members of his staff. A copy of the completed version is included in the Annex 3 to this Report.

The MEPE Township Engineer's staff are responsible for the two main sources of power supply to Kalay town.

- Zi Chaung hydro scheme – built 1996 – installed capacity 1,260kW
- Kalay town diesel power station – 3 units - installed capacity 1,788kVA

In terms of the O and M of the small hydro power scheme at Zi Chaung it should first be noted that it is now working at a much lower efficiency than when installed in 1996 and has a significantly reduced output. If it could develop full power it would meet 66% of the current needs (peak demand) of Kalay town. It can however only generate 900 kW which is just under 50% of the peak demand. The shortfall in power supply is met by a MEPE thermo-electric power station with 3No. diesel engines / generators (2No. of which are now quite old).

An operational constraint is that the output from all these power sources cannot be fully combined / synchronised.

The main difficulties with the current O & M arrangements can be listed as follows:

- No separation of the operation and maintenance roles
- No preventive maintenance
- Lack of special tools
- No manuals for all main items of plant
- Inadequate holdings of spare parts
- Long delays by MEPE HQ in approving purchase major items of spares

There appears to have been an inadequate hand-over from the Chinese contractor on the Zi Chaung scheme at the time of plant commissioning and apart from a few drawings no other documentation to facilitate O & M was given to the MEPE staff. In terms of the quality of workmanship of the original plant, this appears to have been lower than desired e.g. the turbine which now has serious leakage from the casing.

In addition, in terms of access by personnel to the different components of the Zi Chaung scheme for O & M work, the following points should be noted:

- Poor quality access road to the hydro power station from Kalay town

- Inadequate access along the route of the main canal for inspection purposes
- Occasional landslides affect main canal
- No safety chains in the main canal downstream of the dam / takeoff

It may also be noted that with respect to the thermo-electric power station located in Kalay town there are the following additional O & M problems:

- “Original” spare parts not available for old engines, therefore need to have pattern parts made spare
- Pattern parts are of poorer quality and have shorter working life

The organisational structure of MEPE regionally and that of the Kalay MEPE Township Engineer are shown in Figure 16 and Figure 17.

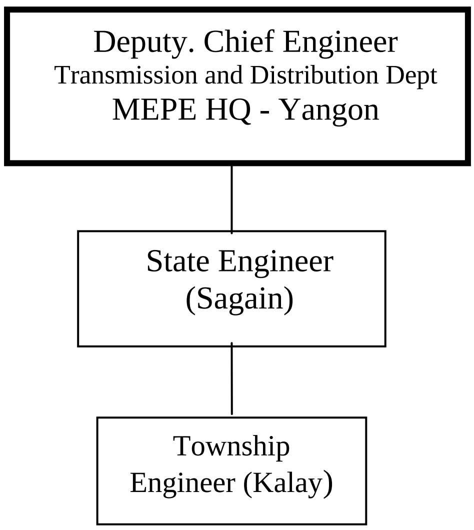


Figure 16 MEPE Regional Structure

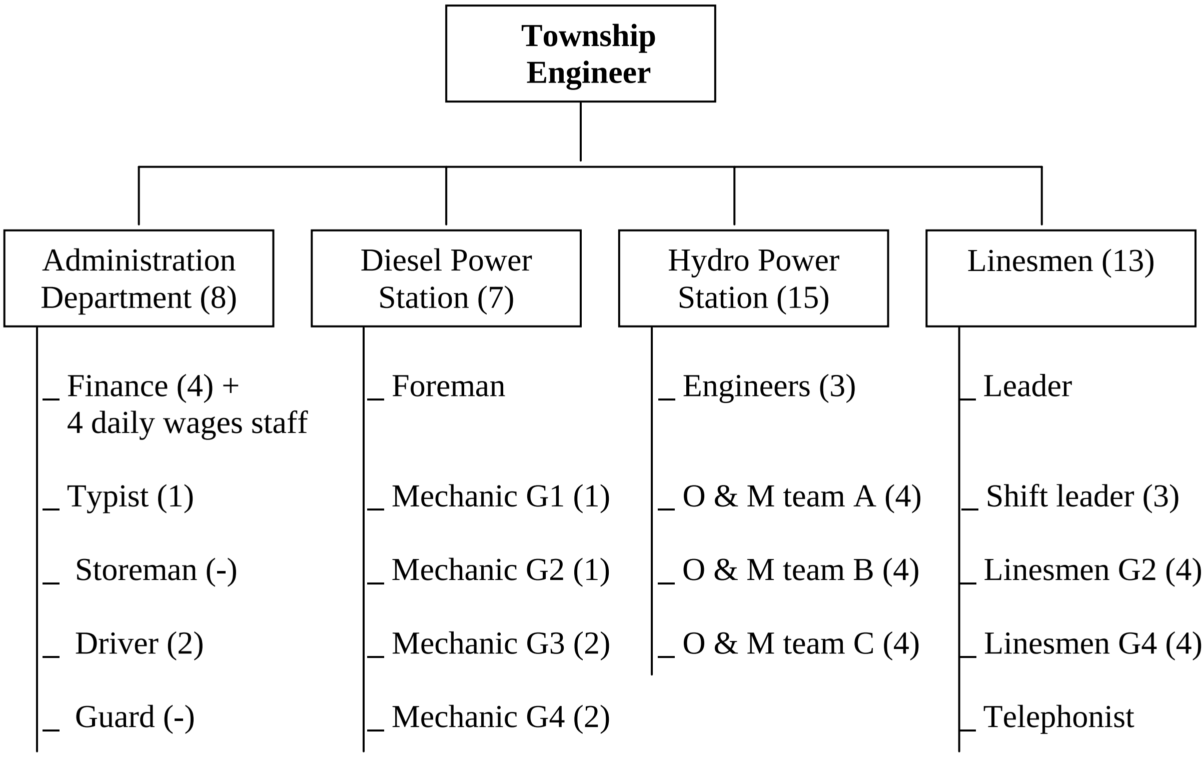


Figure 17 MEPE Township Engineer's Organisation – Kalay Town

The total number of staff employed currently is 43No. whereas the approved establishment is quoted as 60No. Approval has been given by MEPE Regional office to appoint 11 more staff. The staffing arrangements for the O & M of the small hydro-power station at Zi Chaung are as follows:

Total permanent staff = 3 engineers + 12 support staff on shift work

In addition 50 to 60 casual workers who are employed once a year for 1 to 2 weeks to remove large accumulations of silt and sand in the storage pond above the power house. Details of the engineers are:

2 No. Engineers (SAE)

1 No. G1 Engineer/Technician

The above 3 engineers take turns to lead a 12 hour shift. The support staff listed below mainly carry out tasks such data recording. They are divided into 3 teams to work on the shifts:

1 No. G2 labourers / operative

2 No. G3 labourers / operatives

9 No. G4 labourers / operatives

The actual shift / rota system operated at Zi Chaung is as follows:

Day	Daytime shift	Night-time shift	Off
1	A	B	C
2	A	B	C
3	C	A	B
4	C	A	B
5	B	C	A
6	B	C	A

One engineer (SAE) is currently undergoing training at MEPE HQ in Yangon.

A schematic diagram showing the total amount of power generation facilities under their responsibility is included as Figure 18.

The hydro power scheme at Zi Chaung only partially meets the needs of the consumers at Kalay town and has to be supplemented in the dry season and year round during the evening peak load period by diesel engine generated power. In addition the staff also have to operate and maintain three independent smallish diesel power generation systems two of which serve outlying villages. The two villages in question pay for their electricity based on a bulk meter reading whereas all domestic customers in Kalay town have their own meter.

The MEPE staff also give technical advice on an “as required” basis to many other villages which have their own very small diesel generators (there are approximately 160 villages within the Township boundary and some 400 to 500 generators in operation)

In addition to operational problems noted above, some of the organisational shortcomings noted included:

- No MEPE regulations held
- No written guidelines from the State Engineer
- Inequitable charging system between village and town
- Poor information storage at the Town Office
- Staff do not have written job descriptions

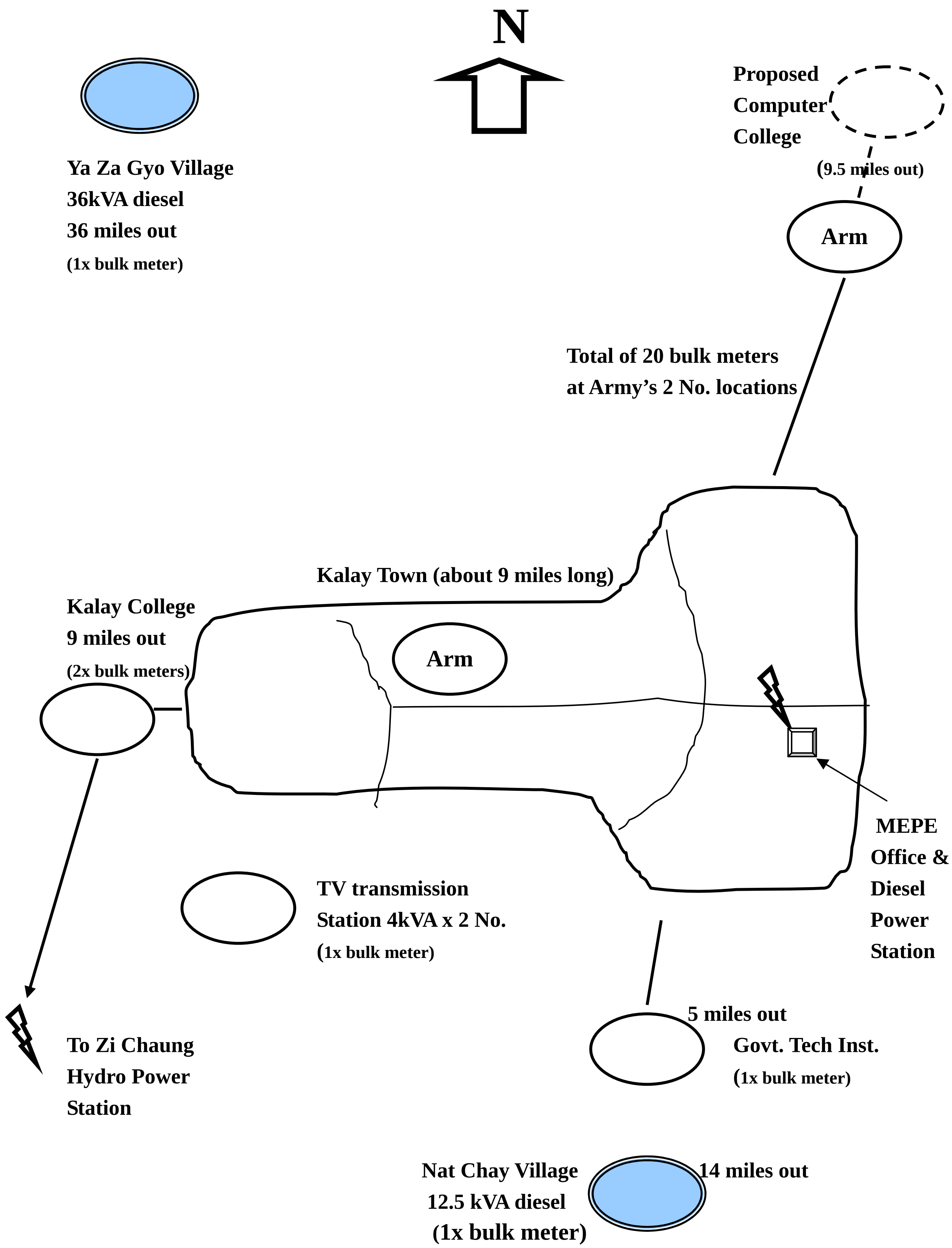


Figure 18 Schematic diagram of electricity supply by MEPE at Kalay Township (NTS)

3.2 Village RE schemes

A number of villages have been visited during the course of the study and interviews held. Initially this was related to the social survey and then subsequently it was to assess different types of NGO facilitated or cooperative built RE schemes using renewable energy.

The villages visited covered a wide and representative geographic area and 3 different forms of renewable energy application were being utilised;

- Micro hydro
- Biogas / ricehusk
- Solar power

As an example (and to show the progress already being made in the form of self-help RE schemes) six case studies are presented on the following pages.

The findings from the related field surveys contributed to the RE strengths and weaknesses assessment in 2.8 and a summary of the key aspects of these six Village RE / VEC case studies is included at the end of this section as Table 6.

__VEC Case Study A – Bambawe Village, Shan State__

The demographic data for this village is 4,600 population – 730 households. 35% of the population are farmers. Population breakdown is: 50% Shan / 30% Myanmar / 5% Chinese / 5% Indian / 10% Other Indian. The findings are tabulated below:

Details of VEC	12 members; copy of regulations provided; not a cooperative.
Population served	Some 200 households are electrified.
Power generation/source	Bulk supply taken from the grid
Project cost data	K3million
Time to construct project	One month.
Aspects of community participation	Village bought own equipment and installed same in 1998 using own labour.
Organisations that assisted project	MEPE gave technical assistance during planning and construction.
Method of funding capital cost	VEC took one year to collect the K30 million for the scheme before commencement
Tariff structure	Standard MEPE tariffs are applied. VEC add 5% to cover their admin costs. VEC read meters then calculate bills and submit drafts to MEPE Township Engineer at Naung Cho. MEPE check total consumption against bulk meter reading for the village supply and issues one bill to VEC. Maximum consumer bill is normally K100 / month. Costs is K25 per night for lights if rechargeable batteries used.
Usage of electricity	Lighting - all houses are metered.
Aspects of willingness and ability to pay	The non-electrified are willing to pay the same as those currently electrified. Average income is between 1 to K400,000 / annum. Savings are K30,000 to K100,000 / annum. K10,000 per household this year to build pagoda
Problems experienced by village	Water shortage in summer, low % of electrification, inadequate high school building. Priorities are: Electricity / Education - School buildings / Health
Other organisations active in the village	6 No. i.e. VPDC, USDA, MCS, VPA, VFA (a cooperative) and VWSDC

VEC Case Study B - Alatchaung Quarter (in Kyimyindine Township)

This community is located west of Yangon city, on the other side of the river where there is no electricity. The community decided to implement its own RE scheme in 1991 and used an existing cooperative, Alatchaung Trading Cooperative Ltd. (ATCL) as the body to do so. Alatchaung Quarter has a total population of 4,500 persons and some 950 families. There are 500-550 members in ATCL. 50% of workforce go to Yangon to work. Some 10% are said to be farmers. Some are boatmen / fisherman. The findings are tabulated below:

Details of VEC	3 voluntary members on ATCL's Board of Directors. 2 auditors (also voluntary). No Annual report to MOC but annual meeting held and representative from MOC Township office invited. ATCL audited annually by latter office and inspected quarterly.
Population served	80 household connections were made initially. Now 180.
Power generation/source	Red Flag (Chinese) generator of 15 kW capacity. The original diesel engine, is currently under repair and replaced by a temporary unit.
Operational cost data	At least 3.5 gallons of diesel are used each evening (normal operation period). Operator's wages are K8,000 per month.
Community participation	The whole system was installed on a community participation basis. All necessary skills were available in the village.
Technical assistance	No external technical assistance for the project was received.
Method of funding capital cost	A loan of K200,000 was given through the Township Cooperative Office. K30,000 remains outstanding. ATCL pay off loan when they can. Such loans not now normally available.
Tariff structure	K25 per day per lamp. No bills are issued. No extra charge if a TV is used. ATCL have a consumer list. Tariff increased to present level in 1999. Monthly collection is K50,000 (mostly spent on diesel fuel). ATCL use Myanmer Economic Bank across the river.
Usage of electricity	ATCL only supplies domestic usage. Normally each household uses one 2 foot fluorescent lamp, some houses also use TV and have a battery to charge and enable its use during the day. About 40 fluorescent "street lights" are also run from the system (free)
Willingness and ability to pay	ATCL have no plans to expand the electricity system. Demand is said to be there if they had the capacity to fulfill it.
Problems experienced by village	The main issue is the high cost of diesel (K5-600 per gallon) as it has to be bought on the open market. Also a logistical problem as it is transported over the river in cans on the small ferry boats.

VEC Case Study C - Heya Ywama Village, Inle Lake

The total number of households in this village is 1,000. The findings are tabulated below:

Details of VEC	Heya Ywama Electrification Committee (HYEC) has 23 members (all voluntary) in the central committee. HYEC established in 1992 when village first electrified. Present Chairman since 1995. HYEC employ 2 meter readers / billers at K3,500 per month and have a small office where the monthly payments are made.. Formal rules and regulations established 1992 and revised 1995.
Population served	Initially there were 501 consumers, this increased to 797 in 1995 and is now 800. Therefore village is 80% electrified.
Power generation/source	Initially (1992) a diesel engine powered system that was subsequently upgraded (1995) to supply by the National Grid.
Project cost data	Total cost of the upgrading was K13.5 million. Originally no agreement that government give funding.Eventually they contributed K9 million.
Aspects of community participation	Construction of upgrading scheme jointly by MEPE and HYEC. HYEC provided skilled (e.g. carpenters) and unskilled workers. Former paid K200/ day and latter K100s / day (today = 600/300)
Organisations that assisted project	Technical assistance from MEPE but no guidance or assistance was received for the setting up of HYEC
Method of funding capital cost	Government promoted initial (1992) electrification due to wish to electrify nearby famous Phang Daw Oo pagoda for tourism and funded the diesel powered station and some of the 0.4 KV distribution system. Balance funded by villagers. Upgrading to National Grid connection involved a 9 mile extension of 11 KV transmission line plus transformer plus additional distribution.
Tariff structure	Up to 1996 there was only a bulk meter and consumer charges were K150 per household per month. After 1996 individual meters were installed. There are also 2 bulk meters. Highest monthly bill is K5,000, lowest is K30. Standard government tariffs used as basis and surcharge added to cover operational cost of HYEC plus system losses. Surcharge K1 per unit in 1995, K2 per unit since 1999.
Usage of electricity	The village's initial priority was lighting but now it is for single phase motors for water pumping and grinding / milling.
Aspects of willingness and ability to pay	Balance of upgrading cost (K4.5 million) raised by HYEC. Cost spread over the 797 consumers equally. 67% paid outright. Remainder paid in instalments over one year. Everyone paid their share.
Other organisations active in the village	HYEC's central committee runs 16 sub committees.

VEC Case Study D - Younetalin Village, Hentada Township, Ayeyarwaddy Division

Electrifying villages in the Division is being spearheaded by the Area Commander (good example of “champion” role). There are plans to electrify 26 more villages using the same concept. Younetalin village was first to be electrified. There are 1100 households in the village. The findings are tabulated below:

Details of VEC	Scheme conceived January 2001, VEC formed then. 12 members. Head is Head of Village. 1 member oversees power plant operations (voluntarily), 1 does accounting and 5 act as collectors. 4 operatives employed. Each receives K2,500 / 10 days. No formal rules yet.
Population served	420 households have been electrified
Power generation/source	Biomass is the energy source for power generation. The waste (burnt rice husk) is used by villagers for different purposes.
Project cost data	Scheme cost was K4.0 million (15 power plant + 25 distribution system) for materials only. Power plant is 140 HP / 135 KVA. Running costs = oil and rice husk (5 to K8,000 / 10 days) + staff costs.
Time to construct project	Scheme commenced operation 15 April, i.e. 3.5 months to arrange funding and build. Power generation plant took 10 days to install.
Community participation	Members of VEC are volunteers. Self funded scheme.
Organisations that assisted project	MEPE constructed the distribution system free of charge and this component was completed in 2 weeks.
Method of funding capital cost	Villagers initially contributed 20 to K40,000 per household (paid in 3 instalments). Balance covered by interest free 12 month loan from Area Commander of Division. Repayments made when possible. After paying off loan, any surplus income will be used for further development of the village
Tariff structure	2 foot fluorescent light K10 / night (4 foot = K15 / night) Television K15 / night Charges collected every 10 days and amount to K60,000. 15 street lights also supplied (no charge). The school also has a free supply.
Usage of electricity	Electricity only be used for domestic lighting (maximum of 3 lights per household) or TV / radio. The supply is from 18 to23.00 hours.
Willingness and ability to pay	The villagers are funding the scheme and outstanding payments were expected to be made shortly.
Problems experienced by village	2 similar but larger plant were also visited (both industrial applications). Poor safety levels observed on all 3 power plants i.e. many pulley belts but no guards installed to protect the operatives.

VEC Case Study E - Saung Po village group

Saung Po village group comprises 21 villages. 5 villages are in the electrification scheme: Total households 730 / population 3160. The findings are tabulated below:

Details of VEC	VEC represents all 5 villages. First set up in 1985 (temporary basis) Formally re-established 1995 (under pressure from Pa O National Army leader). PNA assisted with rules. 6 members meet monthly.
Population served	All 5 villages are 100% electrified.
Power generation/source	Micro-hydro. Generation capacity is 75 kW. Water source also used for irrigation. Operation at full capacity started in 1997.
Project cost data	Total cost was 150 LEK of which the hardware contract was for 45 LEK. Scheme operator is paid 6,000K per month.
Time to construct project	Scheme first conceived in 1985. Took 11 years to complete because of politics (commissioned Feb 96). Should have taken 1 year.
Community participation	Self funded and village participated in construction
Organisations that assisted project	REAM, PNA
Method of funding capital cost	No debt outstanding. No loan provided. Villagers classified into 6 income groups and made monthly contributions. Average annual income K100,000. Highest contribution K10,000 / month.
Tariff structure	Tariffs for the first 3 years were: 10W tube K10 per month (20 W = K20) TV K500 per month Business K1,000 per month Tariffs for lights were doubled 1 year ago and plans are in hand to increase the other tariffs. Electricity for the teacher, monastery, pagodas, health service and school is free. 50 No. 20 W street lights in the 5 villages are also supplied free. K21,900 / month collected.
Usage of electricity	Hours of supply 6pm to 6am. In Saung Po South there are 3no. 20 W lights per house + radio cassette. 5 houses have colour TV and 2 have B/W TV. Electricity also supplied to monastery, 4 pagodas, 4 video houses and 2 karaoke bars. Balance from collection, K14,000 to be spare parts / maintenance fund and distribution line repairs.
Willingness and ability to pay	As a model the scheme encouraged 3 more medium size schemes to start plus several small schemes (20-30 households served)
Problems experienced	There has been some post renewal over the 4 years operation because they are softwood (20 out of 150).

VEC Case Study F - Pin Pu village, Hlaing Thar Village Tract

This village comprises 86 households (total population 640). The findings are tabulated below:

Details of VEC	VEC formed in December 1999. Originally established with UNDP / REAM assistance and has its own regulations. 2 of the VEC Executive Members are Linesmen and also act as bill collectors.
Population served	After the upgrade by this project 42 households were electrified This has subsequently been increased to 55.
Power generation/source	Pico-hydro. Originally the village had constructed a dam and were using an inefficient water wheel. The project involved increasing dam height, renovating / extending powerhouse, a balancing tank + transmission / distribution lines. Scheme generates 3kW using a crossflow turbine (designed for 14kW ready for future upgrades).
Project cost data	Total cost of this upgrade was US$ 7,000. Outgoings are 3,000K per month for the operative / watchman who runs the power plant plus 300K per month to the 2 VEC Members (Linesmen / Collectors). Total 3,600 per month
Time to construct project	Started January 2000 and finished in December 2000.
Community participation	Original scheme started in 1984. Monastery initiated and managed the work and spent 400,000. Villagers gave their labour free.
Organisations that assisted project	Monastery originally, UNDP, REAM and EOJ subsequently
Method of funding capital cost	For the upgrading, aid was provided under Japan's Grass Roots Scheme but the village contributed 60,000K.
Tariff structure	K90 per month for every household in village for public lighting + K200 per "electrified household" where lighting is installed + 150K per "electrified household" where TV is installed. Total monthly income K11,500. Excess funds banked at Yuma in VEC's account.
Usage of electricity	Most houses have one 10W light, three have 2 lights, three B/W TVs. Power also supplied to monastery and 4 pagodas and 48 street lights provide some degree of lighting for the poorer households.
Willingness and ability to pay	Villagers collected K60,000 for upgrading. (average annual income of farmer's household is only K50,000 and others = K20,000)
Problems experienced by village	After commissioning the system was sometimes overloaded due to poor operation (due to rotating the role among inexperienced persons). Resolved by having a permanent employee.

Table 6 Summary of key aspects of the six VEC Case Studies

Case Study Ref	Name of village	Total population	Population Electrified	Source of power	Cost of scheme + (date built)	Funding arrangements
A	*Bambawe Village, Shan State*	4,600 population – 730 households	200 households	Bulk supply taken from the grid	K30 million (1998)	VEC took one year to collect the 3 million for the scheme before commencement
B	*Alatchaung Quarter (in Kyimyindine Township)*	4,500 persons 950 families	80 household connections initially. Now 180.	Diesel engine powered Chinese generator of 15 kW capacity.	K200,000s (1991)	A loan of K200,000 was given by Township Cooperative Office. K30,000 remains outstanding
C	Heya Ywama Village, Inle Lake	1000 households	Initially 501 consumers, 797 in 1995 now 800.	Initially (1992) diesel engine upgraded (1995) to National Grid.	Total upgrading cost K13,500,000 Govt. contributed K90 million	Balance of upgrading cost (K4,500,000) was raised by VEC by spreading cost equally over the 797 consumers. .
D	Younetalin Village, Hentada Township, Ayeyarwaddy Division	1100 households	420 households	Biomass (rice husk)	K4,000,000 = 15 for generation + 25 for distribution (2001)	20 to K40,000 initially contributed per household. Balance of cost covered by loan from Area Commander (interest free)
E	*Saung Po village group*	5 villages total = 3,160 pop 730 hh	All 5 villages are 100% electrified.	Micro-hydro scheme (75 kW) Operation at full capacity began 97.	Total = K15,000,000 Hardware element= K4.5 million (1996)	Villagers made monthly contributions (classified into 6 income groups) Av. =100,000/annum. Highest contribution level was K10,000 per month.
F	Pin Pu village, Hlaing Thar Village Tract	640 population. 86 households	42 households after upgrade Now increased to 55.	Pico-hydro. (Originally village constructed dam + water wheel).	Upgrade cost = US$ 7,000. (2000)	For the upgrading, aid was provided under Japan's Grass Roots Scheme but the village contributed K60,000

Chapter 4 Proposed institutional and organisational schemes

4.1 Key roles and the organisational options

Key roles

From an institutional point of view, the establishment of successful and sustainable RE schemes using renewable energy sources (e.g. mini hydro, biomass, solar and wind power) and replicating these within a successful long term programme, will be dependent on a number of key roles being carried out effectively. These roles, which cover both the implementation and operational aspects of the schemes, are:

- “RE Champion”
- Policy making
- Planning
- Funding
- RE Scheme feasibility studies
- RE Scheme prioritisation
- RE Scheme design and construction supervision
- RE Scheme construction
- RE Scheme operation (technical) and maintenance
- RE Scheme management (administration / financial)
- Capacity building / HRD / education and training
- Management of an effective information / publicity campaign
- Monitoring and evaluation / management of feedback
- Collation of nation-wide operational data

Sustainable development is the pursuit of economic development in parallel with environmental protection. It will therefore be important to conform to national / international guidelines with respect to environmental impact assessments of proposed RE schemes. This further role has therefore to be performed in parallel with scheme implementation and operation to ensure compliance from an environmental protection viewpoint.

Organisational options for the various roles

There are a number of options for carrying out each of the key roles mentioned above as shown in Table 7 overleaf. The evaluation of these options is shown in Table 8.

Table 7 Organisational Options for Roles Related to the Promotion of RE

Role	Organisational options
"RE Champion"	SPDC MPBANRDA MOEP / MEPE Min. of Cooperatives
Policy making	SPDC MPBANRDA MOEP / MEPE Min. of Cooperatives
Planning	MOEP / MEPE MPBANRDA Private sector
Funding	Government MEPE MADB Aid Agencies Private sector Beneficiary community
RE Scheme feasibility studies	MEPE Private sector
RE Scheme prioritisation	MPBANRDA MEPE D / TPDC
RE Scheme design and construction supervision	MEPE Private sector
RE Scheme construction	Private sector MEPE MELC Community participation (VEC)
RE Scheme operation (technical) and maintenance	Community through VEC MEPE MELC Private sector Municipality / Township Development Committee
RE Scheme management (administration / financial)	Community through a VEC MEPE MELC Private sector Municipality / Township Development Committee
Monitoring and evaluation / management of feedback	MEPE REAM
Collation of nation-wide operational data	MOEP / MEPE MoE
Establishment of environmental protection guidelines	NCEA
Training and HRD	MEPE Local technical education institutions Local management colleges International education / training institutions

Table 8 Evaluation of the options for the central roles

Central role	Organisational options	Points in favour	Points against
"RE Champion"	SPDC	● Most powerful organisation ● Regional network ●	● Appears to be no current policy for RE ●
	MPBANRDA	● Role is to promote rural development ● 2 Depts. focussed on same ● Some Govt. funding to PBANRD	● RE not one of DDA's 31 functions ● Focus is on roads / water supply ●
	MOEP / MEPE	● Key role in power generation / distribution sector ● Regional structure ● Opportunity to consolidate non National Grid activities	● Needs to focus on Nat. Grid ● RE appears to have been a low priority in the past ●
	Min. of Cooperatives	● See rural development as one of their missions and motivated to do role ● National network	● No background in sector ● Cooperative system in general does not appear to be performing well
Operations Organisation RE Scheme operation (technical) and maintenance + RE Scheme management (administration / financial)	Community through a RE association (VEC)	● Already examples of it working ● Appear able to set appropriate tariffs ● VEC can be a cooperative ● VEC is on the spot	● Lack of skills ● Weak regarding rules and regulations ●
	MEPE	● Already active in this area re mini -hydro and diesel plant schemes ● National network ● Training facilities / capability	● Small isolated schemes will be logistically difficult / unattractive ●
	MELC	● Recently active in this area ●	● No national network ● Small isolated schemes will be logistically difficult / unattractive
	Private sector	● Introduces competitive aspect ● Usually more efficient therefore better service level	● Locations may be too remote ● Small isolated schemes will be logistically difficult / unattractive

Some of these options, e.g. scheme funding and scheme construction, will remain a matter of choice for the future when the most appropriate option for particular circumstances can be selected. Others, however, are more fundamental since they relate to the central process of RE scheme formulation / implementation / operation. These roles can be linked in 3 key functional groups as follows:

- Strategic planning = Policy making / planning / scheme prioritisation
- Implementation = Funding sourcing / FStudy / Design / Construction supervision
- Operations = O & M / administration / financial management

The process for promoting and achieving sustainable RE using renewable energy sources is shown in Figure 19.

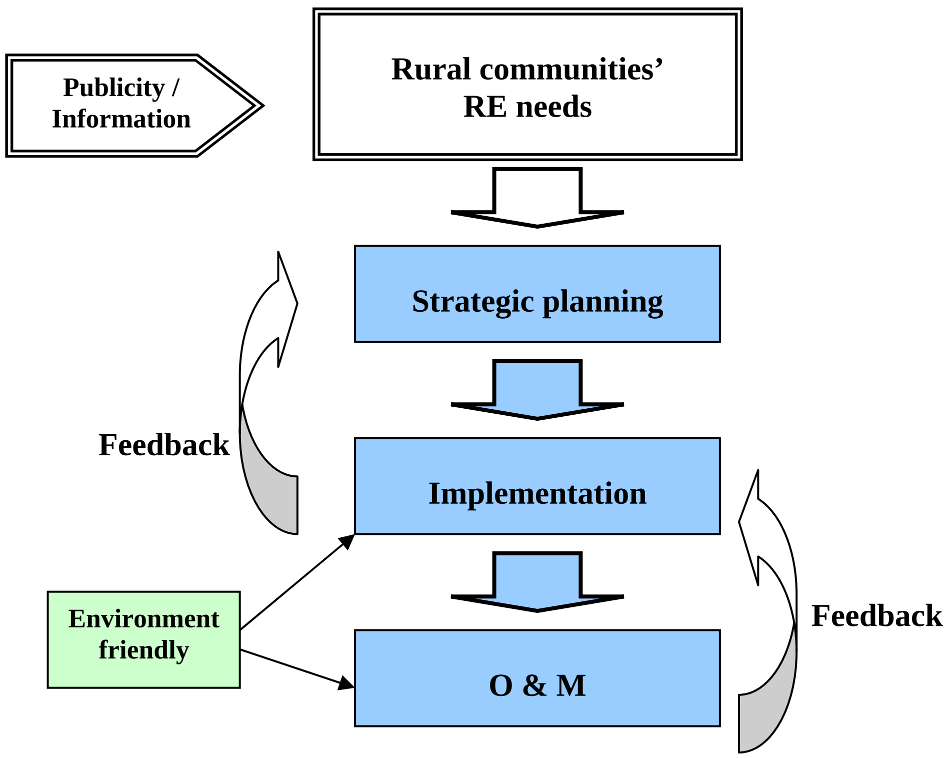


Figure 19 Process for Achievement of Sustainable RE

The above 3 functional groups plus the role of "RE Champion" form the central core of the process of scheme implementation / operation. Figure 20 shows the framework for promoting and implementing sustainable RE using renewable energy.

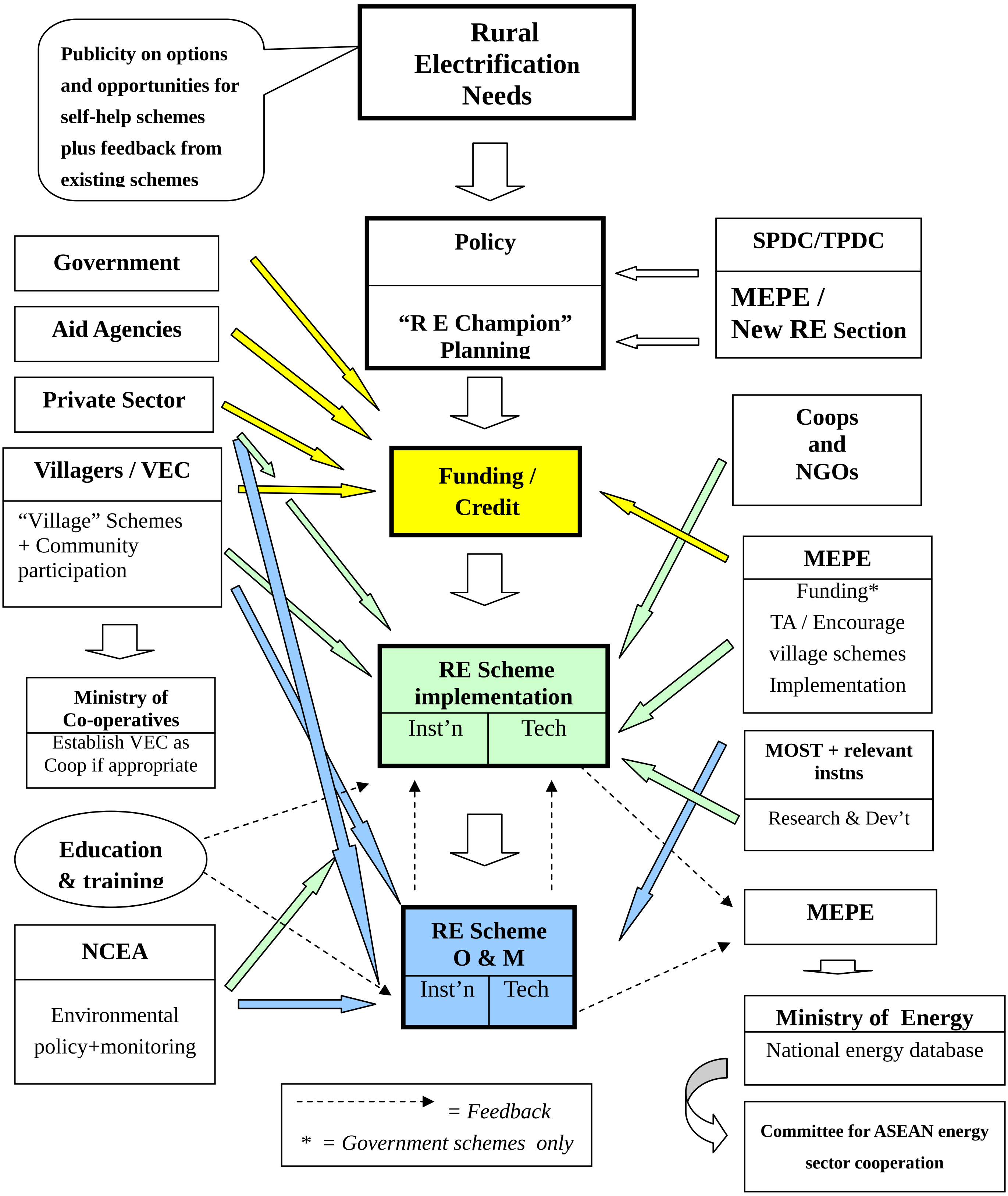


Figure 20 Framework for the implementation of renewable energy projects for RE

4.2 Proposed institutional and organisational arrangements

Given the options in Table 7 and the framework shown in Figure 20 the proposals for the most appropriate organisations to have responsibility for the central roles are presented in Table 9.

Table 9 Organisations Proposed for the Key Roles in RE

Role	Responsible organisation	Other organisations involved
National policy	SPDC	
Strategic planning body	MOEP / DEP	
RE Champion	MEPE	
RE scheme planning and implementation	MEPE or VECs or private sector	NGOs
RE scheme construction	Private Sector or MEPE or MELC and / or beneficiary community	Equipment fabrication cooperatives and NGOs
RE scheme operation and maintenance	MEPE or private sector or VECs	MEPE and NGOs will support VECs
Monitoring and evaluation	DEP +MEPE	NCEA

Three fundamental organisational weaknesses were identified in 2.8, i.e.:

- No apparent ownership of the problems of meeting the RE need
- Many ministries / organisations involved but no central co-ordination
- No “champion” for RE using renewable energy

In order to address these issues it is proposed to establish an RE Section within the Transmission and Distribution Department of MEPE. This new department would act as the RE “champion” and cover the full scope of services for government RE schemes from scheme planning through implementation and O & M where appropriate. It should also manage the necessary information and publicity campaigns.

The proposed organisational structure for sustainable RE is shown in Figure.

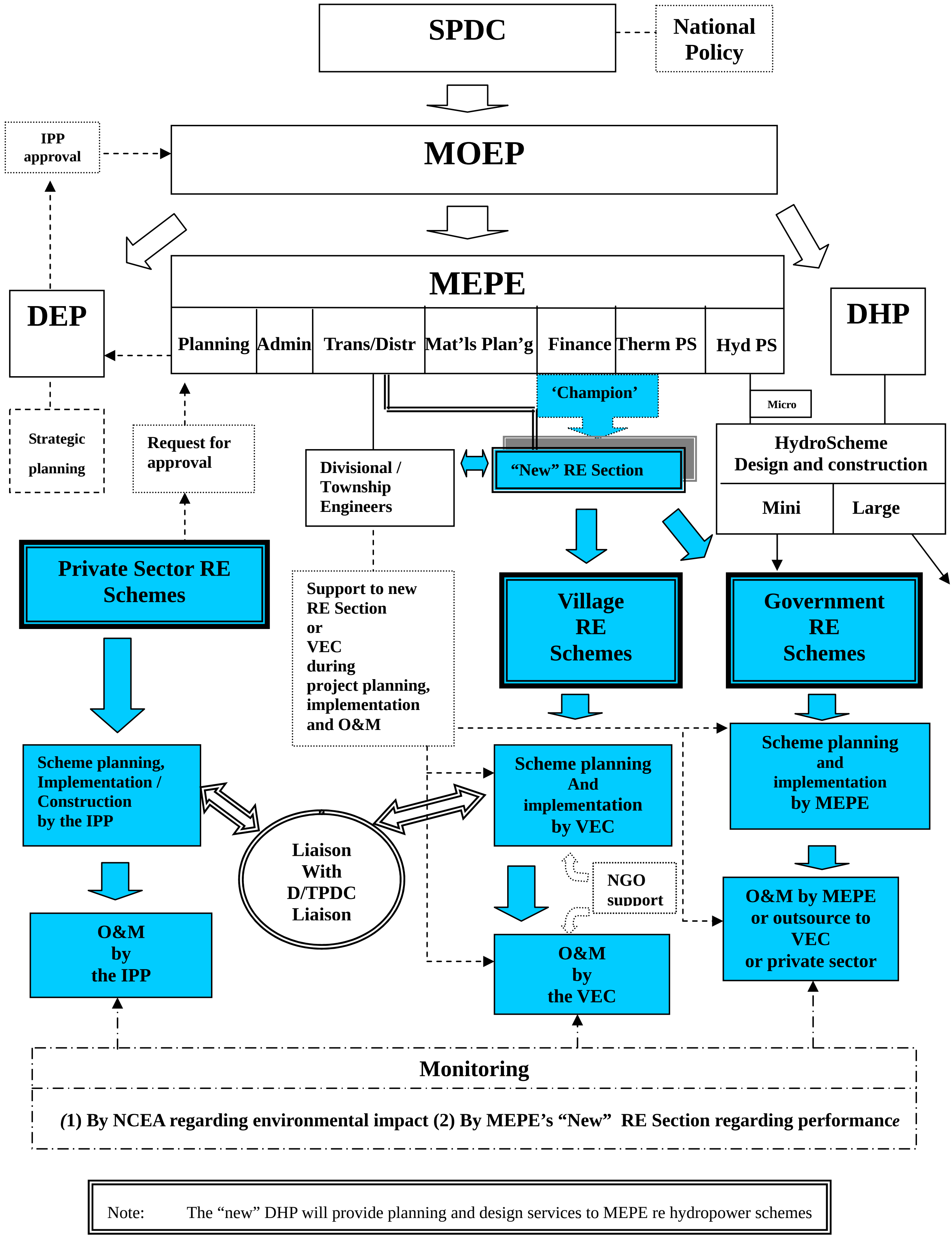


Figure 21 Institutional and organisational structure for sustainable RE

Details of the proposed RE section and its functions and the main procedures that it has to perform are set out in the Manual Part 4-4 (Institutional and Financial Aspects).

The proposed structure of the new RE Section and the linkage with key project deliverables is shown in Figure 22.

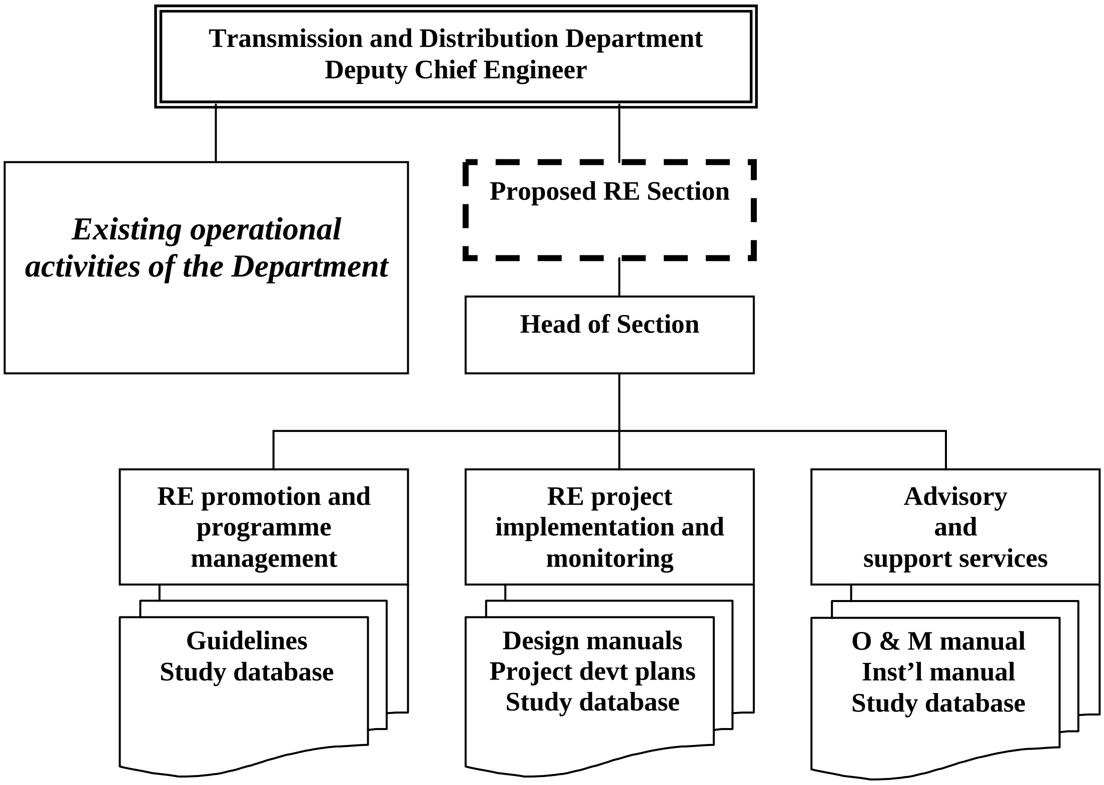


Figure 22 New RE Section and Linkage with Project Deliverables

The 16 procedures for the RE Section detailed in the manual are as follows:

<u>Procedures common to Government and Village RE schemes</u>

- Policy dissemination
- Information management
- Publicity management

<u>Procedures for Government RE schemes</u>

- Project funding - sourcing / management
- Project planning and RE Programme management
- Project feasibility studies
- Detailed site investigations and RE scheme design
- Preparation of contract documents (where necessary)
- Construction supervision and project commissioning
- Management of the O & M arrangements

Procedures for Village RE schemes

- Assist the capacity building of VECs
- Advice on project funding options
- Advice on initial project preparation / feasibility studies
- Advice on site investigations, RE scheme design and preparation of contract
- Advice on construction supervision, community participation and project commissioning
- Advice on O & M arrangements

NGOs and cooperatives

The current situation regarding the role of cooperatives and NGOs has been described in 2.5.

In order to kick start the promotion of RE using renewable energy particularly regarding self-help schemes it is recommended that a new NGO is encouraged to become established (perhaps calling it PREM – Promotion of Rural Electrification in Myanmar).

The establishment of such a new NGO would facilitate using a Grass Root Grant of EOJ and / or establishing a JICA Community Empowerment Scheme to support the kick start process and provide the seed money for RE fund

Policy

In a general sense much of the necessary policy and legislation is in place. However the latter is now quite old and in need of modernisation.

In terms of policy, a major thrust to improve the level of RE would benefit from (1) a restatement by the government of its commitment to the development of the rural areas and (2) the preparation of a strategic plan (with targets and a budget) to improve the level of RE with the focus on the use of renewable energy sources / technologies.

In support of the above, effective publicity demonstrating the opportunities for self help in terms of RE (including reference to examples of what has and can be achieved) is also needed.

Laws

The Electricity Law 1984, a relatively brief document, is in need of review, expansion and modernisation.

Regulations

The MOI Regulations which support the implementation of the Electricity Law 1984 are likewise in need of review, expansion (particularly to cover the different technologies related to various forms of renewable energy) and modernisation.

There is a need for a set of model regulations to serve the VECs in their role of developing, operating, managing and maintaining small isolated RE schemes. Such model regulations could form an attachment to the updated MOI Regulations. They will no doubt need tailoring in some instances to suit particular RE schemes.

4.3 Operation and maintenance

Status of existing O & M of isolated RE schemes

Operation and maintenance of existing isolated electrification systems in the rural areas of Myanmar (i.e. all systems outside the National Grid) is generally carried out by one of the following two organisations:

- MEPE
- VECs

The isolated systems operated and maintained by MEPE are either small hydropower schemes or diesel generator plants and include those in the border areas promoted / owned by MPBANRDA.

The systems operated and maintained by VECs cover a wider range and comprise the following:

- small hydropower schemes
- diesel powered generation schemes
- solar powered battery charging schemes
- solar powered village domestic water supply systems
- biomass (rice husk) schemes

There are also cases where VECs operate and maintain rural electrification systems which take a bulk supply from the National Grid e.g. Heya Ywama Village near Inle Lake and Bambawe Village. VECs have usually been set up on an ad hoc basis with some external assistance e.g. from MEPE or NGOs such as REAM or the Ministry of Cooperatives or the equipment / technology supplier.

Given the low level of rural electrification in Myanmar the number of isolated power supply systems is rather limited. However, some common problems currently affecting operation and maintenance can be identified and include:

- remoteness of some schemes makes getting parts / materials difficult
- shortage of some spare parts and materials due to non-availability in the local market
- high cost of some spare parts, materials and fuel (e.g. diesel)
- inability to buy appropriate materials (e.g. distilled water for batteries)
- relatively short life of some components e.g. the softwood poles normally used for power distribution
- no standard regulations / guidelines for operating organisations
- no national structure to support small isolated power producers

These issues need to be addressed in developing a framework for the sustainable operation and maintenance of isolated power production / supply systems in the future.

Requirements for effective O &M

In order to achieve sustainability, a number of key factors need to be in place in order to ensure that an isolated power supply system is operated and maintained effectively. These are:

- a properly set up operational management organisation
- O& M manuals and guidelines
- trained O & M staff
- availability of spare parts and maintenance materials
- adequate funding
- appropriate and equitable tariff structure
- efficient billing and collection procedures
- transparency in financial matters
- good communications with consumers
- monitoring and evaluation of the process
- technical assistance from MEPE / NGOs

It is also important that there is feedback from the operation and maintenance process to the design and construction processes (refer to Figure 19 earlier). By this means the lessons learned during the working life of a renewable energy RE scheme can lead to future improvements in these areas and produce more efficiency and improve sustainability.

Proposals for efficient O & M of RE schemes are included in the Manuals developed under the study

4.4 Private sector participation

The private sector has several potential roles in the promotion of RE:

- Implementer of IPPs
- Provider of O&M services where these are desired to be contracted out
- Contractor for undertaking RE schemes
- Supplier of RE scheme materials and equipment
- Possible source of finance / funding
- Broadcaster of promotional information

The biggest opportunity for potential private sector participation (PSP) in the electricity sector would be some form of PSP with respect to MEPE. However, this is not foreseen in the short term (despite such trends on the global scene) and is beyond the scope of the present study.

There appears to be interest by the private sector in developing IPPs but there is a deterrent in terms of the tariff levels being regulated to the current MEPE tariff levels. This does not permit viable commercial operations in terms of achieving full cost recovery and an adequate profit margin. This issue needs to be addressed.

4.5 Monitoring and evaluation of schemes

A key factor in achieving sustainable RE is to incorporate a monitoring and evaluation role in the overall implementation process. This has already been referred to in 4.1 and reflected in the institutional and organisation structure for sustainable RE shown in Figure 21. It is proposed that the monitoring and evaluation be done by the new RE department proposed to be set up within MEPE.

Monitoring and evaluation stimulates the production of critical feedback at various stages in the overall project process from RE scheme development through to carrying out O&M and recommends actions to be taken in the light of the analysis of same. Staff allocated to this function will therefore need training and guidance in order to appreciate the significance of the role, understand the scope for taking initiatives and develop the assertiveness needed to instigate the necessary changes that will contribute improvements to the efficiency and effectivenesss of the process of promoting and implementing RE.

On a more administrative basis there is a need to develop a database related to RE and a contribution to such a database has already been made through data collected and collated as part of these studies. The new RE Department proposed for MEPE should take the responsibility of maintaining such a database. Information would initially be gathered at Divisional / Township Engineer level and then fed back to head office in Yangon. The database must be mounted on a PC.

The guardian of the National Energy Database (NED) is the MOE and, as previously stated, MOE sits on 2 important international committees related to energy. The most relevant of these with respect to the use of renewable energy for RE is the committee for ASEAN energy sector cooperation. There is therefore a need for MOE to keep abreast of all developments in the field of renewable energy.

Given MOE's central role regarding all forms of energy and as the guardian of the NED, it will be necessary for the new RE Department to regularly provide MOE with energy use data related to all non National Grid activities. The MOE, in turn, will give relevant feedback to the committee for ASEAN energy sector cooperation regarding the development and outcome of work on renewable energy in the rural areas of Myanmar.

As another route for developing projects to expand RE, it may be possible for MOE to encourage the committee to sponsor renewable energy projects to be undertaken in Myanmar.

4.6 Environmental impact assessment and monitoring

The main responsibility for the environment is with the National Commission on Environmental Affairs (NCEA) which comes under the Ministry of Foreign Affairs. There are proposals to establish a Ministry of Environmental Affairs in the near future.

Environmental law is currently spread across many acts (i.e. there some 57 existing laws which have some linkage to the protection of the environment and they relate to 13 sectors) but it is planned to be consolidated under a new Environmental Law.

It is important that any renewable energy / RE schemes in rural areas do not have an unfavourable environmental impact either during construction or subsequently during their operational life.

Any consultants involved with RE have to be aware of the relevant environmental legislation in order to fulfil their responsibilities under their respective company's Quality Assurance (QA) procedures.

The NCEA was established in 1990 to:

- advise the Government on environmental policies
- act as a focal point and co-ordinating body for environmental affairs
- promote environmentally sound and sustainable development in Myanmar

The NCEA is based in Yangon and comprises a Chairman, Secretary, Joint Secretary and 19 members. The Chairman is the Minister for Foreign Affairs and the members are the heads of department of various ministries dealing with environmental conservation. Four specialised committees function and NCEA is assisted by a staff bureau (currently there are 30 staff).

NCEA is just a policy making body i.e. it does not act as an environmental watchdog (no legal powers for such a role as yet). Enforcement of environmental protection in relation to the fragmented existing environmental legislation is left to the particular sector ministry e.g. forestry and wildlife protection laws by the Ministry of Forestry. NCEA have worked closely with the Ministry of Forestry, YCDC and other bodies to increase environmental awareness

There are no national standards or guidelines related to environmental assessments / impact studies / management plans and the current approach is to recommend the use of the relevant ones used by the World Bank, Asian Development Bank and the World Health Organisation.

There is a proposed change to the existing arrangements with new "consolidated" environmental protection legislation and perhaps a new Ministry (or Department attached to an appropriate existing Ministry) specifically responsible for the environment. The current status of these developments is that the legislation is drafted and the opportune time for it to be implemented is awaited. Once this legislation is enacted it is proposed to follow it with a new Environmental Impact Assessment Law, which has also been drafted.

4.7 Research and development

The Ministry of Science and Technology (MOST) has 5 main departments, is based in Yangon and carries out any work in the regions through the technical institutes. One such institute is the Yangon Institute of Technology (YIT), based at the University campus and its link to MOST is through the Myanma Scientific and Technological Research Department (MSTRD).

MOST were the counterpart agency for the United Nations ESCAP project on the commercialisation of renewable energy. The Physics and Engineering Research Department (PERD) is the main research department and they have been involved in wind and solar energy work. For biomass they developed and tested a gasifier that worked with paddy husk and distributed it to farmers. The rice husk gasifier produces 40 KW and they want to upgrade this to 75KW. PERD's work on solar energy goes back 20 years and includes solar cookers, dryers, water heaters and distillation plants.

YIT began biomass research in 1980 and at one point built a gas plant in their compound to use biomass from water hyacinth but it was not successful (hard scum formed on top of digester). They also tried using distillery waste. They have plans to upgrade / scale up this plant. Recently completed research by YIT was related to solar electric refrigeration and the design and application of windmills for water pumping.

Another ministry that has been active in the field of research and development (R&D), is the Ministry of Forestry (MOF). MOF are strongly promoting fuel wood substitution and were doing research on using biomass for power generation but have now ceased these research activities and have no plans to restart them.

No other research activities related to renewable energy and / or its application to RE are known of at this time.

What is particularly wanted in terms of R&D is research into local material substitution in order to reduce dependence on imports. R&D related to applications of renewable energy in relation to RE should be coordinated / monitored by the new RE Department proposed for MEPE in order that its benefits / findings can be implemented / promoted in the shortest possible time frame.

Chapter 5 Framework for the Development of Human Resources

5.1 HRD and training needs assessment

The capacity building process is shown in Figure 23.

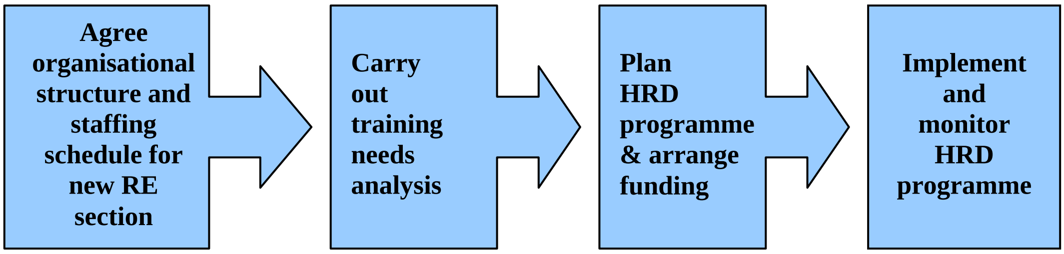


Figure 23 Capacity Building Process

Prior to doing the training needs analysis, a preliminary assessment indicates that there is a need for:

- Engineers who can plan, build, operate and maintain micro hydro schemes less than 100kW
- The development of strategic planning and policy analysis skills for management
- An awareness by management and engineers of the importance of social dimensions in RE scheme development e.g. social factors that contribute to sustainability,
- Training in all aspects of running VECs / operating small isolated RE schemes (implementation, community participation, operational management, administration and financial management)
- Specific technical training e.g. on O & M of gas engines

5.2 Framework for the development of human resources

In order to address the skills shortage of engineers for RE schemes using renewable energy it is proposed to develop the MEPE training centre in Yangon as the focus for capacity building of staff from the divisional offices. The trained staff will, in turn, guide and support the VECs on the small schemes.

A summary of the main areas where capacity building is needed is given in Table 10 together with the related training options.

The overall framework for the development of HRD is shown in Figure 24.

Table 10 Summary of Areas Needing HRD and the Options for Training

Areas needing capacity building / HRD	Options of potential sources of training or skills transfer
Engineers – mini-hydro design and project management skills	MEPE
Engineers – site survey / investigation and construction management	On the job training arranged by MEPE
Management – strategic planning, social components in development of RE projects.	External sources
NGOs – programme management, capacity building, training of trainers	Consultant
VECs – implementation, community participation, operational management, administration and financial management	MEPE + NGO
Operation and maintenance staff – technical and operational safety aspects of particular technologies	MEPE + NGO + MICL + MSTRD

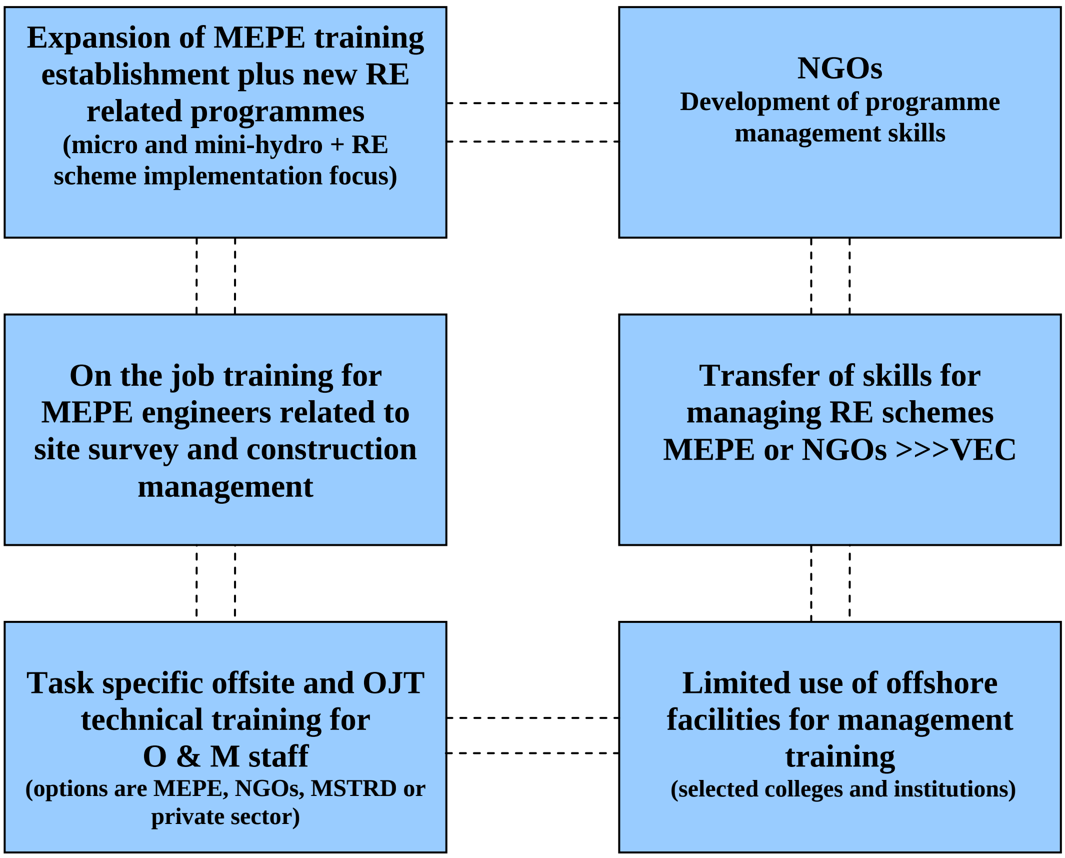


Figure 24 HRD Framework

Chapter 6 Conclusions and Recommendations

6.1 Conclusions

The main conclusions drawn from the institutional studies may be summarised as follows:-

- Various forms of renewable energy are already being successfully used by rural communities for RE
- Clear evidence of benefits of RE
- Willingness of villagers to pay for electrification despite low incomes / limited ability to pay
- Need for an RE promotion campaign
- Desperate need for an appropriate micro credit system
- Effective VECs already formed for existing schemes (some have regulations)
- Having electricity is usually the highest priority / need expressed by villagers
- Villages generally willing to provide community participation
- Lack of focus / champion for promoting RE
- Lack of information systems related to implementing self help schemes
- Evident that schemes can be fast tracked, given the will and funding.
- Skills exist in country to fabricate many important items for both micro hydro and rice husk gasifier schemes
- Some good NGOs / cooperatives already active regarding renewable energy / RE
- Most of the existing legislation and regulations are now quite old and in need of review, expansion and updating
- Need for amendment to banking rules to allow loans to VECs / cooperatives
- Need for VECs to have freedom to set tariff levels on a cost recovery basis and completely independent of MEPE’s national tariff structure

6.2 Recommendations

The key recommendations in the light of the above conclusions and the findings of the institutional studies are summarised below in two groups:-

Public sector

- Create a new RE Section in MEPE in the Transmission and Distribution Department to act as the RE Champion and implementer of all Government RE schemes and supporter of Village RE schemes.
- Bring in new skills to the new RE Section to deal with social dimension of RE work plus promotional work and monitoring and evaluation
- Implement an HRD programme in association with restructuring MEPE
- Expand training facility and programme at MEPE HQ
- As a signal of a commitment to lessening the urban / rural divide the Government should also contribute to an RE fund and encourage self help schemes by promoting them through the TPDC network.
- Implement all current proposals regarding environmental law consolidation and institutional change

Private / NGO sector

- In order to kick start the promotion of RE using renewable energy particularly regarding self-help schemes – set up a new NGO (e.g. PREM – Promotion of Rural Electrification in Myanmar)
- Implement an NGO capacity building / HRD programme in association with establishing PREM
- Look into the feasibility of using Grass Root Grant of EOJ and / or establishing a JICA Community Empowerment Scheme to support the kick start process and provide the seed money for RE fund
- Make VECs cooperatives where possible to give them access to bank loans through the cooperative system

Annexes

Annex 1 List of reference documents

Doc. Ref.	Document name	Date	Author
RE1	Myanmar Energy Master Plan Volumes 1and 2	02/1998	ECFA, JGC Corporation and JDI
RE2	Myanmar Energy Sector Investment and Policy Review Study	03/1992	World Bank
RE3	Country report on improvement of operation of electric power facilities	02/2001	MEPE
RE4	Comprehensive study on sustainable development for Myanmar	06/1995	JDI and ECFA
RE5	Alternative Energy Utilisation in Myanmar	1992	UNICEF
RE6	The Electricity Law	1984	Government
RE7	The State Owned Economic Enterprises Law	1989	Government
RE8	The Cooperative Society Law	1992	Government
RE9	Promotion of Cottage Industries Law	1991	Government
RE10	The Cooperative Society Rules	1998	Ministry of Cooperatives
RE11	The Cooperative Society Model Bye-laws (2)	-	Ministry of Cooperatives
RE12	Myanmar Electric Light Cooperative Society Ltd. Bye-laws	1994	MELC
RE13	Brochures from various ministries	2001	Ministries
RE14	Data pack from Ministry of Cooperatives	2001	Ministry of Cooperatives
RE15	MEPE – Background history	-	MEPE
RE16	1996–2001 transmission expansion program	-	MOEP / MEPE
RE17	Country paper presented at Second ASEAN Renewable Energy Conference	1997	MEPE
RE18	List of Ministries	2001	
RE19	List of environmental legislation	2001	NCEA
RE20	List of all laws	2001	
RE21	Report on Commercialisation of Renewable Energy Technologies for Sustainable Development	2000	ESCAP / UN
RE22	Electricity Regulations	1985	MEPE
RE23	Agenda 21	1997	NCEA
RE24	Myanmar Inventors Cooperative Ltd – Technical data on rice husk gasifier	2001	MICL
RE25	REAM training data	2001	REAM
RE26	Government's 12 political, economic and social objectives	2001	SPDC
RE27	Situation and prospect of wood energy in Myanmar	1999	Ministry of Forestry
RE28	MOEP's aims and objectives	2001	DEP
RE29	Annual Report	2000 / 01	Myanmar Oriental Bank Ltd
RE30	MADB Law	1990	MADB
RE31	MADB Rules	1991	MADB
RE32	Status of micro-finance in Myanmar	2002	MADB

Annex 2 Key Findings from Field Trip 1

- Details of MEPE's regional organisational structure, in particular typical structure of Township Engineer's office, reporting heirachy, operating cost / income, billing and collection procedures and collection efficiency
- Insight into cooperative activities at regional / township level -
- Initiation / testing of village survey questionnaire
- Preliminary assessment of ability to pay – average annual income per household appears to be about K100,000 to K150,000
- Preliminary assessment of willingness to pay – in all villages visited therewas a willingness to pay at least as much as town people currently pay for electricity.
- Evidence of existing mini and micro-hydro schemes and feedback from operation and maintenance of same
- Evidence / examples of community participation on tasks / projects - Fire destroyed 3 houses in Innwai village in recent times and the community contributed to rebuild same. They also make bricks for the temple and repair the roadway. Village Head supervises such work. They also sometimes assist other villages in the group for projects / work. They provide labour free for community projects – common savings pay for materials.
- Understanding of tariff structure in regional areas which invariably follows the national norm - details of same confirmed and comprised 4 categories of user
- Understanding of the billing / collection procedures and collection efficiency – this was invariably high
- Appreciation of the status of electrification in regional / rural areas – confirmed to be very low
- Understanding of the manner in which villages / small townships are managed – all had a Village Peace and Development Council none appeared to have a branch of USDA (Union Solidarity and Development Association), an NGO
- Evidence of private sector initiatives re electrification (small scale) – Ohn Matti village had 10 micro installations
- Evidence of a lack of formal regulations being available to (or utilised by) MEPE staff in the regions

- Evidence of active electrification associations (operating outside of the national cooperative framework) – Bambawe Electrification Committee has been operating for the past 3 years.

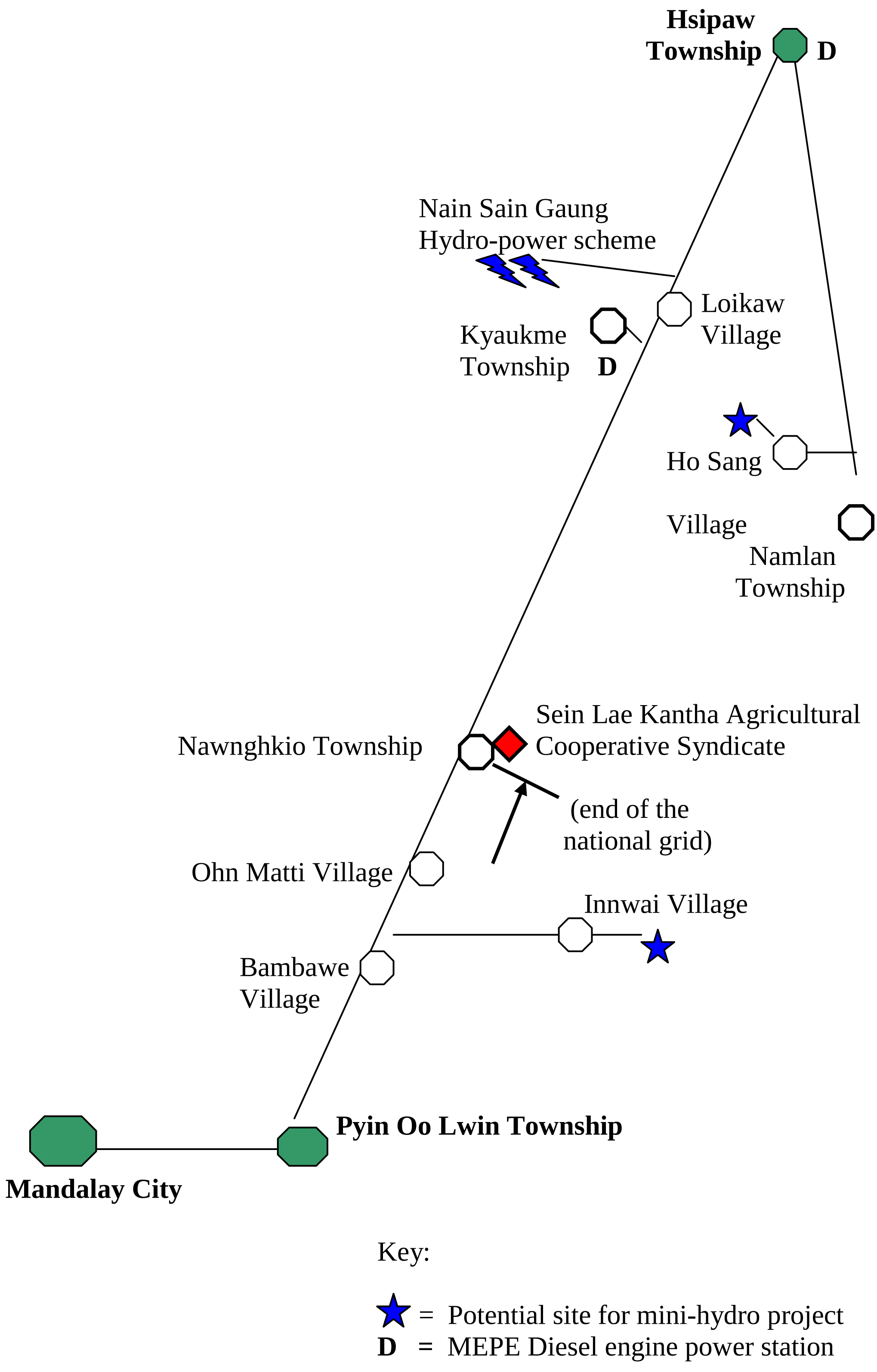


Figure A1 Field Trip 1 - Itinerary

Field Trip 2 – Key Findings (From The Institutional Viewpoint)

- General confirmation of village survey findings in Field Trip 1
- Increased understanding of MEPE regional operations, particularly at state level plus knowledge of their village level operations
- Evidence of formal MEPE regulations in place at regional (village level) offices and of State Engineer's instruction system
- Further evidence of active and effective Electrification Associations (not a cooperative), well organised and proactive with formal rules / regulations in place and achieving a high collection efficiency..
- Evidence of a village community able to raise substantial funds for a major programme of electrification works and also able to organise / contribute to work execution
- Further strong evidence of the desire for electricity by the rural communities and the high prioritisation of this among the key needs.
- Good examples seen of the benefits achieved through rural electrification interms of increased standard of living, increased output from cottage industries and improved educational achievement.
- Evidence of the wish to maintain the rural lifestyle / culture but to have electricity to improve the quality of life.
- Evidence of system put in place to assist the poorer elements of the community to participate in rural electrification project by permitting their up front contribution to be made on an instalment basis.
- Evidence of people willing to give voluntary services to the community by running Electrification Associations
- Further evidence of the government tariff structure having a percentage added by an Electrification Association in order to cover their administration and operational costs as well as the technical losses in the distribution system.
- Evidence of technical innovation and entrepreneurship / private sector initiative.
- Evidence of kerosene lamps being the cheapest form of lighting as opposed to candles which were only used for religious purposes

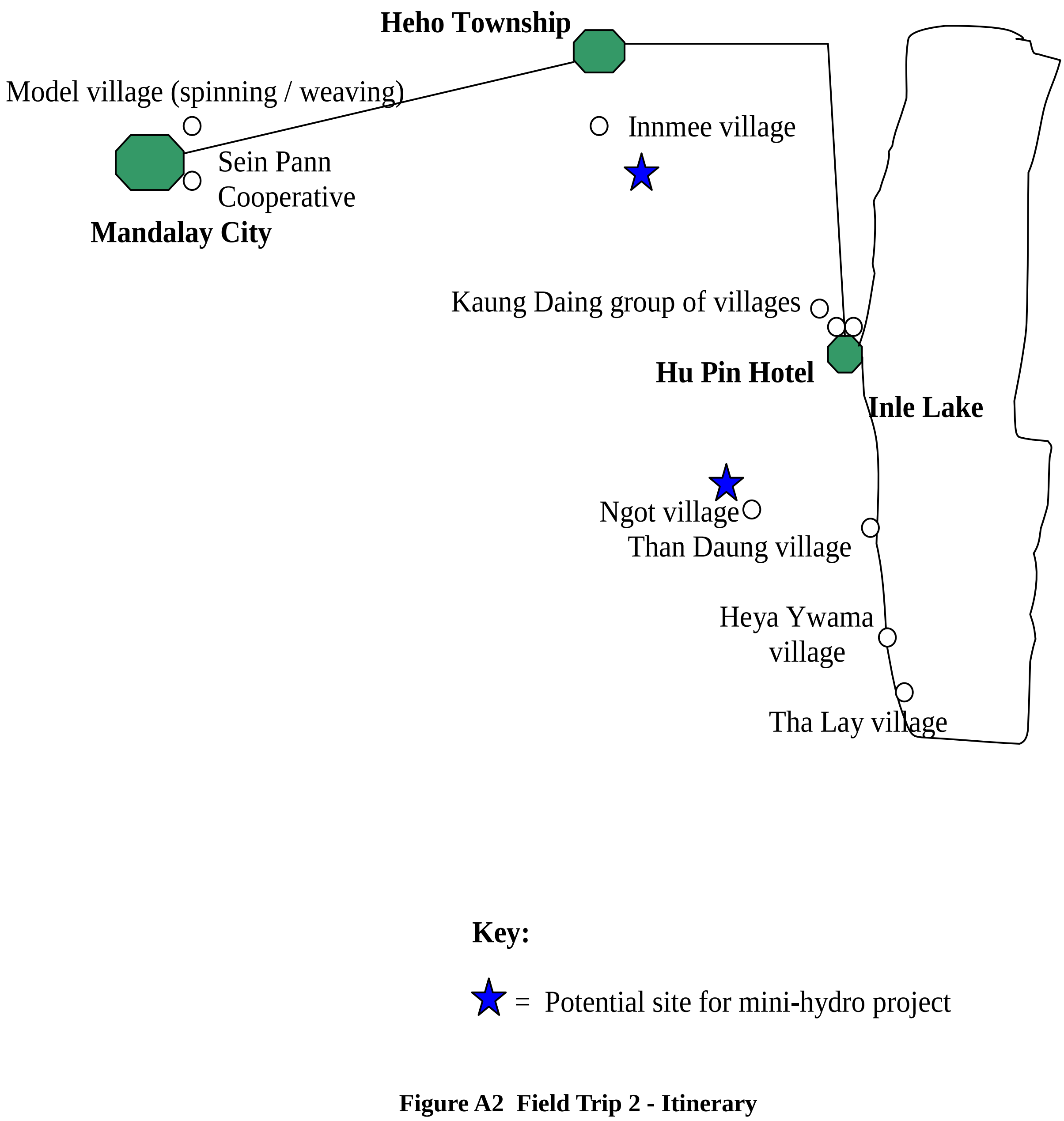


Figure A2 Field Trip 2 - Itinerary

Field Trip 3 – Key findings (from an institutional viewpoint)

- Further evidence of the structure and operations of MEPE in the regions, this time at Hindara Town, Ayerwerwady, a town of 50,000 population fed from the national grid via a 66 KV line.
- Township Engineer has 50 staff and serves 8,000 customers (300 of these are industrial).
- Average monthly consumption is 30,000 kWh and load shedding takes place.
- Prime objective of this one day trip was to meet the members of Village Electrification Committee (VEC) at Younetalin Village in Hentada Township and assess the recently commissioned village electrification scheme (biogas).
- The scheme was completed rapidly. It was conceived in January 2001 (the VEC was also formed then) commenced operation on 15 April i.e. it took barely 3 months to arrange the funding and build.
- The Head of the VEC is also the Head of the Village There are 12 members in the committee. Members have various tasks e.g. one oversees power plant operations (on a voluntary basis), one does the accounting, five act as collectors.
- As yet, no formal rules or regulations have been established by the VEC.
- 1100 households in the village - 420 have been electrified.
- The scheme cost was:
- K1,500,000 – power generation plant (which took 10 days to install)
- K2,500,000 – transmission system (materials only)
- MEPE constructed the distribution system free of charge and this component was completed in 2 weeks.
-
- Villagers are funding the scheme and to date have contributed between 20,000 and K40,000 per household (this was paid in 3 instalments). The difference between the amount raised by the villagers and the capital cost of K4,000,000 was covered by an interest free loan from the Area Commander of the Division. This loan has to be repaid within 12 months. Outstanding payments were actually expected to be made within one month i.e . August 2001

- Electricity can only be used for domestic lighting (maximum of 3 lights per household) or TV / radio. The supply is made to domestic customers from 18.00 to23.00 hours.
- Charges are:
- 2 foot fluorescent light K10 / night
- 4 foot fluorescent light K15 / night
- Television K15 / night
- Charges are collected every 10 days and amount to K60,000.
- Running costs comprise: oil + rice husk (5 to K8,000 / 10 days) + staff costs. There are 4 operatives running the plant (managed by a voluntary VEC member). Each operative receives K2,500 every 10 days.
- Loan repayments are made when a reasonable amount of cash has been accumulated (as opposed to being linked to a specific date / repayment amount). After paying off the loan, any surplus income will be used for further development of the village.
- 15 street lights are supplied by the scheme. No charge is made for this. The school also receives a free supply from 12.00 to 15.00 hours.
- The power plant is 140 HP and 135 KVA – Model RH14 (supplied by MICL)
- The waste product (burnt rice husk) is made available to villagers for cooking pot cleaning and is also used for village road / pathways construction and repairs.
- 2 similar but larger biogas plants were visited. Both were industrial applications (rice milling and rice noodle production). No additional domestic supply was made. The plants were operating when inspected and had been installed for some 4 years with few problems reported.
- Poor safety levels were evident on all biogas power generation plants visited i.e. many pulley belts were used but no guards were installed to protect the operatives.

Note:

The move to electrify villages in Ayeyarwaddy Division is being spear headed by the Area Commander and there are plans to electrify a further 26 villages using the same concept. Younetalin village was the first to be electrified in this manner.

Field Trip 4 – Key findings (from the institutional viewpoint)

- 5 further village surveys completed - general confirmation of village survey findings in Field Trips 1, 2 and 3
- Increased understanding of MEPE regional operations, particularly at state level plus knowledge of their township level operations and training arrangements
- Further evidence of active and effective Electrification Associations (not a cooperative), well organised and proactive with formal rules / regulations in place
- Evidence of a village communities able to raise funds for a programme of electrification works and also able to organise / contribute to work execution
- Further strong evidence of the desire for electricity by the rural communities and the high prioritisation of this among the key needs.
- Good examples seen of the benefits achieved through rural electrification in terms of increased standard of living, increased output from cottage industries and improved educational achievement.
- Evidence of system put in place to assist the poorer elements of the community to participate in rural electrification projects and to arrive at equitable tariff structures
- Evidence of people willing to give voluntary services to the community by participating in Village Electrification Associations
- Evidence of technical innovation and entrepreneurship / private sector initiative plus local skills to fabricate mini hydro components.
- Evidence of private donors
- Evidence of successful Solar powered water supply systems
- Understanding of O and M needs of mini-hydro and solar powered schemes
- Understanding of potential working life of mini-hydro and solar powered schemes
- Understanding of Peace and Development Committee structure at Township level plus linkages to other organizations

Annex 3 Findings from the Monitoring Mission to Zi Chaung Hydro Scheme

Questionnaire for Interviews/Field Surveys

Subject	*Questionnaire for Zi Chaung field trip (16 – 18 Feb 03)*			
Date	*14 February 2003*	*Prepared by*	*Roger Harris*	
Filename			*File Ref. No.*	

Task / question list

Summary of the key technical data	Daytime maximum demand – 800 kW Max demand year round – 1,860 kW Zi Chaung hydro scheme built 1996 Installed capacity 1260 kW Max output now available from Zi Chaung (i.e. much less efficient than early years, full power for only first 4 years) is as follows: 900kW – wet season (140 cusecs) 450kW – dry season (50 cusecs) Kalay Town diesel power station engines (3 No.) are operated from 6pm to 11pm. Two of the engines were out of commission and under repair (both of the Skodas). Typical current outputs from the 3 engines are: Caterpillar 320 kVA = 200 Skoda 860 kVA = 330 Skoda 608 kVA = 240 In addition to supplying electricity to Kalay Town, MEPE supplies some outlying institutions which are connected to the town grid. MEPE also operates and maintains independent diesel power plants serving the TV transmitter and two outlying villages (Ya Za Gyo with 36 kVA generator and Nat Chay with 12.5kVA). Both villages have VECs.
Do they have a copy of the MEPE Regulations? - Administration - Financial - Engineering	 NO) NO) but State Engineer was said to hold NO) a copy of these
Have detailed operating instructions been issued by the State Engineer at various times?	NO
How are their activities audited by MEPE?	Township auditing office visits twice a year Monthly reporting to State Engineer

Are there any other regulations or manuals used? If YES, give details (e.g. manufacturer's manuals)	YES Electricity Law and the associated Ministry of Industry Regulations No manufacturer's manuals held
Do staff have written job descriptions	NO but they are given on-the-job training
Has any formal training been given to any staff or operatives in past 2 years? Hydro power station Diesel power station Office If YES, give details	 YES NO YES One SAE undergoing training at Yangon currently. Admin / finance staff participate in Township accounts training programme
What is your assessment of the training needs? Hydro power station Diesel power station Office	 None specifically None specifically None specifically
Have there been any significant accidents during operations in past 5 years? Hydro power station Diesel power station Office	 NO NO NO
Are there consumer representative groups	NO
Are there any independent village electrification schemes nearby If YES, give details If YES do you give any practical help or assistance to it If YES, are there electrification associations (VECs) for same If YES and known, give details If NO, would they feel able to help in any way if a nearby "village scheme" was proposed in the future	YES 160 villages under the Kalay Township. Most have diesel generators. Usually 2 to 3 per village. Could be a total of 500 units, of which biggest is 7.5kWand smallest 2kW. Also 12 units of 7.5kW hydropower Technical advice when requested which is said to be often The villages with small hydropower schemes may have VEC's but this cannot be confirmed No details available. However, the two outlying villages served by independent MEPE diesel engines have VECs. These only meet when necessary and meetings are not attended by the Township Engineer. VECs arrange for charging villagers based on lights used as there is only a bulk meter Yes, by giving technical advice

Are any NGOs active in the region in relation to rural electrification?	NO
What is your assessment of the ability and willingness to pay for electricity?	They can pay a lot more – some people pay 300K per unit
Are there any significant operational problems currently at the hydro power station? If YES give details	YES Waiting for permission to get spare parts – particularly the large items – these may take 3 months to get permission as the request has to go to Head Office. No manuals Occasional landslides Storage pond silts and requires annual emptying Chinese contractor did not give proper handover No preventive maintenance (but do daily checks) Minimal and inadequate spares holding Problems with excitation equipment
Are there any significant operational problems currently at the diesel power station? If YES details	YES Waiting for permission to get spare parts – particularly the large items – these may take 3 months to get permission as the request has to go to Head Office. Inadequate tools (but linesmen's tools OK) No preventive maintenance or split between operating and maintaining (but do daily checks) No spare parts No manufacturer's manuals Two of the engines (the Skodas) are old– cannot get spares –have to get pattern parts made – these are usually of poorer quality = short working life Poor quality floor
Is the standard government (MEPE) tariff applied	YES – to the Town, i.e. 1 – 50 units K0.5 / unit 51-200 units K10 / unit 201+ units K25 / unit However villagers pay K25 / unit for bulk metered usage and VEC collects charges based on number of lights Villagers therefore pay a disproportionately high tariff compared to town dwellers and on top of this they have to pay for minor maintenance as MEPE only do the big jobs Example:- 10 people in town using 30kW pay K150 10 people in village with bulk meter pay K7,500 = 50 times as much
Is payment of bills at MEPE office?	YES – after MEPE delivers bill to consumer
What is the average monthly	K1.3 million

collection?	
What is the collection efficiency	Nearly 100%
What is the experience of MEPE's Township Engineer (U Aung Thit) Years MEPE service? Years at Kalaymyo? Qualifications? Who does he report to?	 19 years 5 Years AGTI (Associate of Government Tech. Inst.) Divisional Engineer at Sagain
How many staff are actually employed? + what is the nominal establishment? Hydro power station Diesel power station Office (includes Township Engineer) Linesmen Totals	Full-time / Casual / Establishment 3 + 12 on shift / 50-60* / 24 7 / / 10 8 + 4 on daily wages / / 11 13 / / 15 60 * these labourers are employed once a year for one or two weeks to remove silt and sand sediments from the storage pond feeding the power station Reason given for shortfall between actual staff and the approved establishment was that no authority had been given to make the outstanding appointments Note: From 10/2/03 approval has been given to appoint 11 staff 3 at the office(office assistant, guard / timekeeper and storekeeper) 3 at the diesel power station 5 at the hydro power station Those at the power stations are proposed to be trained on the job to do mechanical tasks
Staffing details - hydro power station	Total = 3 + 12 on shift work + 50 to 60 casual workers employed once a year 2 Engineers (SAE) 1 No. G1 Engineer/Technician -- 1 No. G2) 2 No. G3) Labourers / operatives 9 No. G4) (doing data recording) *Rota system:* Day / Daytime shift / night shift / Off 1 / A / B / C 2 / A / B / C 3 / C / A / B 4 / C / A / B 5 / B / C / A 6 / B / C / A

Staffing details - diesel power station	Total = 7 1 Foreman 1 No. G1) 1 No. G2) Mechanics (but not qualified) 2 No. G3) 2 No. G4)
Staffing details - office	Total = 8 + 4 Finance (4) + 4 daily wages staff Typist (1) Store (-) Driver (2) Guard (-)
Staffing details - linesmen	Total = 13 4 No. G1 – 1 Leader + 3 Shift leaders 4 No. G2* 1 No. G3 (telephone operator) 4 No. G4* * means 1No. of each is stationed in Tahan quarter at the opposite end of the Township to the MEPE compound (8 miles East).
Do all staff generally have adequate experience and skills and qualifications for the job	Township Engineer says YES
Are there difficulties getting properly experienced and qualified staff?	Township Engineer only has authority to appoint labour State Engineer chooses and sends other staff
What are the key areas of weakness?	Low level of education Lack of qualifications
How many bulk meters? How many consumer meters? Give details of other meters Give details of customers Does the total number of customers include nearby villages?	30 (Jan 03) 2029 - domestic 15 – small industries power meter 1 – street lighting ------------------- Total = 2075 meters / customers Details of industrial customers: (e.g. Rice or oil mills or other major industries) No major industries only light industry such as oil mill, ice tube maker, distilled water production, small machinery Other groups of customers are Army establishments and colleges YES – the 2No.with diesel engines maintained by MEPE - both have bulk meters
Is there a meter repair / recalibration workshop	NO

Average monthly consumption ? Load shedding takes place between?	Approximately 300 MWh 18.00 to 23.00 hrs.??
What is the organisational structure of MEPE regionally	See attached diagram
What is MEPE Township Engineer's organisation structure at Kalay Town for:- Overall organisation Hydro power station Diesel power station Office	See attached diagrams
Are detailed monthly report submitted to the State Divisional Engineer? If YES are following 5 pro-formas utilised:- Demand summary Income / outgoings Demand / supply Transformer data Collection data	YES YES YES YES YES YES
What is my assessment of the standard of record keeping at the following locations. Hydro power station Diesel power station Office	 Not seen None evident Information available but storage poor – shelves stacked with old paper records - fire hazard
What are the communication facilities between the 2 main locations	Telephone

Summary of the institutional and operational problems observed

- Only survival maintenance (no preventive maintenance)
- No MEPE regulations held
- No written guidelines from the State Engineer
- Lack of tools
- Lack of spare parts
- Need to have pattern parts made – poorer quality / shorter working life
- All plant working at low efficiency
- No manuals for all main plant
- Appears to have been an inadequate hand-over from Chinese contractor on Zi Chaung
- Long delays by MEPE HQ in approving purchase major items of spares
- Office appears extremely littered – no document storage
- Poor quality turbines
- Max output from all power sources cannot be combined
- Inequitable charging system between village and town
- Poor access road to hydro power station
- Inadequate access to main canal
- Occasional landslides affect main canal
- No safety chains in channel
- Earthen floor in diesel power station
- Operation and maintenance roles mixed
- Staff do not have written job descriptions

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

FINAL REPORT

Volume 7 Supporting Report

Institutional/Socio-Economics

Part 7-1	Institutional Study
Part 7-2	**Economic and Financial Study**
Part 7-3	Social Survey

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

Final Report

Volume 7 Supporting Report

Part 7-2 Economic and Financial Study

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1 OBJECTIVES

Taking into account the characteristics of rural electrification by renewable energy, the objectives of Economy and Finance Study is 1) to study to formulate and propose options of financing the fund for RE and 2) to study to formulate and propose options of allocations of the funding for RE, which can contribute the increase the rural electrification ratio in a most cost effective manner.

2 PRESENT ECONOMIC AND FINANCIAL CONDITION OF MEPE

2.1 Overview of the Economy of Myanmar

Table 1 shows Myanmar's key indicators for an over view of the economy of Myanmar. Myanmar's per capita GDP is about US$160. This is about 1/12 of the neighboring Thailand and 1/5 of China. Myanmar's primary sector is agriculture with 35% of GDP and 65% of labor force belong to agriculture. In terms of the system of the economy, Myanmar is mixed with private activity dominant in agriculture, light industry, and transport, and with substantial state-controlled activity, mainly in energy, heavy industry, and the rice trade. Government policy in the last 11 years, 1989-99, has aimed at revitalizing the economy after three decades of tight central planning. As a result, private activity has markedly increased; foreign investment has been encouraged (until 1988, it was zero but by 1997 it increased to 419 million $US). A major challenge is the monetary and fiscal stability as indicated by the high rate of inflation and the considerable difference in the official exchange rate and the market rate. The official fixed exchange rate is a major cause of the informal market trade, which may make published estimates of Myanmar's foreign trade greatly understated. Thus the trade deficit could be much larger than the official Figure, which makes Myanmar difficult to reduce the external debt.

This study requires reasonable Figure of exchange rate. However, there is no official exchange market, but only official regulated exchange rate. As mentioned above, to use official rate of about 6.0 Kyats/$ will greatly distort the analysis. Rather here in the Study, the exchange rate was assumed to be 500 Kyats/$ for year 2001 taking into account actual market prices. For example, the kerosene or diesel oil price of early 2001 here in Myanmar is K500-1,000 per gallon which is equivalent to about $1-$2 in international market (April 2001 for diesel—Japan $1.92/gallon or $66/bbl, USA $1.14/gallon or $40/bbl—see Table 6).

Table 1 Myanmar Key Indicators

Myanmar Key Indicators (Source: IMF-International Monetary Fund, WB-World Bank, and MNPED-Ministry of National Planning and Economic Development, Myanmar)

COMPARATIVE GDP, POVERTY and SOCIAL (IMF, WB)	**Myanmar**	**(Thailand)**	**(China, Mainland)**	**(Japan)**
Population, mid-year (millions, 2000)	45.6	62.6	1,263.5	126.4
GDP: US$ billion, 2000 (IMF estimate)	7.3	121.9	1079.8	4759
GDP per capita, $US, 2000 (IMF estimate)	160.8	1946.5	854.6	37,625.0
GDP real growth %, 2000 (IMF estimate)	5.5	4.3	8	1.7
Poverty, % of population below national poverty line, 1997 estimate, (IMF, WB)	23	12.5	10	N/A
Urban population (% of total population, 1998, WB)	27			
Life expectancy at birth (years, 1998, WB)	60			
Infant mortality (per 1,000 live births, 1998, WB)	78			
Child malnutrition (% of children under 5, 1998, WB)	43			
Access to safe water (% of population, 1998, WB)	38			
Illiteracy (% of population age 15+, 1998, WB)	16			

KEY ECONOMIC Indicators and LONG-TERM TRENDS (WB)	**1978**	**1988**	**1997**	**1998**
GDP (Kyats billions)	31.7	76	1,067.40	1,143.90
Gross domestic investment/GDP	18.2	12.8	11.7	
Exports of goods and services/GDP	5.5	3.1	0.8	
Gross domestic savings/GDP	11	11.1	11.1	
Gross national savings/GDP	10.7	11.4	7.6	
Total debt service/exports	28.2	34.3	7.4	5.3
Foreign direct investment	0	0	419	288

STRUCTURE of the ECONOMY, % of GDP, (MNPED)	**FY1989**	**FY1997**
Goods	61.0	60.4
Agriculture	39.0	35.6
Livestock & Fishery	7.4	7.3
Forestry	1.8	1.0
Mining & Energy	0.9	1.4
Processing & Manufacturing	9.3	9.3
Power	**0.7**	**1.0**
Construction	1.9	4.9
Services	16.2	18.7
Transportation	3.8	4.3
Communications	0.7	1.6
Financial Institutions	0.5	1.9
Social & Administrative Services	6.7	6.7
Rental & Other Services	4.6	4.2
Trade	22.7	20.9
GDP at Factor Cost	100.0	100.0

PRICES and GOVERNMENT FINANCE, (WB)	**1978**	**1988**	**1997**	**1998**
Consumer prices, % Change	-6	16	29.7	51.5
Implicit GDP deflator % Change	0.8	25.2	32.9	34
Current revenue, % of GDP	14.9	8.5	7.7	
Current budget balance, % of GDP	2.5	-1.4	3.4	
Overall surplus/deficit, % of GDP	0.6	-3	-0.9	

TRADE BALANCE, US$ millions (WB)	**1978**	**1988**	**1997**	**1998**
Exports of goods and services	265	372	1,511	1,634
Imports of goods and services	527	585	2,667	2,789
Resource balance	-263	-213	-1,156	-1,155

EXTERNAL DEBT and RESOURCE FLOWS, US$ millions (WB)	**1978**	**1988**	**1997**	**1998**
Total external debt	953	4,432	5,063	5,680
Total debt service	76	128	116	93
Composition of net resource flows				
Official grants	38	97	73	67
Official creditors	220	253	-28	52
Private creditors	87	-31	102	83
Foreign direct investment	0	0	80	70
Portfolio equity	0	0	-2	0

(Source: IMF-International Monetary Fund, WB-World Bank, and MNPED-Ministry of National Planning and Economic Development of Myanmar)

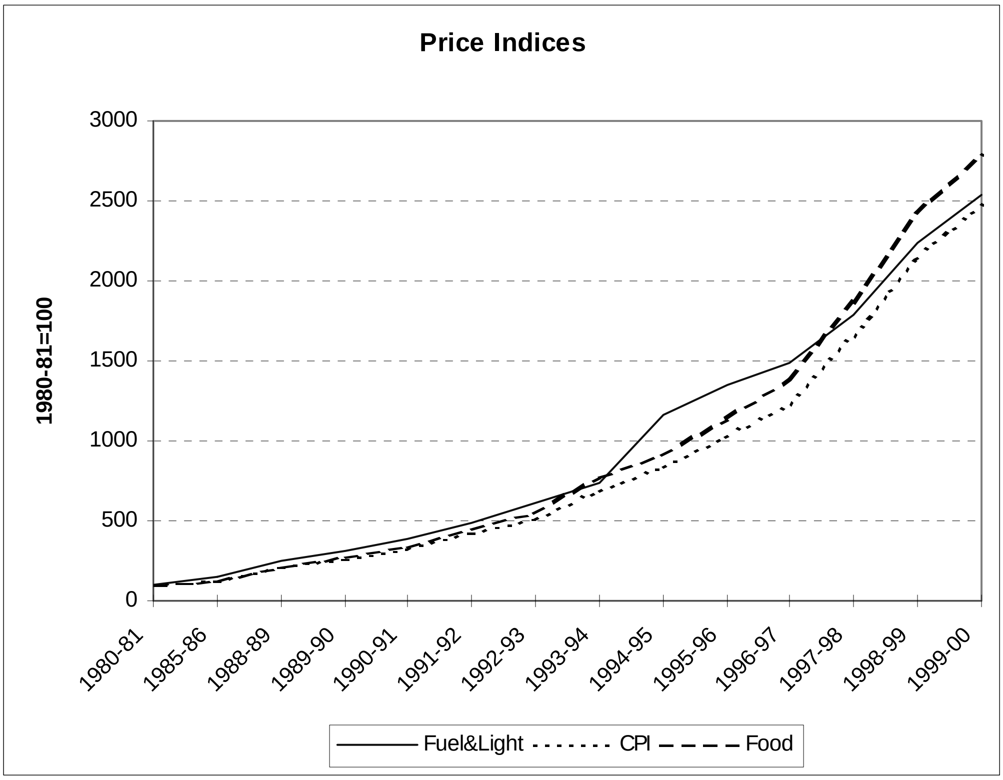
From the point of RE, major concern is the prospects of income and the alternative fuels of electricity in rural area, which determines the villagers' willingness to pay. Such a concern can be investigated by looking into the prices of food or agricultural products, which are the major source of income for a farmer and the prices of fuels, which are the primary indicator of willingness to pay for electricity.

Next Table 1 shows the growth rate of price indices, or inflation, Consumer Price Index (CPI), Fuel & Light and Food for the decades of 80s and 90s. Figure 1 shows the historical trend of these indices. Table 1 shows the clear difference of the 80s and the 90s. The inflation in 90s is more than doubled compared to the 80s. The rate is high, especially for food, followed by fuel & light. CPI, the general consumer's index has the smallest inflation. Actually, the recent trend in Figure 1 shows that the inflation is highest for food. Although, the prices of fuel & light may be dependent on the imported oil products, the data here shows that their price increase is probably the lowest.

The relatively high inflation for food and low inflation for fuels means that the price of income source of agricultural goods is increasing while the relative prices of fuels are decreasing. This implies that the relative expenditure for fuels might be somewhat decreasing. The possibility is that the relative increase of income of farmers would have increased the number of household who can afford more spending for fuel and light.

Table 2 Price Indices

PRICE INDICES (Source: Central Statistics Office, Myanmar)	Growth Rate (1980-1989)	Growth Rate (1990-1999)
CPI	13.7%	23.3%
Fuel & Light (Kerosene & Candle)	11.5%	25.3%
Food	11.7%	26.4%



2.1 Power Sector and MEPE

2.2.1 MEPE and Other Power Producers

The power sector in Myanmar's economy increased its share from 0.7% in FY1989 to 1% in FY1997 (see "Structure of Economy", Table 1). This implies the increasing importance of power sector in the economy of Myanmar (in Japan it is about 1.9% in 1999).

In terms of the capacity of power generation MEPE has the share of ¾ of total installed capacity in Myanmar. Next Figure 2 shows the changes during the past two decades in MEPE's share by type of power generation and other organization. The points here are;

1) MEPE's share in power generation have not changed since 1981, although the share declined slightly by 2%,

2) Even though Myanmar is endowed with rich hydro resources, the share of hydro power has been unchanged,

3) The components of fossil fuels have changed with increased share of gas and decreased share of diesel and thermal.

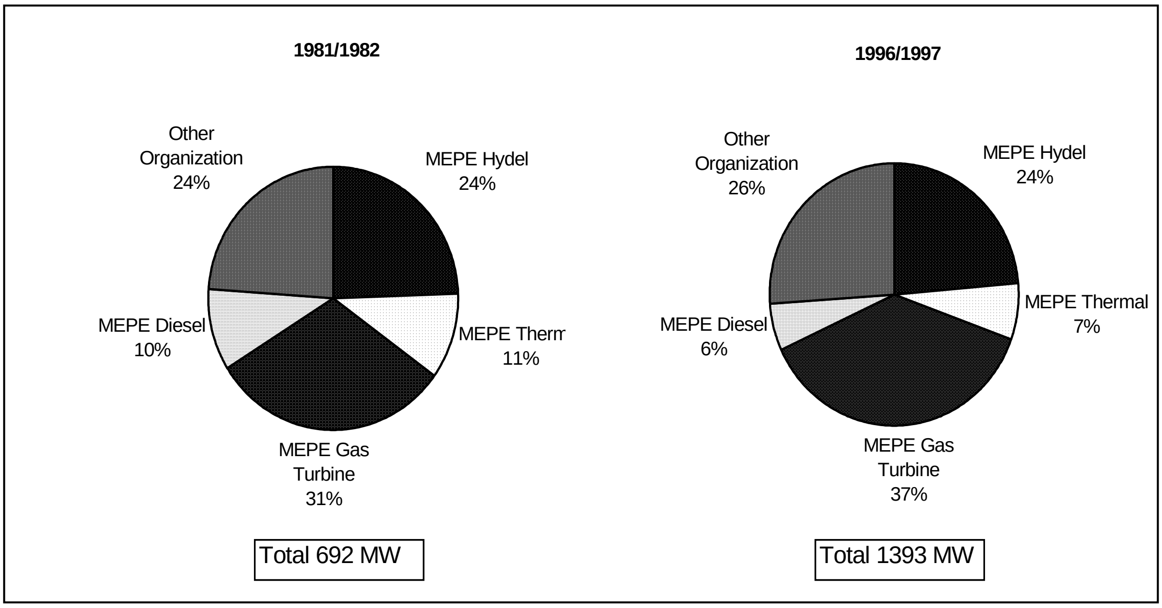


Figure 1 Change in Share in Installed Capacity by Type and Other Organization

The power generation by other organization is disaggregated in the next Figure 3. It shows the share of installed capacity by other ministries (excluding MOEP—MEPE). Ministries of Defense and Energy take about the half of the total followed by Industry and Agriculture and Irrigation. These existing independent systems by different ministries suggest 1) MEPE has the potential of supplying of additional 25% of demand in the ministries of Myanmar government itself and 2) potential increase in efficiency through the coordination of these ministries by connecting each other and by allocating fund in a cost-effective way.

For example, one can compare the costs of two cases of 1) independent generation by the Ministry of Agriculture and Irrigation, for example, and 2) expansion of MEPE generation capacity and grid to sell electricity for that Ministry. Depending on the situation the latter is cheaper than the former because of the scale merit. Without coordinated electricity generation planning, the possibility is the exclusion of the latter case even if the latter case is cheaper than the former.

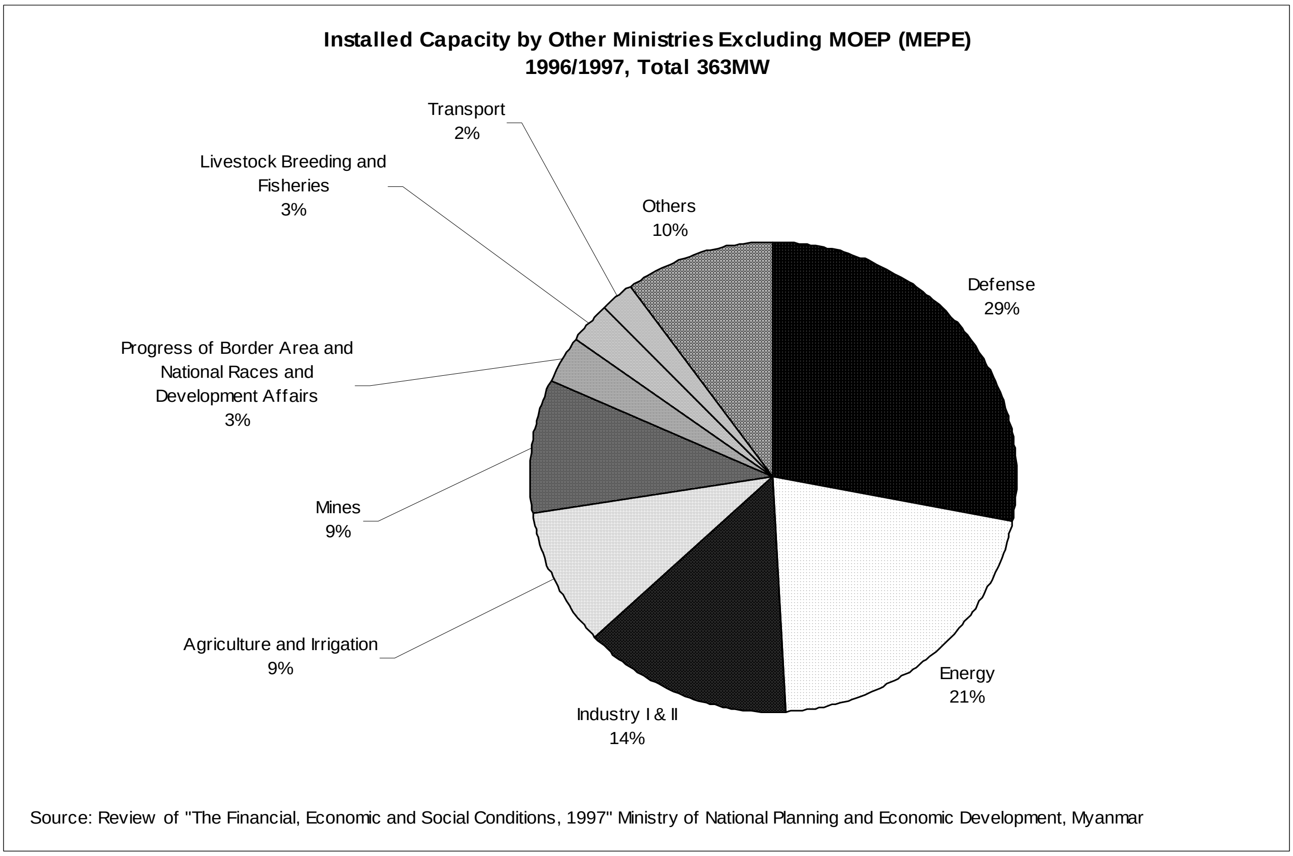


Figure 2 Installed Capacities by Other Ministries

2.2.2 MEPE Expansion of Install Capacity and Losses

In the past decade, MEPE expanded the capacity from 792 MW (1989-90) to 1,172MW (1999-2000), almost 50% larger. The total generation increased from 2,494 GWh to 4,788 GWh, about 91% of increase. Because the growth of generation is larger than the growth of capacity, the generation per unit capacity has increased. This implies a shortage of capacity compared to the actual generation.

These increases are not continuous, but rather stepwise as shown in below Figure 4. It seems one step of capacity expansion took 5 years.

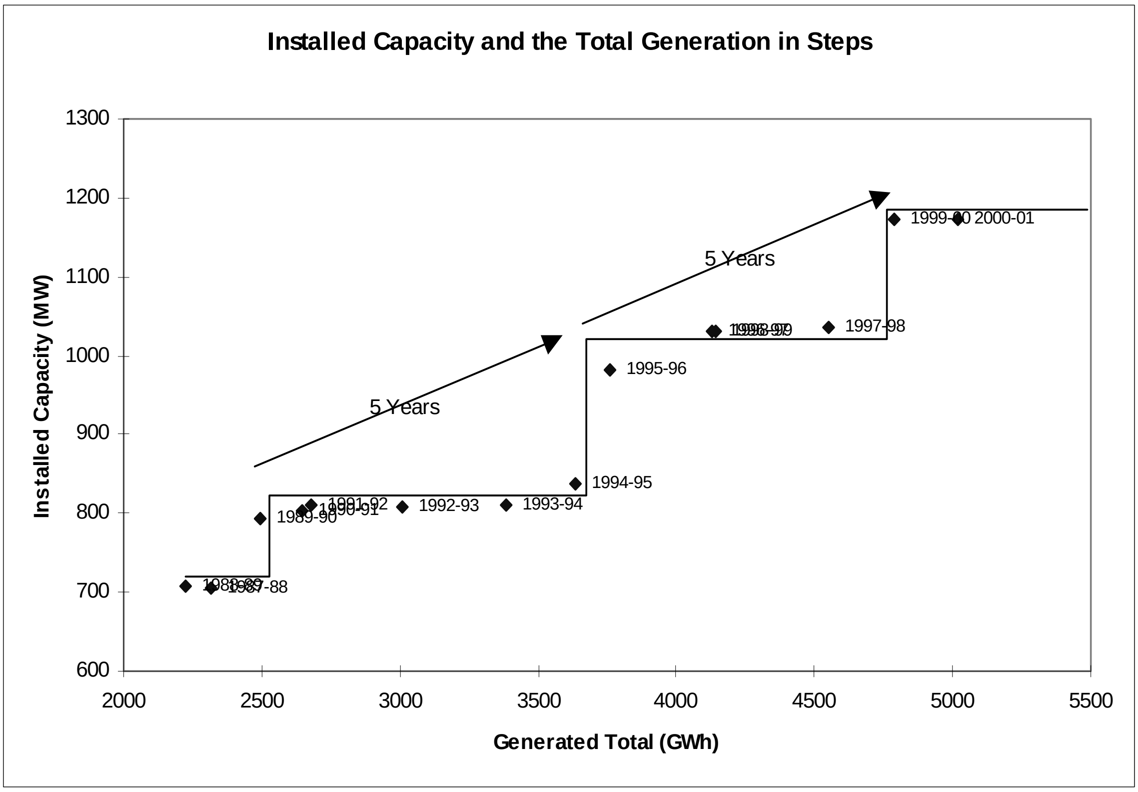
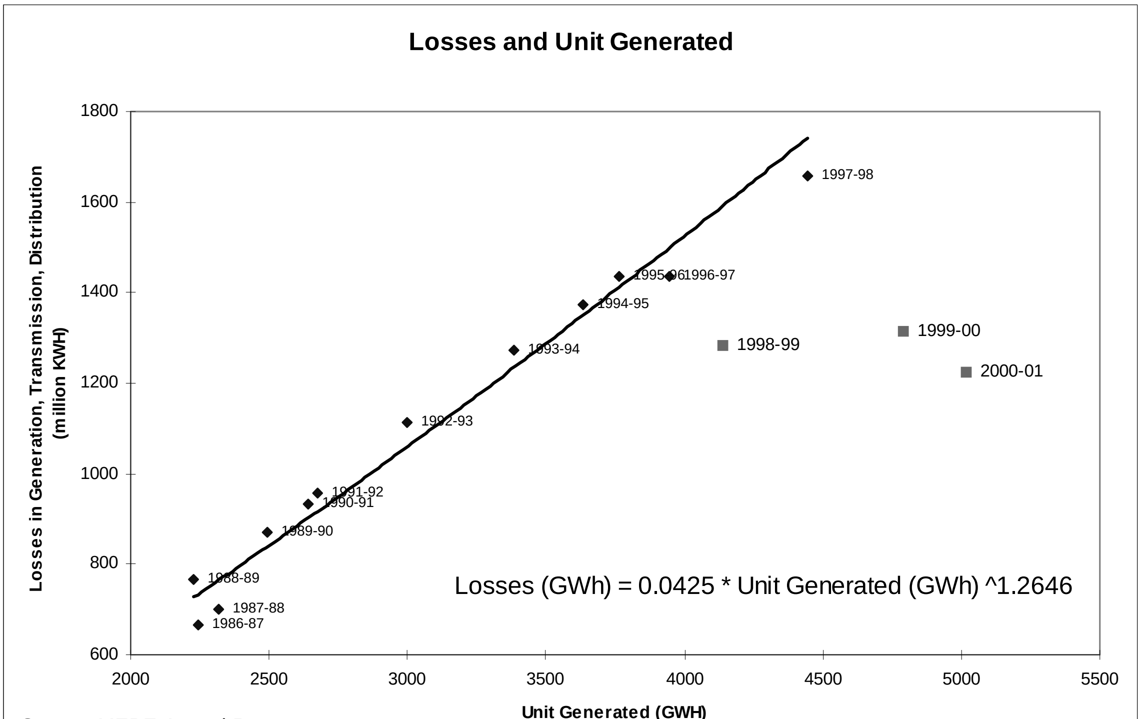


Figure 3 Installed Capacity and the Total Generation in Steps

Next Figure shows the relationship between losses and unit generated. The growth trend line is the fitted line for the period from 1986-87 to 1997-98. The latest three points are excluded because they are provisional. The fitted equation shows that the elasticity of losses for the generation is more than one—1.26, means that one percent of expansion of generation causes 1.26 percent of increase in losses. In other words, the more MEPE generates, the more increase in the rate of loss. This suggests that the reduction of loss is critical for RE if it is supplied from the extension of grid.



Source: MEPE Annual Report

Figure 4 Losses and Units Generated

At this moment, the losses reached more than 30% of total generation including technical and non-technical losses. In such a situation, the benefit from loss reduction could be significant especially from the reduction of non-technical loss such as a theft of electricity. In theory, the investment for loss reduction (K/Units) could be up to the marginal benefit or the sales price of unit. According to MEPE, the average selling price per unit in 1999-2000 is K5.86/ kWh. Because the losses is about 1,660 GWh, the lost opportunity is 1.660*5.86 = K9.73 trillion. Under this situation, the investment into the reduction of electricity loss can be justified up to K5.86/kWh. Considering that the power generation is using fossil fuels in more than 83%, the lost benefit or the cost of the losses could be much higher. As will be detailed in chapter 5, if the power is provided by grid, the benefit in terms of the saved fuel from the reduction of loss is at least US$0.03/kWh or K15 /kWh (1$US = K500) —more than two times valuable than the MEPE’s unit generation cost.

2.2.3 MEPE Tariff

The detailed MEPE tariff rates are summarized in the Attachment 1: Electricity Tariff of MEPE

The next figure compares the historical change of MEPE energy charge (general purpose base rate), MEPE fixed charge (general purpose base rate), and the price index of fuel& light. As will be clear, the fixed rate is close to the price index, whereas the energy charge is still 1/10th of the price level compared to the early 1980's.

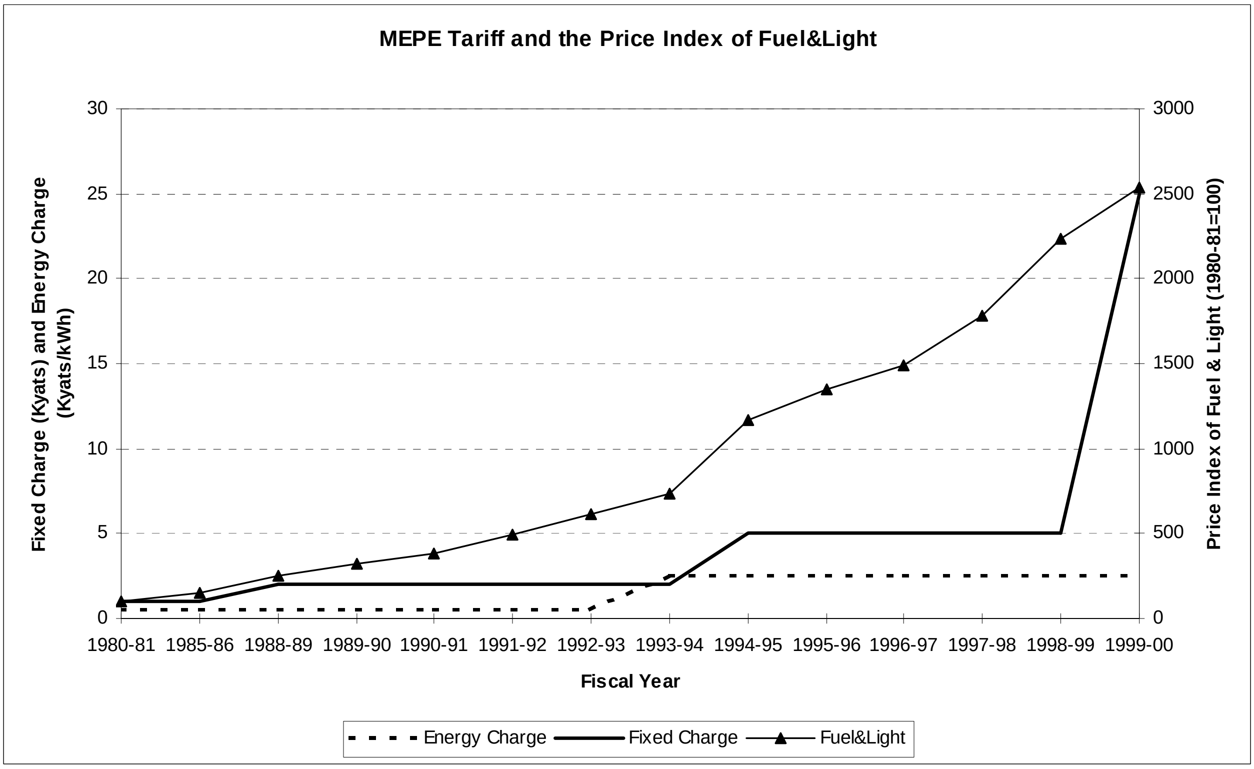


Figure 5 Historical Changes in MEPE Tariff and Price Index of Fuel & Light

This significantly low level of charge might be a result of a consideration of a poor and social stability. However, as will be discussed later the charge is significantly lower than the economic cost of electricity, thus it would have caused significant burden on the energy sector of Myanmar. Because rural electrification ratio is low and the MEPE electricity supply is prioritized to cities, the cheap price of electricity would have helped the urban residents more than rural residents.

This means that the primary beneficially of MEPE electricity supply is the city residents. Considering that the economic cost of electricity is higher than the present MEPE tariff, the difference has to come from somewhere else. Because there is no such tax like electricity tax or the equivalent, the burden is on not only on the MEPE electricity consumer, but also those who are not consuming MEPE electricity. From the point of RE, therefore, the MEPE electricity consumers of city residents should become the major financial sponsor, at least at the initial stage of the investments.

Although an earmarked tax on electricity consumption is one of such policy tool, it may not be applicable because of political constraints. In fact, the progressive structure of income tax of Myanmar implies that the urban residents are contributing more to the general governmental revenue than rural residents. This means that a little more relative increase of MEPE expenditure for rural than urban area has the same effect of a burden on urban residents, although this is a matter of balance between financial fairness and political priority.

2.3 MEPE Financial Statements

- Income Statement

Table 3 Income Statement

Consolidated Revenue Accounts (million Kyats) Year	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01
Income Total	433.2	481.1	544.1	816.0	860.8	880.2	979.3	1069.6	2044.1	2890.1	3185.1	3697.1	4219.5	20072.6	22381.3
Sales of Electricity	424.3	442.8	532.0	779.0	822.2	839.8	918.0	1021.7	2001.0	2827.3	3086.3	3530.0	4084.8	19743.4	21976.2
Others	8.9	38.3	12.1	37.0	38.6	40.4	61.2	47.9	43.0	62.8	98.8	167.1	134.7	329.2	405.1
Generation Expenses	182.6	215.2	285.0	423.3	491.8	587.8	641.5	588.0	690.0	889.7	898.2	1608.8	4104.9	18316.1	17935.8
Salaries & Wages	9.2	10.5	10.9	23.7	23.3	24.2	23.7	30.3	30.7	31.6	31.2	30.2	27.1	32.6	34.2
Fuel Consumption	80.8	103.8	163.7	240.1	316.5	391.5	447.6	374.1	433.9	613.6	597.0	1281.1	3746.0	1663.2	1554.7
Purchase of Electricity	3.9	1.2	1.3	2.3	2.0	7.4	4.2	7.4	4.1	4.0	2.8	2.7	10.6	16173.6	15884.2
Depreciation	81.1	92.2	102.6	146.3	137.7	143.7	151.5	143.5	193.7	202.9	214.1	213.9	210.1	226.9	233.7
Maintenance, Repairs, and Other Expenses	7.6	7.5	6.5	10.9	12.3	20.9	14.5	32.7	27.7	37.6	53.0	80.9	111.1	219.8	229.0
Transmission Expenses	22.5	27.5	28.8	42.1	41.4	45.1	46.6	86.9	106.9	113.9	146.3	108.5	185.3	230.5	239.3
Salaries & Wages	3.5	4.0	4.0	9.0	20.6	21.6	11.7	15.1	15.6	15.5	15.1	15.5	16.1	44.0	45.0
Depreciation	12.5	16.9	17.2	11.9	17.8	20.2	18.5	39.6	53.9	54.7	62.9	46.0	72.8	72.8	75.0
Maintenance, Repairs, and Other Expenses	6.4	6.6	7.6	21.3	3.0	3.3	16.4	32.2	37.4	43.6	68.3	47.0	96.5	113.7	119.4
Distribution Expenses	28.9	31.6	35.0	65.1	71.2	82.9	92.2	100.9	128.4	158.9	274.3	341.1	324.4	444.2	462.8
Salaries & Wages	10.4	11.2	11.6	26.9	26.8	28.7	29.4	39.2	41.0	41.6	41.7	42.5	40.8	58.9	61.9
Depreciation	11.2	11.9	13.9	21.1	24.5	29.9	45.6	49.1	63.0	74.1	125.8	169.6	112.2	179.9	185.3
Maintenance, Repairs, and Other Expenses	7.3	8.5	9.5	17.1	19.9	24.3	17.3	12.6	24.4	43.2	106.9	129.0	171.4	205.3	215.6
Administrative Expense	195.3	207.9	236.0	200.6	208.5	197.2	258.8	309.3	432.4	608.9	685.1	699.6	740.1	1878.6	1970.8
Salaries & Wages	27.9	31.0	31.7	58.4	59.1	59.2	60.1	80.8	86.8	91.2	88.7	93.6	96.2	103.8	109.0
Depreciation	11.2	10.4	11.0	10.8	11.9	9.8	12.7	13.6	21.6	54.2	58.2	62.9	40.1	66.7	68.7
Maintenance, Repairs, and Other Expenses	28.2	24.1	21.2	35.4	51.2	40.2	41.7	60.8	80.5	153.9	220.5	216.6	261.6	604.6	591.7
Interest Expenses	112.4	125.2	148.6	61.2	45.2	44.9	94.5	97.5	114.4	120.7	108.2	85.5	84.9	73.1	64.5
Commodity & Sales Tax	15.6	17.2	23.5	34.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Commercial Tax	0.0	0.0	0.0	0.0	41.0	43.0	49.8	56.6	129.1	189.0	209.6	241.0	257.3	1030.4	1136.9
Total Expenses	429.3	482.2	584.8	731.1	812.9	912.9	1039.1	1085.1	1357.7	1771.3	2004.0	2758.0	5354.8	20869.3	20608.8
Profit/Loss before Taxation & State Contribution	3.9	-1.1	-40.7	84.9	47.9	-32.7	-59.8	-15.5	686.4	1118.8	1181.2	939.1	-1135.3	-796.8	1772.5
Income Tax	0.0	0.0	0.0	0.0	14.4	0.0	0.0	0.0	205.9	335.6	354.3	247.5	0.0	6.2	738.0
State Contribution	1.2	0.0	0.0	84.9	33.5	-32.7	-59.8	-15.5	480.5	783.1	826.8	577.7	1300.1	14.4	1721.9

- Balance sheet

Table 4 Balance sheet

Balance Sheet (million Kyats) Year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Assets															
Fixed Assets															
Capital Expenditures	2567.3	3154.0	3177.5	4545.1	4714.0	5138.2	6179.7	8073.7	9779.4	10534.3	11458.5	12328.3	13792.6	14668.1	15593.5
Less:- Accumulated Provision for Depreciation	832.6	969.5	1115.3	1958.4	2142.8	2351.4	2580.4	2864.7	3256.4	3644.6	4046.7	4561.2	4865.5	5411.9	5974.6
Net Capital Expenditure	1734.6	2184.6	2062.2	2586.7	2571.2	2786.7	3599.2	5209.0	6522.9	6889.7	7411.8	7767.1	8927.1	9256.2	9618.9
Capital - Work in Progress	2636.5	3008.2	3683.3	3684.9	4007.4	4042.7	3830.4	2381.4	1497.2	2685.2	3957.6	6836.0	8628.1	11474.8	12647.4
Current Assets															
General Stores	768.4	739.0	712.1	677.4	759.5	781.2	747.8	869.5	1045.6	1077.0	1537.6	2730.7	3525.3	3807.4	4112.0
Fuel, Petrol, Oil & Lubricant	1.8	1.5	2.6	3.5	9.7	8.2	9.1	12.5	21.1	23.9	24.6	74.7	100.1	115.1	132.3
Consumer's Accounts	81.9	109.3	125.0	163.6	172.5	120.6	161.2	195.8	403.0	528.3	648.5	706.3	1127.4	5330.7	5933.6
Other Debtors	246.7	237.1	250.5	356.2	578.3	542.6	612.3	626.4	625.8	764.6	922.1	1084.0	1427.9	1499.3	1574.2
Cash in hand	0.0	0.0	0.0	0.1	0.1	0.2	0.1	0.1	0.5	0.6	0.4	0.5	0.9	0.9	0.9
Cash in transit	31.4	45.4	19.8	14.7	11.9	11.0	13.2	15.1	8.6	8.1	4.7	17.8	25.5	26.8	28.1
Cash at Bank	70.3	62.3	126.8	124.0	142.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	1200.5	1194.5	1236.9	1339.6	1675.0	1463.8	1543.5	1719.4	2104.6	2402.4	3137.9	4614.2	6207.0	10780.1	11781.2
Total Assets	5571.6	6387.3	6982.4	7611.2	8253.6	8293.2	8973.2	9309.8	10124.7	11977.2	14507.3	19217.3	23762.2	31511.1	34047.4
Liabilities															
Government Equity Capital	161.8	161.8	161.8	161.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Government Loan	164.4	164.4	164.4	164.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Government Guranteed Loan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Current Account with the Government	26.0	26.0	26.0	26.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Union consolidated Fund	275.9	265.8	255.7	255.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Government Account(1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Initial Investment	0.0	0.0	0.0	0.0	607.8	3814.3	3814.3	3814.3	3814.3	3814.3	3814.3	3814.3	3814.3	3814.3	3814.3
Government Account(2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operating Investment	0.0	0.0	0.0	432.2	748.4	1004.8	1237.6	1489.7	2023.9	2900.1	4392.3	6497.7	11867.7	16520.5	19063.6
Revenue Account	329.1	332.9	282.3	136.1	136.1	136.1	136.1	136.1	136.1	136.1	136.1	136.1	136.1	136.1	136.1
Capital Reserve	28.8	32.1	40.8	215.9	234.7	374.2	422.6	458.7	605.6	1094.9	2012.7	3493.1	3977.5	7081.4	7081.4
Foreign Loan	1673.7	2020.0	2233.9	2311.8	2416.6	2354.4	2531.7	2541.0	2489.8	2440.6	2361.4	2488.1	2409.2	2331.1	2250.7
Bank Loan (State Investment)	2762.4	3178.2	3419.1	3419.3	3419.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	5422.1	6181.1	6583.9	7123.1	7563.0	7683.8	8142.3	8439.8	9069.6	10385.9	12716.8	16429.3	22204.8	29883.4	32346.1
Current Liabilities															
Consumer's Deposit	79.0	83.3	84.8	99.6	110.5	120.1	129.6	137.6	146.9	168.4	191.7	224.0	254.1	259.2	264.4
Other Creditors	70.5	122.8	313.7	388.5	580.2	489.3	701.2	732.4	908.1	1422.9	1598.8	2114.0	1303.4	1368.5	1436.9
Total	149.5	206.1	398.5	488.1	690.7	609.4	830.9	870.0	1055.0	1591.3	1790.5	2338.0	1557.5	1627.7	1701.3
Total Liabilities	5571.6	6387.3	6982.4	7611.2	8253.6	8293.2	8973.2	9309.8	10124.7	11977.2	14507.3	18767.3	23762.2	31511.1	34047.4

- Cash flow

Table 5 Cash flow

Cash Flow Statement (million Kyats) Year	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01
Source of Fund															
Internal Cash Generation															
Net Income Available For Fixed Charges	123.9	129.0	98.0	-85.1	45.2	44.9	94.5	97.5	114.4	120.7	108.2	85.5	84.9	73.1	64.5
Depreciation	120.5	136.8	145.8	843.1	184.4	208.7	229.0	284.3	391.7	388.1	439.8	514.5	304.3	546.3	562.7
Total Internal Cash Generation	244.3	265.8	243.8	758.0	229.6	253.6	323.5	381.8	506.1	508.8	548.0	600.1	389.2	619.4	627.2
Borrowings															
Local Bank Borrowing	337.5	415.7	240.9	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Foreign Loan	290.5	408.6	316.2	224.7	156.1	104.1	217.1	34.8	5.3	0.0	29.0	186.0	0.0	1.1	0.0
Total Borrowings	628.1	824.4	557.1	224.9	156.1	104.1	217.1	34.8	5.3	0.0	29.0	186.0	0.0	1.1	0.0
Other Sources of Fund	-6.2	-6.8	-1.5	607.3	335.0	396.0	281.2	288.2	681.1	1365.5	2410.0	4035.8	5404.4	7756.8	2543.1
Total Sources of Fund	866.2	1083.4	799.4	1590.2	720.8	753.6	821.8	704.8	1192.5	1874.3	2987.0	4821.9	5793.6	8377.3	3170.3
Application of Fund															
Capital Investment Program															
Project Construction	573.7	958.4	698.6	1369.2	491.5	459.4	829.2	445.0	821.5	1942.9	2234.4	3748.3	3256.4	3722.1	2098.0
Total	573.7	958.4	698.6	1369.2	491.5	459.4	829.2	445.0	821.5	1942.9	2234.4	3748.3	3256.4	3722.1	2098.0
Debt Service															
Interest	112.4	125.2	148.6	61.2	45.2	44.9	94.5	97.5	114.4	120.7	108.2	85.5	84.9	73.1	64.5
Loan Repayment	116.0	62.4	102.3	146.7	51.3	166.2	39.8	25.5	56.6	49.2	108.2	59.3	78.9	79.2	80.4
Total	228.4	187.5	250.9	207.9	96.6	211.1	134.3	123.0	170.9	169.9	216.3	144.8	163.8	152.3	144.9
Variation in Working Capital															
Cash Increase (Decrease)	-28.6	6.0	39.0	-7.8	16.1	-143.8	2.1	1.9	-6.1	-0.5	-3.5	13.3	8.0	1.3	1.4
Other than cash Increase (Decrease)	92.7	-68.6	-189.0	21.0	116.7	226.8	-143.8	134.8	206.2	-238.0	539.8	915.5	2365.4	4501.5	926.1
Net Increase (Decrease)	64.1	-62.6	-150.0	13.2	132.8	83.0	-141.7	136.7	200.1	-238.5	536.3	928.8	2373.4	4502.8	927.4
Total Application of Fund	866.2	1083.4	799.4	1590.2	720.8	753.6	821.8	704.8	1192.5	1874.3	2987.0	4821.9	5793.6	8377.3	3170.3

3 EXAMPLES OF RE BY RENEWABLE ENERGY IN MYANMAR

The community based RE in Myanmar, which was surveyed during the mission, was summarized from the points of financial, economic, and O&M.

Refer Attachment: RE by Renewable Energy in Myanmar

4 FINANCIAL AND ECONOMIC ANALYSES OF RENEWABLE-BASED RE

In this study, the renewable energy sources considered for RE are small/micro hydropower, wind energy, photovoltaic, and biomass energy.

4.1 Cost

4.1.1 Economic Characteristics of Renewable Energy

Conventional thermal power plants use fossil fuels such as oil, natural gas or coal. In all these cases the fuel can be stored for various periods of time with a view to meeting daily, weekly or seasonal fluctuations in the electricity demand. Also the stored fuels can be brought to anywhere if necessary.

The renewable-based systems or power plants use the flow of natural energies, which are unstable depending on time and space. Renewable energies such as solar energy, wind, rivers' water flow, and biomass are renewed periodically or continuously depending on the natural environment.

There are some exceptions. For small hydropower, a man-made small reservoir up-stream may allow modulation of water flow volume by hourly periods. For biomass the way to store depends on the type of source. Solid like wood and rice husk can be stored as it is. The store of animal mature for biogas requires additional care not to loose the gas contents.

These characteristics of renewable energies have several consequences.

1) Cost of Storage

Because of the unstable supply, it might be necessary to prepare storage of electricity or to complement with other stable system. Especially such small systems like small-scale photovoltaic and wind systems often require batteries because the time of power demand (usually nighttime) and the time of power supply (daytime for photovoltaic panel) differs. For small hydro and biomass, construction of special structure to store the water flow or the biomass makes it possible to adjust the supply timing to the demand timing.

2) Low Capacity Utilization Rate

The element of inefficiency of renewable energy is not only the mismatch of physically available peak and the peak of human demand, but also the uncontrollable nature itself. Thai is, for the renewable-based power plants or systems, the power from sun, river, or wind varies by day and night and by season makes capacity utilization rate low.

Because of the low utilization rate, it cannot take advantage of the scale merit. In other words, the unit cost tends to be higher than the system for a large urban demand. Or the size can be larger, but the actual supply tends to be much smaller than the potential.

4.1.2 Characteristics of Cost Structure

The components of the cost usually classified as the investment cost, operating cost and repair-maintenance cost.

Except for biomass power plants, one of the common characteristics of renewable-based electricity production is that the resource itself is “free of charge”; sun, wind, and water. Moreover, operating and repair-maintenance expenditure are low, particularly in the case of photovoltaic solar panel and wind turbines.

Thus, the structure of the cost of a kWh delivered by a renewable-based system includes a large part for the initial investment amortization, zero for the fuel expenditure (except for biomass power plants) and a very low or moderate part for the operating and maintenance expenditures.

This structure is completely different from the one of a kWh delivered by fossil fuels (thermal power plants and diesel generator): the initial investment cost is low, whereas the expenditures for fuel and operating-maintenance are considerably high.

4.1.3 Cost Comparison Method

One of methods to compare the costs of an electric kWh produced by renewable energies is to compare the overall discounted cost of a kWh (investment, operating, repair and maintenance cost). This method is particularly useful during the initial phases of a rural electrification project (feasibility study and preliminary estimates), mainly for a quick comparison between conventional options and options utilizing various renewable energies available.

The cost is represented by the value of annualized cost C, so that the sum of the annual payment of C in present value for the whole plant life is equal to the total present value of cost Ct, which include initial investment cost, O&M cost and fuel cost if required. The relationship can be formulated as follows with discount rate r and period of n years of plant life.

$Ct \quad = C \times 1 / (1+r) + C \times 1 / (1+r)^2 + ...+ C \times 1 / (1+r)$

$= C \times (1 / (1+r) + 1 / (1+r)^2 + ...+ 1 / (1+r)^n)$

$= C \times ((1+r)^n - 1)/(r \times (1+r)^n)$

$= C / CRF$ [CFR: Capital Recovery Factor = $r \times (1+r)^n / (1+r)^n - 1)$]

Or $C = C_t \times CRF$

For example, the annualized cost of total $1000 in present value for ten years with discount rate 15% is calculated as $199.25 (= $1000 \times 0.15 \times 1.15^{10}$ / (1.15^{10}-1). This means that the present value of $1000, for example the investment of the first year and no other cost, is equivalent to pay annually $199.25 for ten years under the discount rate 15%.

To think about monthly cost, the monthly discount rate and the number of month instead of year can be applied to the above equation. However, in this study, for the purpose of simplicity, it is calculated as 1/12 of the annualized cost. For the above case it is calculated as $16.6 (=199.25/12).

With this annualized or monthly value, the comparison with benefit is also getting easy. The above example is equivalent to say that the monthly benefit or the sales of $16.6 for the total cost of $1,000 in present value has IRR 15% for life of 10 years.

The unit production cost or kWh cost depends on the length of the operation. The length of the operation is represented by the load factor L. If the operating kW is constant, the L is given by the annual operating hours divided by the total hours of a year—8,760 (=365 days x 24 hours). Then the unit production cost Cp is given by the ratio of the annualized operating cost and the total output in kWh. With annualized cost C, load factor L, and the capacity K (kW), the unit production cost Cp ($/kWh) is calculated as follows.

$Cp = C / (K \times 8{,}760 \times L)$

For example, given the annualized cost $200, capacity 1kW, operation 10 hours (load factor = 10/24), Cp will be 0.054 (= 200/(1 x 8,760 x 10/24) or about five cents per kWh.

4.2 Benefit

The key in the analysis of rural electricity supply investments is the correct measurement of the benefits of electricity consumption. The principle of benefit valuation is to measure the value of incremental electricity supply to the consumers. Therefore it should be applied to the additional investments or replacements, but should not include the avoided cost. For example, if the benefit includes the avoided costs of an isolated grid based on diesel generation as the benefits of connecting the area to a central grid, it is over estimation, unless the project is replacing an existing diesel generation.

The primary difficulty of measuring the value that consumers allocate to additional power supply is that lack of an observable competitive market price for electricity. The actual willingness of consumers to pay for incremental supply, therefore, has to be estimated from observed consumers' behavior with and without power connections.

One simplest alternative for consumers' willingness to pay is the electricity tariff. This has drawbacks: electricity supply is often priced below cost. Nevertheless, the tariff actually paid is the only unambiguous signal given by consumers as the minimum value. For this reason, the tariff represents a lower bound of willingness to pay.

As electricity usually is not an internationally traded commodity, the demand for it within a grid system depends on price charged. The question is how to determine the price or the value of a kWh consumption of electricity.

One, which can be measured, is the cost of using alternative energy (kerosene lamps, diesel engines or pumps). As these alternative private uses are observed at the consumers' level, their cost is an economically legitimate measure of the willingness to pay for certain applications of energy that can be replaced by electricity.

The willingness to pay usually declines as consumption increases up to the point, where willingness to pay only equals the tariff-based use of electricity.

The quality improvement is also a big factor for an increase of willingness to pay. Indeed the improvement of voltage or the superior lighting quality of electricity versus kerosene will, for example, 1) improve the education to provide more time for study at night and 2) improve the facility of hospital to contribute to the health.

As such, contrary to the case of cost, the direct benefit from the consumption of electricity does not differ by the differences of sources whether from conventional diesel power or state of art solar photovoltaic power. However, the use of renewable energies will yield additional benefit from the point of pubic utility or from the point of the whole country as follows.

1) Renewable energies bring cost savings from the replacement of existing fossil-fuel-based alternatives.
   - The replacement of diesel power supplied electricity will save at least the fuel cost, although it requires larger initial investment costs compared to diesel-based system.
   - The replacement of candle or kerosene will add the economic benefit to the country.
2) Renewable energies bring indirect benefits from the reduction of CO_2 emission and other environmental benefits.

4.3 Discount rate

Discount rate is the cost to raise capital and borrow money in the market. It can be calculated as a weighted average of the cost to borrow money and the cost of capital. The cost to borrow money can be represented by the weighted average of dominant borrowing rates. For example, it is calculated as the weighted average of lending rates of domestic and foreign lenders. The cost of capital can be represented by such as the expected return of the market portfolio and the value of marker return calculated from a model such as capital asset pricing model.

In case of public project such as the rural electrification by government, the discount rate is often represented by the rate that government borrows from public, for example the long-term government bond rate.

The discount rate in this study should follow the latter case. However, all official saving and lending rates are controlled by government, the calculation of discount rate by public figures can be misleading. Therefore, the study cannot have a reliable value of discount rate. Instead, in this study, the discount rate was estimated roughly to be somewhere between the government lending rate and unofficial market rate.

4.4 Financing

4.4.1 Governmental Involvement

As the volume of initial investment cost is important, the renewable energies are more sensitive to the discount rate than the options with a high operating cost (e.g. fuel price for diesel). To choose a low discount rate means to give priority to the long-term options and the public authorities should intervene with basic investments such as those in the electrification of rural areas.

Therefore, the general interest and social justice are consistent with the promotion of solutions giving priority to long-term options, such as renewable-based electricity production. Also, at the community as well as at the individual level, when financial sources are not easily available, it is desirable that a preferential access to the adequate and low cost financial sources should be given to renewable-based electrification options.

On the other hand, in the case of RE undertaken by local community or private companies, the non-availability of adequate financing for initial investment may induce the promoters to prefer conventional options such as diesel generators, which need a low initial investment. However, the high operating and repair-maintenance expenditures to be borne by the operators and users may penalize them strongly. Here, the role of public authorities is to encourage of renewable-based solutions, which need low operating expenditures.

Therefore, in the case of renewable-based RE, the public authorities had better participate in the initial investments, in the same manner as they do for basic investments such as communication networks or education and health infrastructures. Financially, it would be more promising if the local operators use financial resources of their own and their customers to cover the operating and repair-maintenance expenditures. This secures the sustainability of the investments and avoids public authorities' participation to cover operating deficits.

The governmental involvement could be especially efficient for relatively large and long-life systems like hydropower system. However, a governmental involvement into a remote and small system like a system of small PV based battery-charging station or small-scale wind power system could be costly because of the transaction and administration costs. In such a case, financing initiative from individual users or community could become more realistic option.

Although the marginal cost of transaction and administration tend to be large to finance small systems compared to large systems, supply of electricity to rural and remote area is considered an important part of government responsibility. For most of developing country, however, the governmental priority of RE is not high. Fortunately, as the system becomes small, the required capital becomes small, means that locals have more chance to raise capital by themselves for small system.

Taking these trade-offs into consideration, the direct involvement of government had better focus on comparably larger systems of renewable based system like mini hydropower from the point of financial cost. For small systems of remote area like biomass gas engine, the governmental aid had better focus on the credit market to help locals to raise capital by themselves.

4.4.2 Financing Problems and Options of Private Sector for Small Systems

The problem of private sector is that there is no market infrastructure to handle the required capital flows to finance RE including relatively large system of hydropower and relatively small system like PV and rice husk gas engines.

There are at least two finance-related concerns. First, purchasers of small renewable-based systems must be able to obtain credit from banks or from distributors. Second, manufacturers and distributors must be able to secure working capital if they are to provide credit to customers.

1) Purchaser Credit

The need for purchaser credit is clear. The renewable-based small systems like a small solar battery charging station or rice husk gas system costs at least several hundred dollars for each unit. For rural residents of developing country, the amount could be more than their annual income. It is comparable to buy a car in a developed country. In developed country, when one wants to buy a car, a well-established financial infrastructures link customers to manufacturers to capital markets and a wide array of financing choices are available from banks, leasing companies and dealers. But in most developing countries, such financing of large amount is unavailable.

One potential scheme is supplier's credit, especially leasing scheme from manufacturers or distributors. Because the ownership belongs to the supplier, usually the initial down payment is not necessary. For example, in the Dominican Republic, Soluz, a for-profit entity affiliated company is supplying nearly 1,000 poor rural households with solar systems tailored to their individual needs. Households will pay just a few dollars each month for the service, even less than they would owe if they had purchased a system on credit. In fact, it is comparable to how most end users pay for electricity—through small monthly payments.

2) Working Capital for Manufacturers and Distributors

Working capital is necessary to provide supplier's credit to customers from the point of manufacturers and distributors. No sophisticated financing schemes available—like the purchase of loans by third parties, which is common in debt markets of industrialized countries. Another problem is the small-scale of the projects, which makes the projects unattractive for large investors.

One potential solution is that the rural vendors of renewable energies might bundle and sell its receivables to outside investors directly. The investor would be given a percentage of the interest paid by purchasers and the companies would be able to provide financing to another round of customers. As the amount of bundled receivables from the market grows, a debt fund mechanism might be developed that holds receivables from many projects, into which many investors could buy. This would help achieve the economies of scale that are available in the automobile, credit card and debt markets of developed countries.

A more sophisticated scenario is that the rural vendors would approach a commercial bank or finance company for a loan or an equity investment. The bank or finance company would gather the individual renewable-energy loans into renewable-energy portfolios and sell them to an investment bank. The investment bank would bundle these into securities and sell them to insurance companies and other institutional investors.

For example, one private Dutch investment bank, Triodos Bank, lowered the cost of solar electricity for rural households by providing loans for the purchase of solar house system (SHS) to solar-service companies, credit institutions, NGOs and village cooperatives that have already proven successful. In 1995, Triodos extended a $52,000 loan to a SHS provider in Uganda, and in 1996 loaned $390,000 for similar project in Swaziland. The debtors pay back the loans with the money they receive from lease or interest payments on the systems of their individual customers.

These options are potential and do not promise anything for Myanmar. For a country like Myanmar, whose financial system does not rely on market mechanism, the above options might not be applicable. Rather, community-based cooperative approach like financing lead by village leader or monastery with the help of local government might be more realistic, although it cannot take advantages of the scale merit of market mechanism as mentioned above.

5 CASE OF MYANMAR; FINANCIAL & ECONOMIC ANALYSES OF RE

5.1 Benefit

The quantifiable benefit of rural electrification was estimated by the willingness to pay. The willingness to pay was estimated based on the next least cost alternative of electricity. The field survey found that for 100% of villagers of non-electrified village, the primary demand for electricity is for lighting. The alternatives of electricity for lighting in rural area are 1) candle and 2) diesel oil. The price of one piece of candle for one night is about K10 to K20; therefore the expenditure will be at least K300 to K600 /month. The consumption of diesel oil for lighting is about one gallon for one month at the price of about K1000. The actual prices depend on the location. Usually, the price is higher in remote area than in the urban area because of the transportation cost.

As a conclusion, the most likely range of monthly household expenditure for lighting, in the survey, is estimated to be between $1 and $2 ($1= K500) depending on the location and lifestyle. This is the minimum level of willingness to pay for electricity for lighting. The use of electricity is not limited for lighting. In fact it is indispensable for radio, TV, Karaoke, Refrigerator and etc. For those who can afford these appliances, the willingness to pay would be much higher than this range.

The benefit of rural electrification for a villager does not distinguish between renewable energies or fossil fuel energies. However, the cost does.

5.2 Cost

The cost of rural electrification depends on the way of supply. Generally speaking, the power plants of fossil fuels are relatively small in its capital cost compared with plants of renewable energy such as hydropower and solar photovoltaic system. Accordingly, the feasibility of RE by fossil fuel depends on the price of fuel, whereas the feasibility of RE by renewable energy depends on the initial capital cost.

5.2.1 Opportunity Cost of Capital & Selection of Discount Rate

The opportunity cost of capital is measured by interest rates (discount rate). When a project of RE is considered as a governmental project, rate of treasury bond 11% (2000) represents the cost of public money (see Table 6.1). However, because the inflation rate is much higher than this rate, the real discount rate has been negative. This means, the government of Myanmar would have tolerated a public project with even a negative value of IRR. This is essentially equivalent to subsidy. The so-called “7% rule” says that the interest of 7% would double the initial amount in ten years. For example, if the government rate is lower than private sector by 7%, it means the government is subsidizing a half of the cost for a project of 10 years capital recovery period. Or it is equivalent to subsidize 7% of total interest and principal payment every year.

From the point of a private sector, the interest rates set by authorities are too low and their real levels are highly negative. Because of such a distortion in the credit market, it is said that informal credit market charges at the interest rate of annual 35% to 40%. In real term, this is in the range between 0% to almost 30% depending on inflation. The average inflation of the past 10 years is about 25%, thus the real interest rate, which can represent the discount rate, would be between 10% and 15%.

Considering this, the rate 15% is used here as an upper bound of discount rate. The discount rate is, fundamentally, a measurement of discount of future value—means a measurement of risk and uncertainty in the future. They charge high interest rate to lend money because the risk and uncertainty in the future is high. In the case of Myanmar the high inflation rate would be clearly the pressure to raise the real discount rate. Another important factor is the supply and demand balance of money. The high discount rate of private sector implies the relatively strong demand for money compared to the relatively short supply of money in private sector. In contrast, the public sector was prioritized for the supply of money with increased money supply in regulated environment, which would have caused the negative discount rate in real term at the expense of inflation and money supply shortage in private sector.

The difference of the discount rate between public and private seems to be more than 15%. It means that in Myanmar, the government is subsidizing public projects more than 15% of total interest and principal payment every year.

5.2.2 MEPE National Grid

From MEPE Grid, the cost per unit is K1.04/kWh for 1997-98. After the change in tariff in 1999, the cost estimate for 1999-2000 isK6.19/kWh.

According to MEPE, for the total power generation is 4,700 GWh for 1999-2000. The source of power for National Grid is mostly from hydro, thermal and gas (see next Figure). The diesel is usually for isolated system in remote important area, the diesel can be neglected as a source of power for National Grid. The total generation by fossil fuels is 4,000 GWh (83.5%). As seen in the Figure, recently fossil fuels began to have much more weight for the MEPE power generation than hydropower. For the purpose of a rough estimate of the international value of the fuels, assuming the thermal efficiency is 38%. Then, the generation from the fossil fuels is equivalent to the magnitude of more than 7 million bbl of crude oil equivalent (gas-6.9 million, petroleum products-0.55 million) or more than $US 140million (US$20/bbl).

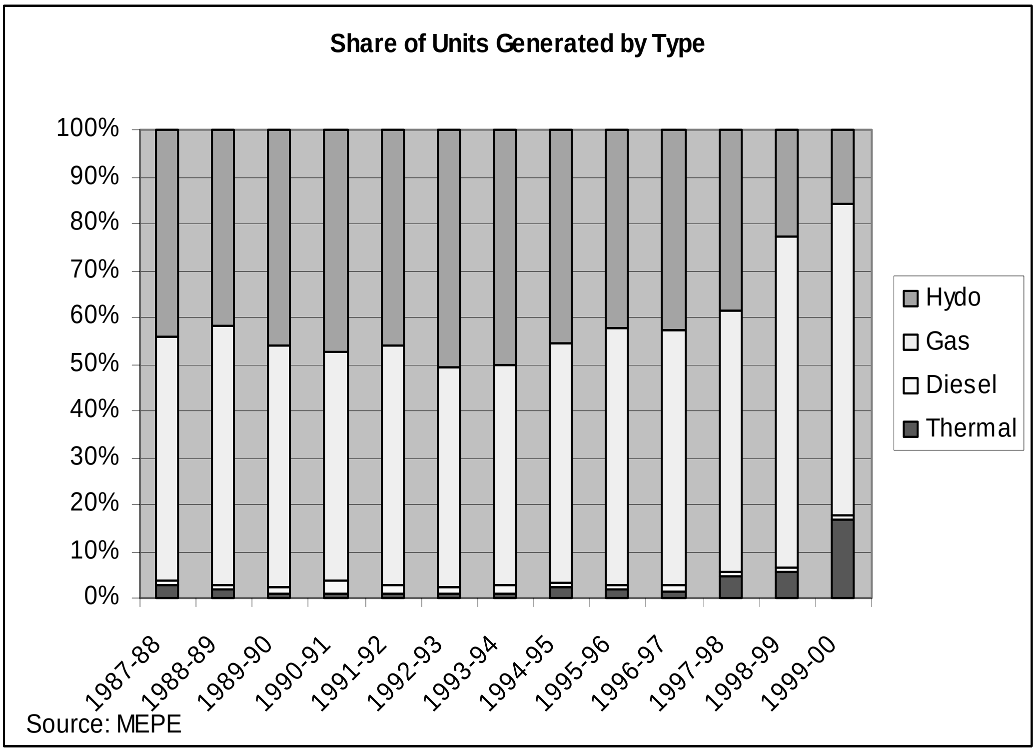


Figure 6 Share of Units Generated by Type

Therefore, the opportunity cost of power consumption from MEPE National Grid will be at least (cost of fuel) $US 0.03/kWh or K15/kWh (K500/$US)—at least two to three times higher than the current MEPE's generation cost in its balance Table. This cost estimate is the lowest bound. The actual cost could be much higher than this because the estimate is based on the highest possibility of thermal efficiency,

Because the average selling price is about K6/kWh, the government of Myanmar is losing at least K9 of potential sales of hydrocarbon for every unit of power generation. It means that the government of Myanmar can save up to about K9 /kWh if it promotes renewable energy, instead of extension of the existing National Grids.

5.2.3 Independent Diesel Generation System

According to MEPE, the installed capacity of diesel generator is 64,920 kW with total 494 units (1998-99), giving the average of 131kW capacity per generator. As shown in Figure 5.1, from the data of commercially available diesel generators of various makers, this average capacity of generator of 131 kW is estimated to consume diesel oil about 0.29litter/kWh. The international price of diesel oil is at least US$0.253/litter (see Figure 5.2—price of in USA excluding tax—the lowest among developed countries). Therefore, the diesel fuel cost for unit power generation is calculated as 0.29 litter/kWh x US$0.253/litter = US$0.073/kWh

This means that MEPE's cost for diesel power generator is at least US$0.073/kWh or K36.5/kWh (1US$ = K500). This Figure is the lower bound because the present MEPE's diesel engine is old and the fuel efficiency would be much lower.

This means that the Myanmar government may save up to 36.5-5.86 (current average payment) = K30.6 /kWh by promoting renewable energy.

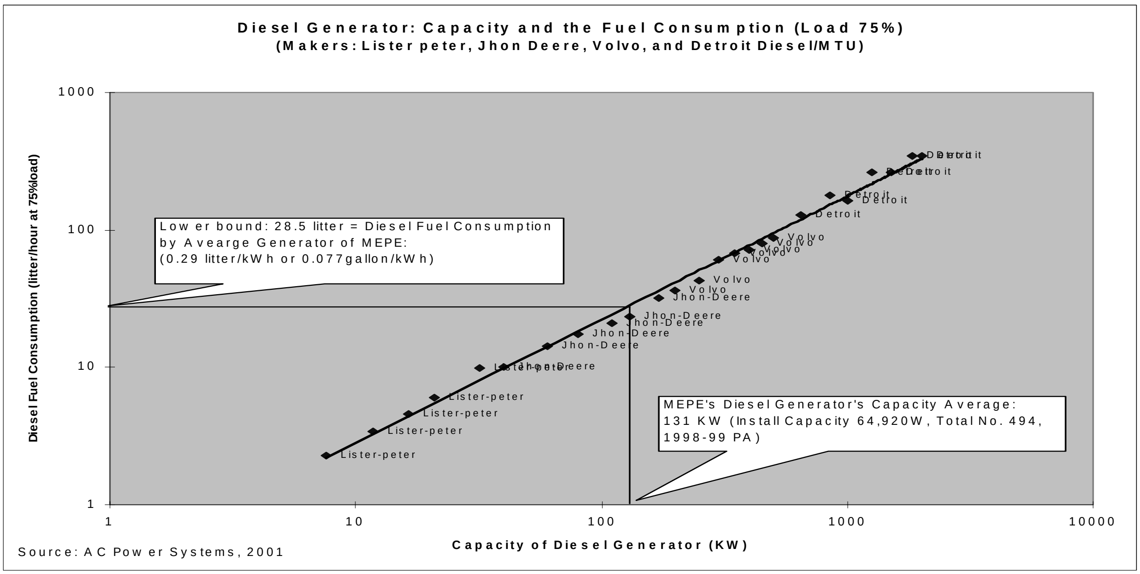


Figure 7 Diesel Generator: Capacity and the Fuel Consumption

Table 6 Price of Petroleum Products

END-USER OIL PRODUCT PRICES AND AVERAGE CRUDE OIL IMPORT COSTS

April 2001

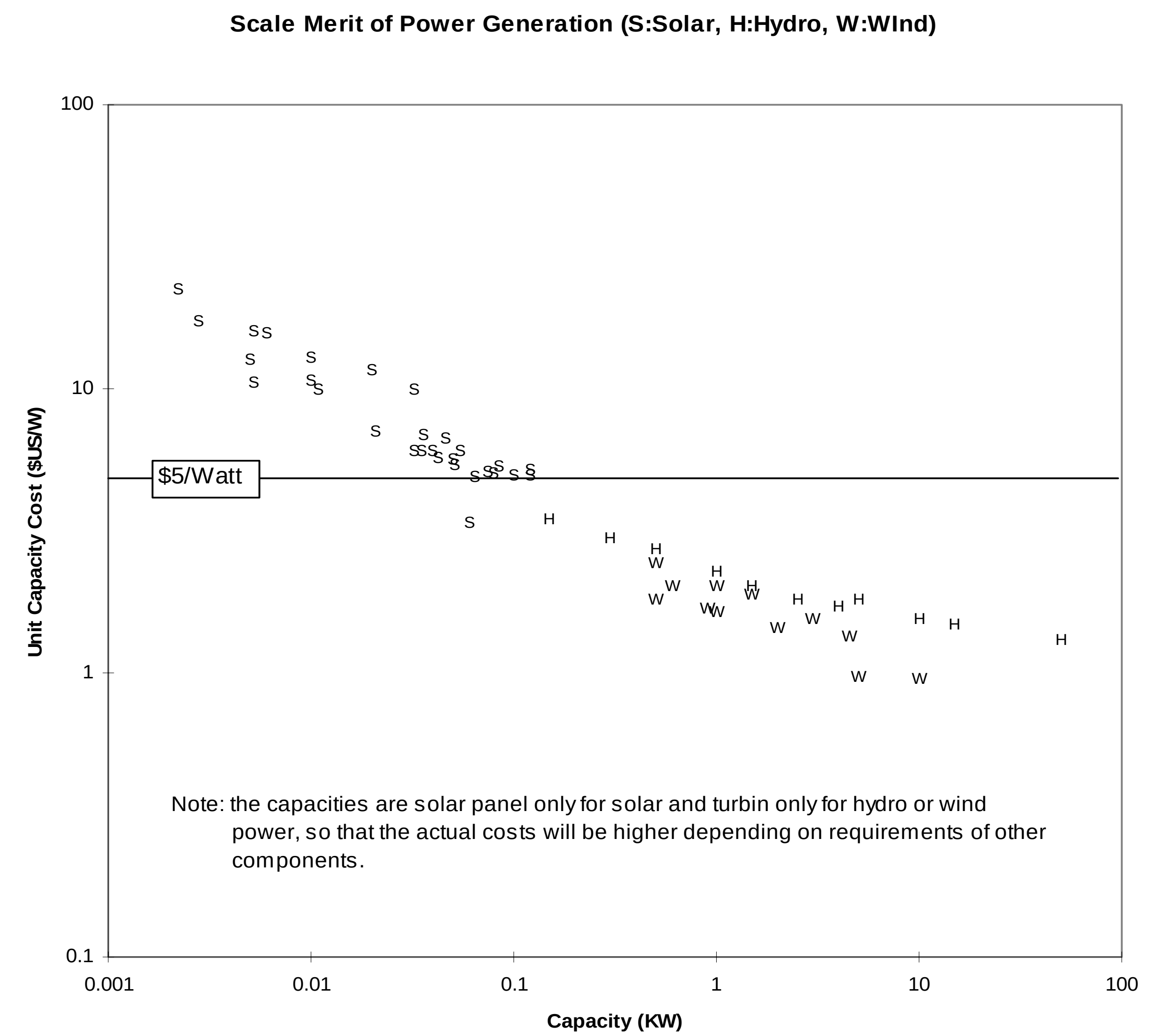
END USER PRICES FOR PETROLEUM PRODUCTS[1]

	National Currency						US Dollars					
			Percent Change Previous Month		*Percent Change Year Ago*				*Percent Change Previous Month*		*Percent Change Year Ago*	
	Price	**Tax**	*Price*	*Excl. Tax*	*Price*	*Excl. Tax*	**Price**	**Excl.Tax**	*Price*	*Excl. Tax*	*Price*	*Excl. Tax*
GASOLINE[2] Price per Litre												
France	7.109	4.929	*4.4*	*8.6*	*-0.1*	*4.7*	0.969	0.297	*2.7*	*6.8*	*-5.5*	*-1.1*
Germany	2.116	1.452	*3.2*	*9.2*	*13.4*	*30.5*	0.967	0.303	*1.5*	*7.5*	*7.2*	*23.3*
Italy	2068	1352	*1.4*	*3.5*	*1.6*	*4.0*	0.955	0.330	*-0.2*	*1.9*	*-3.9*	*-1.7*
Spain	139.1	81.0	*3.2*	*6.8*	*4.3*	*9.4*	0.747	0.312	*1.5*	*5.0*	*-1.4*	*3.4*
UK	0.760	0.571	*0.9*	*11.8*	*-2.9*	*-2.6*	1.090	0.271	*0.4*	*11.2*	*-12.0*	*-11.7*
Japan	108	59	*-0.9*	*-2.0*	*3.0*	*6.5*	0.874	0.397	*-3.2*	*-4.2*	*-12.1*	*-9.2*
Canada	0.761	0.308	*12.9*	*21.4*	*12.1*	*19.2*	0.488	0.291	*12.9*	*21.4*	*5.6*	*12.3*
USA	0.413	0.101	*8.1*	*11.0*	*3.8*	*5.4*	0.413	0.312	*8.1*	*11.0*	*3.8*	*5.4*
AUTOMOTIVE DIESEL[3] Price per Litre												
France	4.459	2.469	*2.4*	*3.8*	*1.1*	*8.2*	0.608	0.271	*0.8*	*2.1*	*-4.4*	*2.2*
Germany	1.430	0.740	*1.6*	*3.3*	*20.6*	*54.7*	0.654	0.315	*-0.1*	*1.6*	*14.0*	*46.2*
Italy	1381.67	739.06	*-2.0*	*-4.2*	*1.2*	*2.7*	0.638	0.297	*-3.5*	*-5.7*	*-4.3*	*-2.9*
Spain	99.14	44.90	*-0.9*	*-1.7*	*2.6*	*4.8*	0.532	0.291	*-2.5*	*-3.3*	*-3.1*	*-1.0*
UK	0.660	0.458	*-6.6*	*-1.3*	*-6.7*	*-1.8*	0.946	0.289	*-7.1*	*-1.9*	*-15.4*	*-11.0*
Japan	88	36	*0.0*	*0.0*	*3.6*	*6.1*	0.712	0.419	*-2.3*	*-2.3*	*-11.6*	*-9.5*
Canada	0.699	0.242	*-0.4*	*12.6*	*7.2*	*9.3*	0.449	0.293	*-0.4*	*12.6*	*1.0*	*3.0*
USA	0.371	0.118	*1.6*	*2.4*	*-0.5*	*-0.8*	0.371	0.253	*1.6*	*2.4*	*-0.5*	*-0.8*
DOMESTIC HEATING OIL Price per 1000 Litres												
France	2720.0	725.0	*2.0*	*-1.5*	*-1.9*	*11.5*	370.6	271.8	*0.4*	*-3.1*	*-7.3*	*5.3*
Germany	765.1	225.5	*9.3*	*11.6*	*12.6*	*15.9*	349.7	246.6	*7.5*	*9.8*	*6.5*	*9.5*
Italy	1563000	957898	*-1.4*	*-2.9*	*0.1*	*7.7*	721.6	279.4	*-2.9*	*-4.5*	*-5.3*	*1.8*
Spain	64191	21951	*-2.5*	*-3.2*	*0.9*	*1.2*	344.7	226.9	*-4.0*	*-4.8*	*-4.6*	*-4.3*
UK	199.03	39.78	*0.6*	*0.8*	*8.1*	*9.8*	285.6	228.5	*0.1*	*0.2*	*-2.0*	*-0.5*
Japan[4]	50400	2400	*-0.2*	*-0.2*	*9.8*	*9.8*	407.1	387.7	*-2.5*	*-2.5*	*-6.3*	*-6.3*
Canada	..	..	..	..	..	..	..	..	..	..	..	..
USA[5]	368.3	..	*-4.7*	..	*2.6*	..	368.3	..	*-4.7*	..	*2.6*	..
HFO FOR INDUSTRY[3, 6] Price per Metric Ton												
France	1051.0	121.8	*-9.2*	*-10.3*	*-2.5*	*-2.8*	143.2	126.6	*-10.67*	*-11.7*	*-7.8*	*-8.1*
Germany	341.3	35.0	*-2.0*	*-2.2*	*11.1*	*12.5*	156.0	140.0	*-3.58*	*-3.8*	*5.0*	*6.3*
Italy	406364	60777	*3.5*	*4.1*	*0.2*	*0.3*	187.6	159.6	*1.85*	*2.5*	*-5.2*	*-5.2*
Spain	30217	2235	*-1.3*	*-1.4*	*-13.6*	*-14.5*	162.3	150.3	*-2.89*	*-3.0*	*-18.3*	*-19.2*
UK	118.41	26.77	*-1.1*	*-1.4*	*-4.0*	*-5.1*	169.9	131.5	*-1.66*	*-2.0*	*-13.0*	*-14.0*
Japan	26526	1263	*0.0*	*0.0*	*11.6*	*11.6*	214.3	204.1	*-2.26*	*-2.26*	*-4.8*	*-4.8*
Canada	..	..	..	..	..	..	..	..	..	..	..	..
USA	..	..	..	..	..	..	..	..	..	..	..	..

1 Mid Month Prices.
2 Unleaded premium (95 RON) gasoline for France, Germany, Italy, Spain, UK; regular unleaded gasoline for Canada, Japan and USA.
3 VAT excluded where it is refundable: HFO for Industry, Automotive Diesel for Industry.
4 Kerosene.
5 Previous month data.
6 High sulphur fuel oil price for France, Spain, UK and Japan; low sulphur fuel oil price for Germany and Italy.

5.2.4 Renewable Energy

The cost of renewable energy depends on many factors. One common factor is the scale. The below Figure 8 shows a rough range of cost of renewable energy by type of solar, hydro and wind at international level. Because the actual cost varies by many other factors, the Figure should be looked to see that scale merit is common characteristics for these types of energies.



Source: Solar; "Wind & Sun", June 28, 2001 (Northern Arizaona) Retail Prices of Various makers including Solarex, Unisolar, Siemens, Kyocera
Hydro; Windstream Power System Inc, July 27, 2001
Wind; "Innovative Energy", July 27, 2001 Retail Prices of Various makers including World Power Technologies and China Depot

Figure 8 Economy of Scale of Power Generation

The most important factor of cost is, as will be discussed below, is the type of energy sources.

Here, four types of potential renewable energies are considerd. They are hydropower, solar energy (photovoltaic panel combined with battery), wind energy, and biomass (rice hask engine).

1) Hydro Electric Power

Based on field survey and the information from local constructor (U Khun Kyaw, refer attachment), the average cost of hydropower is about K0.4 million /kW or around US$ 800/kW for construction materials. This is the capital cost only and the construction was implemented by the community for free, so that the real cost could be much more higher. The low cost is at the expense of quality. In fact, the Figure above shows the price of turbine of international quality costs more than $1000/kW.

At this minimum level, the cost of $800/kW with 15% of discount rate for 10 years is equivalent to an annualized cost of about;

$159/kW-800 x 0.15 x $1.15^{10}/(1.15^{10-1})$. Assuming 100 W per family, it is $15.9 for each household or about K664 /month/ hh. Assuming the life is 10 years and the real cost is two times of it ($1,600/kW), then the cost of $1,600/kW with ten years of life is equivalent to those of 40years of life (international quality) with about $2,000/kW (discount rate 15%), $3,000/kW (10%), and $5,000/kW (5%).

Compared to the other renewable energy, one of the advantages of hydropower is the long life of 40 to 50 years or more. This merit becomes significant as the discount rate becomes small. This suggests that a hydroelectric power project especially of high quality with long life is best suitable for a public project of low discount rate.

2) Solar Photovoltaic

Take the example of Kone-le village (refer attachment). The total 120 households are electrified with Solar BCS. The total cost, which was donated, was estimated to be about US$7,672 including the 520 W solar PV system and battery charging station with 8V batteries. In this case, the capacity for each household is about 4.3 W (=520/120). In fact, they use electricity for a small lamp of 4W for about four hours per day (16 Wh/day/hh). The capital cost per household is about $63 (=7,672/120). Assuming the life is 20 years and the discount rate is 15%, the annualized cost is 63*0.15*1.15^20/(1.15^20-1) = $10.1. This means the capital cost is about K420/month/hh. Although this value could be within the reach of average family, it may be outside the range for a poor villager of remote or central arid area.

3) Wind Power

The capacity and the cost of wind power vary considerably. Here in Myanmar the wind power is an equivalent to sunshine for solar panel for the purpose BCS. The wind turbine is equivalent to solar panel. Generally speaking the unit (kWh) cost of the wind turbine is lower than solar panel (see figure 7), however, the wind condition determines the actual power output. In this regard, the cost of RE by wind power can be more or less than the case of above-mentioned solar power.

4) Rice hask gas engine

Based on field survey, the latest data shows that the cost to electrify 420 households for lighting cost about K4 million or $10,000 (=$18/hh, US$1 = K400 (early 2001)). Assuming 10 years of life and 15% of discount rate, this is equivalent of monthly payment of about $0.37/m/hh or K190/month for each household. This value is close to the present MEPE tariff level.

5.3 A Reference Case: RE by Diesel

As mentioned before, the critical factor of the fossil fuel power is the price of fuel. In this regard, the purpose of below model is to see the relationship between the diesel oil price and the required benefit to make the project feasible.

Sample model

- Diesel Generator Model: Generator: Deere Powered Generator JS
  - Capacity:170 kW
  - Price: $21,268.00 ($125/kW), California, USA, FOB
  - Fuel Consumption: 32.0 litters (8.47 US gallon)/hour at 75% load
- Rural Electrification Assumptions
  - Distribution and other cost than the above cost are neglected
  - 1000 households
  - Consumption: 50 kWh/hh/month (100-200 W/hh), 6 hours/day, 360 days/year
  - O&M cost: 6% of the capital investment cost
  - Project Life is 20years with negligibly short time of construction period

- Sample Calculation (Table 6)
- Discount rate 10%
- Benefit: At the tariff rate (benefit) for $1.00/month/hh, the present value of accumulated benefit is $102,163.
- Cost: At the fuel price $1.00/gallon, the present value of accumulated cost is $185,956
- The net present value is 102,163-185,956 = $-83,793
- The IRR is incalculable. In other words, no matter what (even it is negative) the discount rate, the net present value cannot be positive. It means that the project can never be justified on the ground of comparative IRR.

The sample calculation of the above assumption is presented in Table 7.

Table 7 Benefit and Cost Streams of RE by Diesel

		Benefit ($, 2001 constant)				Cost ($, 2001 constant)					
Year	Discount factor (Rate 10%)	No. HH	Benefit/ month/hh	Total Benefit/year	Accumulated Present Value	Capital Investment (Construction)	O&M (6% of Const.)	Fuel Price/ gallon	Total Fuel Cost	Total Cost/year	Accumulated Present Value
2001	0.91	1,000	**1.00**	12,000	10,909	**21,268**	1,276	1	18,295	40,839	37,127
2002	0.83	1,000	**1.00**	12,000	20,826		1,276	1	18,295	19,571	53,301
2003	0.75	1,000	**1.00**	12,000	29,842		1,276	1	18,295	19,571	68,005
2004	0.68	1,000	**1.00**	12,000	38,038		1,276	1	18,295	19,571	81,373
2005	0.62	1,000	**1.00**	12,000	45,489		1,276	1	18,295	19,571	93,525
2006	0.56	1,000	**1.00**	12,000	52,263		1,276	1	18,295	19,571	104,573
2007	0.51	1,000	**1.00**	12,000	58,421		1,276	1	18,295	19,571	114,616
2008	0.47	1,000	**1.00**	12,000	64,019		1,276	1	18,295	19,571	123,746
2009	0.42	1,000	**1.00**	12,000	69,108		1,276	1	18,295	19,571	132,046
2010	0.39	1,000	**1.00**	12,000	73,735		1,276	1	18,295	19,571	139,592
2011	0.35	1,000	**1.00**	12,000	77,941		1,276	1	18,295	19,571	146,451
2012	0.32	1,000	**1.00**	12,000	81,764		1,276	1	18,295	19,571	152,687
2013	0.29	1,000	**1.00**	12,000	85,240		1,276	1	18,295	19,571	158,356
2014	0.26	1,000	**1.00**	12,000	88,400		1,276	1	18,295	19,571	163,510
2015	0.24	1,000	**1.00**	12,000	91,273		1,276	1	18,295	19,571	168,195
2016	0.22	1,000	**1.00**	12,000	93,885		1,276	1	18,295	19,571	172,455
2017	0.20	1,000	**1.00**	12,000	96,259		1,276	1	18,295	19,571	176,327
2018	0.18	1,000	**1.00**	12,000	98,417		1,276	1	18,295	19,571	179,847
2019	0.16	1,000	**1.00**	12,000	100,379		1,276	1	18,295	19,571	183,047
2020	0.15	1,000	**1.00**	12,000	**102,163**		1,276	1	18,295	19,571	**185,956**

In the above model, the monthly benefit is given. Based on the same model, next is to find the necessary monthly benefit (required payment) under the given diesel oil price and IRR. The area below each IRR line is the area of feasible combination of diesel price and the required benefit. If there is no subsidy and no tax, then the required benefit should be the monthly payment.

There are four lines of IRR. They are 1) IRR 0% with life 20 years, 2) IRR 10% with life 20years, 3) IRR 20% with life 20 years and 4) IRR 0% with life 50 years. The life is assumed to be 20 years and the line of 50years is just for reference and the Figure shows there is not much difference between 20 yeans of life and 50 years of life. Any point in the specific line shows a combination of diesel price and the required benefit (financially it means the sales price), which give the IRR represented by the line. Any point under the specific IRR line has a greater value than that IRR.

Three values of IRRs—0%, 10%, and 20% —are arbitral. The selection of IRR usually depends on the alternative use of the capital. As mentioned above, the upper bound of discount rate of Myanmar was speculated around 15%. It means an IRR greater than this number is generally accepTable. However, this Figure changes depending on the inflation, monetary policy, and economic performances of Myanmar. Therefore, the study cannot take the Figure as granted. Rather this study assumes that generally 20% of IRR is considered to be a sound level for commercial investment. If the project has the nature of public utility and the sponsor is public, the required IRR tend to be lower because of the public necessity of the project. Also the public fund can tolerate risk and uncertainty than a private fund because of the collective nature. Often the value of 10% is considered to be large enough for public projects.

The characteristics are that the differences by IRR are small and they extend in parallel. The difference between the IRR 0% and IRR 20% is about $0.3 or K150 in required benefit and the difference does not change. This characteristic comes from the nature of conventional energy sources of low initial cost and dependency on the annual variable cost—here it is the fuel cost. This characteristics of little differences by IRR suggest that this type of energy source is not attractive from the point of public project and is better be left to private sector.

Because the current diesel oil price in the market is K500/gallon(1$/gallon) or sometimes more than K1000/gallon($2/gallon), the required benefit should be more than $2/month/hh or sometimes more than K1500/month/hh. For the official price of K160/gallon, the minimum benefit required is around 300 to K450/month/hh. Considering that the benefit of RE is between K500-1000/month/hh, the maximum level of diesel oil price for electrification that a rural community afford is around K300-600/gallon. In fact, the present level of price of more than K500/gallon is the limit that a community can afford, so that villagers who used DG for electrification will be forced to stop it sooner or later.

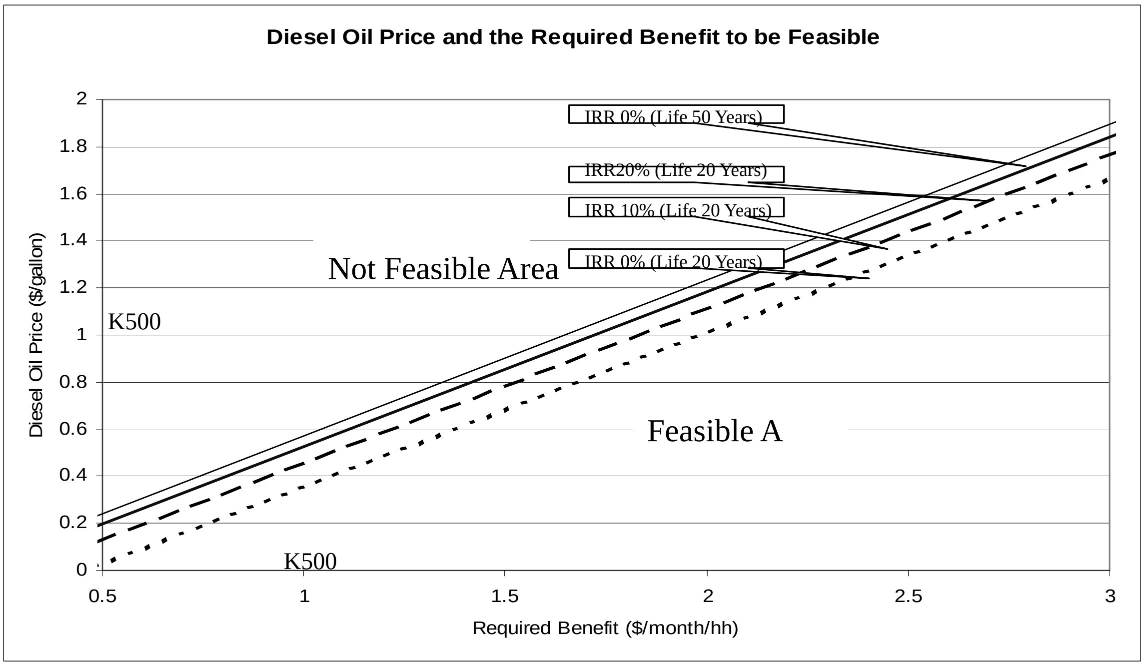


Figure 9 Diesel Oil Price and the Required Benefit

5.4 RE by Renewable Energy

For renewable energy, the critical factor is the initial investment cost. In this regard, the purpose of this model is to see the relationship between the initial capital investment cost and the required benefit to make the project feasible.

Sample model

- A renewable energy plant
  - 150-200kW of Capacity with no fuel cost (Hydroelectric power)
- Rural Electrification Assumptions
  - Distribution and other cost than the above cost are neglected
  - 1,000 households
  - Consumption: 100-200W/hh, 10hours/day, 360 days/year
  - O&M cost: 2% of the capital investment cost
  - Project Life is 40years with negligibly short time of construction period
- Sample Calculation (Table 8)
  - Discount rate 10%
  - Capital cost; $400,000 ($2,000/kW)
  - Benefit: At the tariff rate (benefit) for $1.00/month/hh, the present value of accumulated benefit is $117.3 thousand.
  - Cost: The present value of accumulated cost is $441.9 thousand
  - The net present value is 117.3- 441.9 = $ -324.6 thousand
  - The IRR is minus 4%, means that this project would be better choice if compared to the diesel option of the above example in terms of IRR.

The sample calculation of the above assumption is presented in Table 6.

Table 8 Benefit and Cost Streams of RE by Renewable

		Benefit ($, 2001 constant)				Cost ($, 2001 constant)				
Year	Discount factor (Rate 10%)	No. HH	Benefit/ month/hh	Total Benefit/year	Accumulated Present Value	Capital Investment (Construction)	O&M (2% of Const.)	Fuel	Total Cost/year	Accumulated Present Value
2001	0.91	1,000	**1.00**	12,000	10,909	**400,000**	8,000	0	408,000	370,909
2002	0.83	1,000	**1.00**	12,000	20,826		8,000	0	8,000	377,521
2003	0.75	1,000	**1.00**	12,000	29,842		8,000	0	8,000	383,531
2004	0.68	1,000	**1.00**	12,000	38,038		8,000	0	8,000	388,995
2005	0.62	1,000	**1.00**	12,000	45,489		8,000	0	8,000	393,963
2006	0.56	1,000	**1.00**	12,000	52,263		8,000	0	8,000	398,478
2007	0.51	1,000	**1.00**	12,000	58,421		8,000	0	8,000	402,584
2008	0.47	1,000	**1.00**	12,000	64,019		8,000	0	8,000	406,316
2009	0.42	1,000	**1.00**	12,000	69,108		8,000	0	8,000	409,709
2010	0.39	1,000	**1.00**	12,000	73,735		8,000	0	8,000	412,793
2011	0.35	1,000	**1.00**	12,000	77,941		8,000	0	8,000	415,597
2012	0.32	1,000	**1.00**	12,000	81,764		8,000	0	8,000	418,146
2013	0.29	1,000	**1.00**	12,000	85,240		8,000	0	8,000	420,463
2014	0.26	1,000	**1.00**	12,000	88,400		8,000	0	8,000	422,570
2015	0.24	1,000	**1.00**	12,000	91,273		8,000	0	8,000	424,485
2016	0.22	1,000	**1.00**	12,000	93,885		8,000	0	8,000	426,226
2017	0.20	1,000	**1.00**	12,000	96,259		8,000	0	8,000	427,809
2018	0.18	1,000	**1.00**	12,000	98,417		8,000	0	8,000	429,248
2019	0.16	1,000	**1.00**	12,000	100,379		8,000	0	8,000	430,556
2020	0.15	1,000	**1.00**	12,000	102,163		8,000	0	8,000	431,745
2021	0.14	1,000	**1.00**	12,000	103,784		8,000	0	8,000	432,826
2022	0.12	1,000	**1.00**	12,000	105,258		8,000	0	8,000	433,809
2023	0.11	1,000	**1.00**	12,000	106,599		8,000	0	8,000	434,702
2024	0.10	1,000	**1.00**	12,000	107,817		8,000	0	8,000	435,514
2025	0.09	1,000	**1.00**	12,000	108,924		8,000	0	8,000	436,253
2026	0.08	1,000	**1.00**	12,000	109,931		8,000	0	8,000	436,924
2027	0.08	1,000	**1.00**	12,000	110,847		8,000	0	8,000	437,534
2028	0.07	1,000	**1.00**	12,000	111,679		8,000	0	8,000	438,089
2029	0.06	1,000	**1.00**	12,000	112,435		8,000	0	8,000	438,593
2030	0.06	1,000	**1.00**	12,000	113,123		8,000	0	8,000	439,052
2031	0.05	1,000	**1.00**	12,000	113,748		8,000	0	8,000	439,468
2032	0.05	1,000	**1.00**	12,000	114,317		8,000	0	8,000	439,847
2033	0.04	1,000	**1.00**	12,000	114,833		8,000	0	8,000	440,192
2034	0.04	1,000	**1.00**	12,000	115,303		8,000	0	8,000	440,505
2035	0.04	1,000	**1.00**	12,000	115,730		8,000	0	8,000	440,790
2036	0.03	1,000	**1.00**	12,000	116,118		8,000	0	8,000	441,048
2037	0.03	1,000	**1.00**	12,000	116,471		8,000	0	8,000	441,284
2038	0.03	1,000	**1.00**	12,000	116,792		8,000	0	8,000	441,498
2039	0.02	1,000	**1.00**	12,000	117,083		8,000	0	8,000	441,692
2040	0.02	1,000	**1.00**	12,000	**117,349**		8,000	0	8,000	**441,869**

6 FINANCIAL OPTIONS FOR THE PROMOTION OF RENEWABLE-BASED RE IN MYANMAR

6.1 Existing Financial Options for RE

1) Banking System

The center of the finance is the Central Bank of Myanmar (CBM), which is under the Ministry of Finance and Revenue (MOFR). Because Myanmar always prioritized the financing to the governments' borrowing needs, it has led to high and inflationary growth of reserve money (at rates of 20-30 percent annually). Although the public sector's share of domestic credit has declined in recent years, it is still two-thirds of the total. Indeed, Myanmar's medium- and long-term debt (almost all of which is public sector debt) totaled US$5.9 billion (80% of GDP) at end-March 1999, of which US$0.46 billion are interest.

There are four state-owned commercial banks—the Myanma Economic Bank (MEB), the Myanma Investment and Commercial Bank (MICB), the Myanma Foreign Trade Bank (MFTB), and Myanma Agricultural Development Bank (MADB).

Private banks have expanded in number from four at end-1992 to 20 in March 1999. Private banks branches doubled to 105 during 1998/99 alone; by contrast, the state banks operate a network of over 550 branches. Some of the private banks are partly owned by the government. In March 1999, private banks held 56% of deposits and extended 22% of domestic credit. By contrast, the four state banks extended 16% of domestic credit compared to 63% of credit provided by the CBM.

The interest rates are regulated by the government. The next table shows the selected interest rates set by the government.

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Table 9 Myanmar Selected Interest Rates (%) (Source: Central Bank of Myanmar)

Year	1996	1997	1998	1999	2000	Average
Average Inflation	21.8	20.0	33.9	49.1	11.4	27.24
Central Bank Rate	12.5	15.0	15.0	15.0	12.0	13.9
Five year treasury bonds	10.5	14.0	14.0	14.0	11.0	12.7
Savings rate maximum	12.0	15.0	15.0	15.0	12.0	13.8
Private lending to village banks (MADB)	13.0	13.0	13.0	13.0	….	13
Private lending to farmers	18.0	18.0	18.0	18.0	17.0	17.8
Private small personal loan	36.0	36.0	36.0	36.0	36.0	36.0

Most of the rates except year 2000 are negative in real term (nominal rate minus inflation). This offer of negative interest credit does not expand in rural area. This is because of the absence of bank branches and lack of required collateral. As a result, it is said to have initiated the development of informal credit markets at the interest of positive rate in real term (private small personal loan).

2) Financing by a Village

Because of the limited availability of credit, the villagers finance by themselves through such organization like village electrification committee. If the committee can collect the all the necessary amount of money at one time there will be no extra cost of capital. If it is collected with several installments, then somebody have to take the burden of at least the cost of inflation. Considering the average inflation of the past 5 years is 27% it is equivalent of the borrowing money at the rate of 27%.

6.2 Problems

There are two big obstacles for a funding of RE by renewable.

The fundamental reason of the difficulty of funding for RE in Myanmar is the low-income level of rural family. The willingness to pay is about $1 to $2 per household per month. Most of conventional technology of RE by renewable cannot be feasible under this price level with IRR 20% or more of commercial level. This is the level that only a local home-made technology with a limited quality and life could meet. In other words, electricity from conventional renewable energy is more expensive than a rural family in Myanmar can afford thus funding for it is very difficult from the point of financial and economic feasibility, if not impossible.

The low income is reflected to the capacity to pay. Or more accurately, it is the ability to continue monthly payment of $1 to $2 for many years. Because the income base of rural family is fragile depending on the weather and the health of the family, a long-term commitment to continue to pay is even more difficult. This is the reason why the most banks require collateral as a strict condition.

The other obstacle for a rural community is the limitation in borrowing money to start a collective project. Though the availability of a bank or the accessibility to a bank is limited for a rural community, there were some banks for farmers like Myanmar Agricultural Development Bank (MADB). However, the lending was constrained by the collateral or the value of agricultural products that a family can produce in a year. Indeed, there are very few who has the big enough asset to borrow money for RE for hundreds or thousands of households, therefore, the finance for RE was limited to the community's own effort to collect money through such organization as village electrification committee. Otherwise, their options were to wait for MEPE supply or donation from outside.

Although financial options cannot solve the first obstacle—the cost of technology and the income level of rural Myanmar, this problem suggests that the source of funding for nationwide RE by renewable should tolerate zero or even negative level of financial/economic return. In other words, only a central government can afford the fund for RE of conventional technologies. Among all the cheapest is the rice husk gas engine, which can produce electricity within the range of $100-$400/kW. As will be mentioned below, this technology could be the target of private sector or local community.

To be reminded here is that the objective is to promote RE but not maximize the IRR or to find commercially feasible projects. Rather, here, IRR is an indicator of financial options to analyze the least cost or cost-effective ways of RE.

As for the second obstacle, the problem is the requirement of collateral to borrow money for a rural family. But the objective is not to borrow money, but to construct plant for RE by renewable. There are two solutions for this. One is to ease the constraint of collateral and expand the credit for the purpose of RE. Another is to build the plant of RE by government and then manage by the government, or sell or lease it to the community.

To apply these solutions, the types of RE were categorized in to three—1) rice husk gas engine for especially for delta area, 2) micro hydro for mountainous area, and 3) solar and wind power for remote area.

6.3 Preferred Lending Rate: Cost of Capital by Type and Discount Rate

To compare the costs of electricity by type, the capacity cost and production cost by type and discount rate is calculated in the below table. One assumption to be clarified here is the minimum capital required. From financial point of view, the smaller the initial capital requirement (small capacity), the easier to fund it. The minimum capacity for RE depends on the type. The minimum capacity for rice husk for RE here is assumed to be 50 kW. The solar/wind is assumed to be able to have a smallest unit (40 W). This is assuming a small scale SHS to be shared by two households. Although BCS system would be more cost effective, a small scale SHS requires smaller capacity and is presented here for the purpose of the comparison based on the minimum capital requirement. For micro hydro, because it can be regarded as full-scale electrification, a capacity of 100 kW, which is relatively larger than other types, is assumed.

Table 10 Capacity Cost and Production Cost by Type and Discount Rate

TYPE of Renewable Energies	Rice Husk	Solar/Wind	High Quality Microhydro
Assumptions			
Minimum Capital Required ($US)	20,000 (50kW/330hh)	300 (40W/2hh)	500,000 (100kW/660hh)
Capital cost per kW ($US/kW)	400	7000	5000
Capital Required ($US/hh)	60	175	750
Availability	100W x 10 hours/day (1kWH)	4W x 5 hours/day (20WH)	100W x 24 hours/day (2.4kWH)
Life	20 years	20 years	40 years
Cost Comparison			
Capacity Cost ($/hh/month) Disc.10%	0.58	1.71	6.39
Capacity Cost ($/hh/month) Disc.0%	0.25	0.73	1.56
*Production Cost ($/kWh) Disc.10%	0.02	2.85	0.09
*Production Cost ($/kWh) Disc.0%	0.01	1.22	0.02

*Production cost based on only capital required

The next figure compares the above capacity costs and production costs with willingness to pay, MEPE tariff level, diesel fuel international cost, thermal plant fuel international cost, and MEPE energy unit charge.

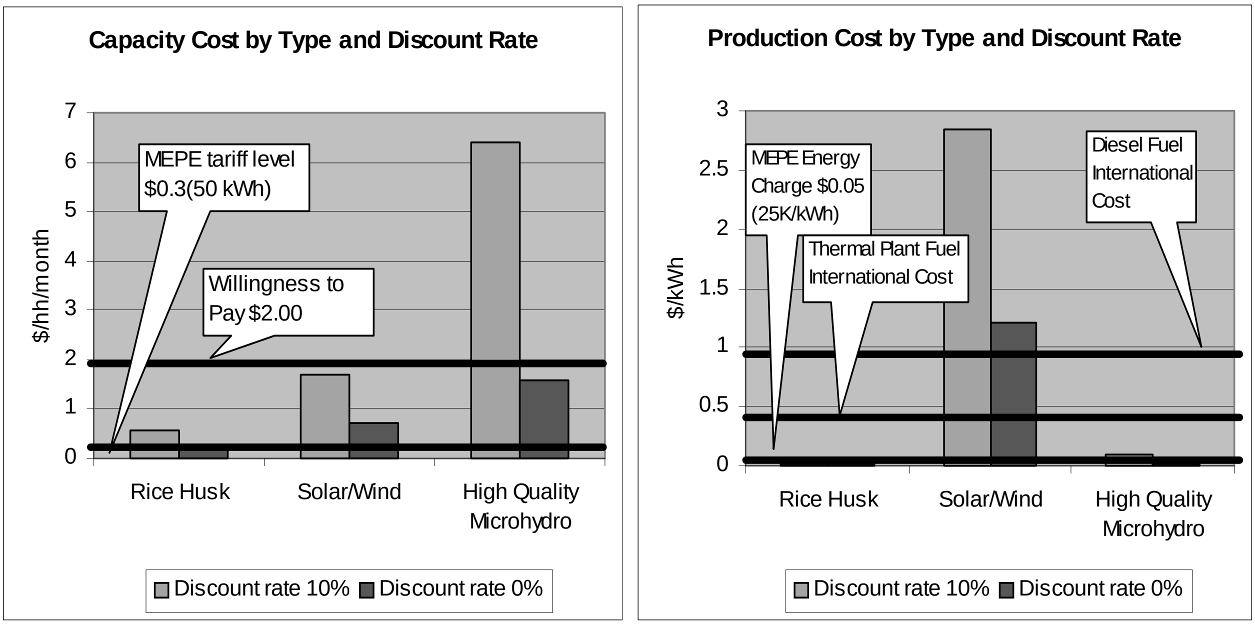

Figure 10 Capacity and Production costs by Type and Discount Rate

The capacity cost is a rough measure of the cost to get electricity without asking its quality and availability. While micro hydro can provide electricity of national grid level for 24hours, which can be used not only for light but also for other electric appliances, the electricity from solar/wind is limited for lighting level of appliances.

The willingness to pay is based on the costs of lighting. Therefore, a comparison of the capacity cost provide the information whether the type of RE can be justified only for the purpose of lighting. In this regard, all types are within the range of willingness to pay if the discount rate comes close to zero. For discount rate 10%, hydropower is less competitive compared to other types. From financial point of view, it means that a lending rate of more than 10% would exclude the options of hydropower. To make hydropower feasible, the upper bound of the lending rate or discount rate would be a several percent, if looked only for the purpose of lighting.

For MEPE tariff level, only the rice husk with lower discount rate can be competitive. Other options cannot compete with the electricity of present MEPE tariff level.

The comparison of production cost is useful to compare the cost of intensive and long time use of electricity. Indeed, if compared with MEPE grid cost, it is the cost comparison with urban level of electrification. The figure shows that from financial point of view, solar/wind option cannot compete with other types, whereas, rice husk and high quality hydro becomes outstanding for both cases of discount rates. Especially for the case of low discount rate, both rice husk and micro-hydro can be competitive even with the present level of MEPE energy charge per unit.

This analysis confirms that RE by most of renewable energies would be feasible if lower discount rate is given. However, solar/wind cannot be feasible in terms of production cost, means for intensive and long-time electricity user.

6.4 Financial Options for Fund

Another important financial issue is the cost of minimum unit and the number of household for which the minimum unit can supply. The lower the cost of minimum unit and the fewer the household involved, the easier to raise fund.

Regarding this, the financial options are categorized into three as follows by the magnitude of the minimum capital required.

1) Family level: initial capital requirement of up to a few hundred dollars with one family or neighboring families: type—solar and wind (small scale SHS or small scale battery charging station)

2) Community level: initial capital requirement up to several tens of thousands dollars: type—rice husk

3) Government level: initial capital requirement over several hundreds of thousands dollars: type—hydro electric power

6.4.1 Options of Family Level (small scale BCS or SHS)

The objective is to raise several hundred dollars by one or neighboring families for the purpose of electrification by solar or wind power for light.

The magnitude of several hundred dollars is equivalent to annual income of one household. One family cannot afford this magnitude of payment at one time. However, above analysis of lending rate shows that the capacity cost is below the willingness to pay of two dollars with discount rate of 10% or more. This means solar/wind based small-scale SHS or solar battery charging system should be affordable with appropriate financial arrangement. There are several options.

1) Use MADB Under Present Scheme

Apply to MADB directly by individual family. In this case the collateral can be the solar panel or wind turbine that they supposed to buy. It means the system will be owned by MADB or Myanmar until the family finishes the payment.

2) Create RE Fund in the Village (10-100 households)

A village family's annual donation reaches to 5% to Monastery. It means that typical households have some money for disposal.

Knowing this, first, an electrification association should be created with the members who have intention to install solar power unit, for example. Then, the electrification association should be able to collect fund for RE fund, which will be used for the purpose of electrification. Each member can donate (save) for RE fund, for example 1% or 2% annually depending on the affordability of each member. The bank account of the fund should be opened. Here, the association is expected to manage this account as a revolving fund of RE for all members. In other words, the association would have to work as a revolving fund manager.

For instance, after one year, the fund should be available for a member of highest monthly payment offer with some favorable offers like free charging fee for other members. The member then can return payment back into the fund with interest lower than the local market rate but higher than the rate of inflation minus deposit rate (about 15%).

For another instance, the association itself can own a small battery charging station to manage by itself with profitable level of charging fee, which will be returned into the fund to be used to expand the capacity of the battery charging station, which is expected to bring more revenue to RE fund.

6.4.2 Options of Community Level

The objective is to raise fund of hundreds to thousands of dollars for the purpose of RE by rice husk or community level battery charging station.

Consider the case of rice husk with 20 years of life. The assumption is 50kW for about 300hh with capital cost of about $20,000 or about $60 per household. $20,000 is about the annual income of the total village of about 50 to100 households. This amount is too large for a single family to raise; rather it requires collective financial scheme. However, there is no financial mechanism to raise this amount of capital in rural area. Therefore, a community has to raise this fund by itself. Or new funding mechanism has to be prepared.

1) Fund by a Community: Create RE Fund in the Community (100-1000 households)

This is essentially the same as the RE fund for family level. The difference is that the initial capital requirement is ten times larger that the case of family level. Therefore the number of the member of electrification association for RE fund has to be ten times larger.

A grant from foreign institution is also the case. However, a grant directly put into the beneficiary usually ends up within the beneficiary. For example, a donation of a solar battery charging station does not induce the electricity consumer to pay the fair cost of electricity; so that the a donation of a capital does not generate extra value to be disseminated.

Rather a grant had better be put into a pool of RE fund, which is managed by a third party like NGO to be allocated to the most needed or to the community who can pay most.

2) Fund from new Agency (or bank) of RE: Create RE Fund Account in the Agency.

A new governmental agency of RE, which is expected to be created under MEPE authority, is assumed here to work as a coordinator of RE as well as a provider of initial capital and a coordinator of private capital for RE. It is expected to work as RE version of MADB from financial point of view. The existing MEPE local branches can take the initiative. Or, to take advantages of the existing financial institution, the agency can commission the task of banking and financing activity to MADB or existing private bank.

There are two important financial functions as a governmental agency. First is to pool RE related resources and fund to take advantages of the economy of scale. Second is to implement RE policy by differentiating the financing terms such as interest rate and monthly payments by type of RE, political importance, and the level of income.

As for the function to pool RE related resources, the agency of RE, because it is governmental agency, potentially could have many sources of capital. Potential sources include:

a. or deposit from community initiated fund,

b. Revenu Contribution e from MEPE electricity sales,

c. Tax revenue (for example RE tax on MEPE electricity consumption),

d. Concessionary two step loan for RE from foreign institutions (WB, ADB, JBIC and etc),

e. Foreign grants,

f. Sales of electricity from its own RE system.

Especially the sales of electricity from its own RE system could be a stable source of fund. If the owned system is below several hundred of kW, then the agency could charge directly from the villages. If the capacity is large enough to supply to National Grid, then the agency might sell power to MEPE. Suppose that the agency got a mini hydro of 10MW scheme through foreign grant, which is quite large for RE, however, could contribute to National Grid if connected. Then the agency should seek a power purchase agreement with MEPE to sell the power. The revenue from the sales can be used for the funding of the agency.

Using such fund as seed money, the first financial task of the agency is to pool financial resources for RE taking the advantage of the economy of scale. In other words, the agency would be a nationwide manager of accumulated RE fund from many communities' RE projects.

Implementation of policy through financial arrangement can be direct or indirect. The direct approach is to make financial arrangement by itself directly for the customers (communities). The indirect approach means to involve private sector—private banks, suppliers, and NGOs—to take advantage of their close affiliation to potential customers.

For example, the agency of RE, namely MEPE, could provide loan to the vendors of rice husk gas engine and solar panel through its financial function, which can do it itself or can do through MADB or private banks. A low interest rate loan would work as a working capital for the supplier. The supplier then can make appropriate financial arrangement for the purchasers of their products with low interest rate. In this approach, the supplier is expected to work as a sales and promoting agent of the agency of RE, means that there would be larger chance to find potential customers of renewable-based RE. The next figure shows the basic financial framework of the agency of RE for RE.

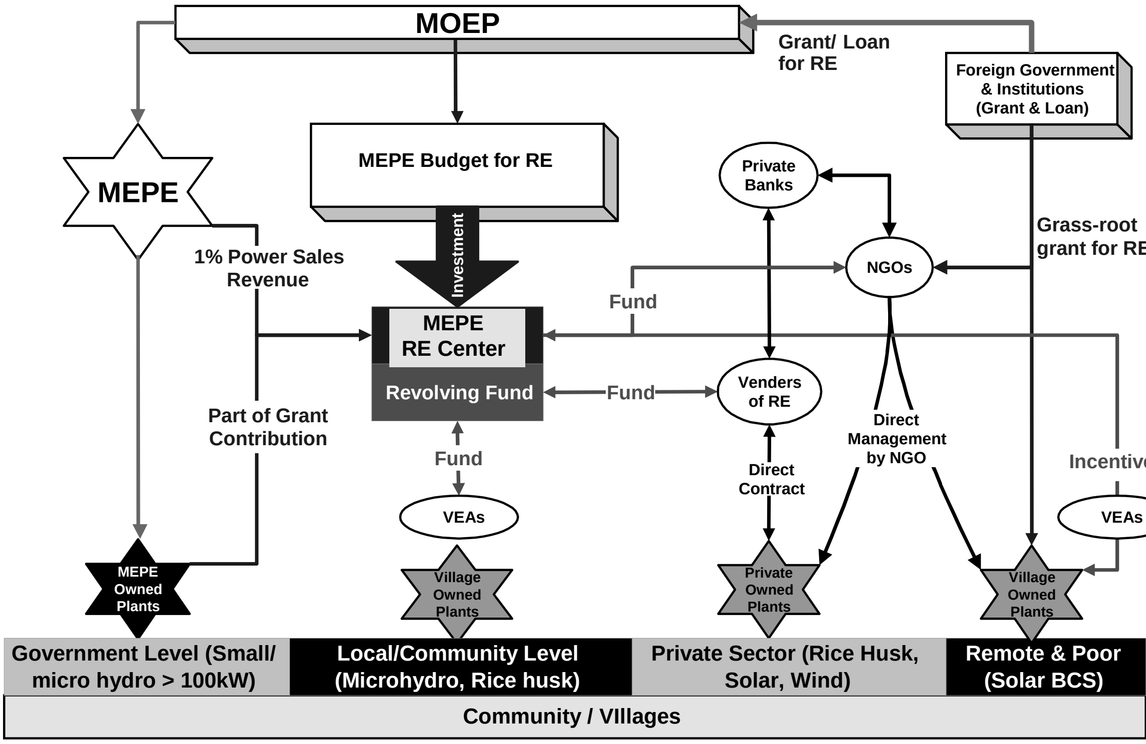

Figure 11 Basic Financial Framework of RE Agency for RE

6.4.3 Options of Government Level

Some type of renewable-based RE is capital intensive, however, because of the quality and the long life, it becomes preferable in long-term. Such type is the high quality long-life hydroelectric power. It is expected to work as long as 40 years. Only organizations of government level can afford this type of RE.

Because of the high cost of initial investment, funding from beneficiaries (communities) cannot be expected. However, in long-term, the cost becomes lower than the willingness to pay, means it can pay in long-term with positive interest rate of several % in real term.

The problem is how to recover the cost from the beneficiaries. If it is the extension of governmental plan, the tariff have to be based on the current tariff level, some level of subsidy would be required. If it is a private project then the tariff level must be high enough to recover the cost or the cost must be recovered from somewhere else.

Because the present regulation of power supply in Myanmar allows the community supplier of up to 300 kW of capacity to set its own tariff level if permitted by the government, the latter case allows the tariff level to exceed the official level—say 2 $/kWh based on the willingness to pay. Considering that it would be a long-term project of up to 50 years. Although there is a risk for a community that the MEPE grid can be reached during this period, the MEPE tariff would be increased significantly if considered the span of 50 Years. Moreover, the income of the community will eventually grow to increase the community's affordable monthly payment so that they can finish the payment earlier.

Especially when foreign grant for renewable-based RE is involved, a scheme to funnel the revenue from the electricity sales to the agency of RE seems more promising for the prospects of RE.

Table 11 Summary of Financial Options

Family Level (< $10,000) for Solar/Wind		
Initial Source of Capital	**Existing Banks (MADB)**	**A group of Household**
Financial Arrangement	Direct Contract	Revolving fund within the group
Ownership (Responsibility of payment)	A family	A family or the group
Collateral	Property of the family, System itself	Property of the families, System itself
Maximum Lending rate with average sales of $2/hh/month	5% or less in real term	
Community Level (> $10,000 & < $100,000) for Rice Husk		
Initial Source of Capital	**Electrification Association (Community)**	**MEPE (Agency of RE)**
Financial Arrangement	Revolving fund within the association	Contract with the agency, or subcontract with suppliers or private bank
Ownership (Responsibility of payment)	Electrification Association (Community)	Electrification Association (Community)
Collateral	System itself	System itself
Maximum Lending rate with average sales of $2/hh/month	30% or more for rice husk in real term	
Government Level (> $100,000) for Long Life Micro Hydro		
Initial Source of Capital	**MEPE (Agency of RE)**	
Financial Arrangement	MEPE (Agency of RE)	
Ownership (Responsibility of payment)	MEPE (Agency of RE)	
Collateral	System itself	
Maximum Lending rate with average sales of $2/hh/month	5% or less in real term	

7 ECONOMIC USE OF ELECTRICITY GENERATED

Electricity consumption in rural area, the consumption generally peaks at nighttime for residential use. The renewable energy, especially of hydroelectric power, however, can supply electricity daytime as well as nighttime. In this regard, the economic use of electricity means a productive use of electricity in daytime.

In our survey, electric power demands in daytime in the rural area of Myanmar are listed as follows:

- textile, tailor, sewing;
- sawmills, furniture, wood weaving;
- oil-mill, rice-mill, sugarcane processing;
- drying vermicelli, beans;
- ice producer;
- water supply pump, irrigation pump;
- BCS for battery charging;
- restaurants (lighting, refrigerators, heating);
- video theaters, Karaoke shop, film theater; and
- retail shops.

Figure 12 assumes that all the diesel engines for these industries will be replaced by electric motors. The total electric power consumption is estimated to be about 231 kW (see demand forecast of Nam Lan RE Scheme). The total consumption from 8 a.m. to 4 p.m. is 231 x 8 = 1,840 kWh/day. Because the industries are using the mechanical power directly from diesel engine, the actual power substituted by electricity will be slightly smaller. Assuming motor efficiency of about 86% (average standard motors of 15 HP), the required energy input to the industries would be 1,840 x 0.86 = 1,580 kWh/day. To provide this amount of electricity by diesel engine, the required diesel oil is about 158 gallon = 1,580 kWh / 10 (kWh/gallon of diesel in Myanmar) with efficiency of about 19 %. The monthly cost is about 158 gallon x 30 days x $1.00/gallon = $4,740/month. Because there are about 50 such domestic industries, it is about $95/month/industry.

One of the domestic industries will consume nearly 1,840 kWh/day x 30 days / 50 industries = 1,100 kWh/month/industry on an average. Under MEPE tariff schedule, the electricity bill will be more than K24,000 ($47, energy charge K25 /kWh above 200 kWh) for each domestic industry.

In comparison of economic benefit, both the nighttime users and daytime users pay far less than the economic value of the electricity. There are clear distinction, however, that the nighttime user is small in consumption but large in number of customers whereas the industrial users consume large but small in number of customers.

In consideration of this, introduction of annual fee in the name of contract renewal or membership fee of VEC, which is different between non-daytime users and daytime users, may be worth to consider. For example, annual membership fee may be $10 for nighttime only users (or users of 50 kWh/month or less) in addition to MEPE tariff and $50 for daytime users (or users of 50 kWh/month or more).

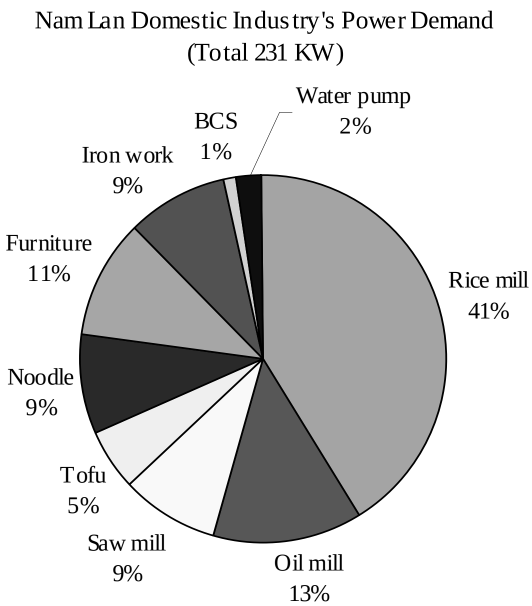

Figure 12 Forecast Daytime Demand of Nam Lan RE Scheme

In the Central Dry Zone (CDZ) in particular, the power for pumping up groundwater through deep wells (300 m) and the power for pump irrigation are the resources indispensable.

On the Shan Plateau and in Kachin State, there are certain demand for heating in the winter season and demand for hot water for shower in the tourist hotels.

There is power demand for drying agriculture and agro-industry products like garlic in Shan.   At present, garlic is transported from Shan to CDZ for natural drying under sunshine.

As the demand of public facilities in the villages, the following are conceivable:

- primary schools (up to 4th grade) and middle school;
- community center often in the monastery;
- monastery;
- library attached with IT education facility;
- Rural Health Center (RHC), clinic;
- Village Office.

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

FINAL REPORT

Volume 7　Supporting Report

Institutional/Socio-Economics

Part 7-1	Institutional Study
Part 7-2	Economic and Financial Study
Part 7-3	**Social Survey**

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

Final Report

Volume 7 Supporting Report

Part 7-3 Social Survey

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CHAPTER 1 INTRODUCTION

The Study Team prepares the Supporting Report for those who read the Guideline of the Study on Introduction of Renewable Energy in Rural Areas in Myanmar. The Study was started in January 2001 in accordance with the Scope of Work and Minutes of Meeting which were exchanged by the Ministry of Electric Power of Myanmar (MOEP), Myanmar Electric Power Enterprise (MEPE), and Japan International Cooperation Agency (JICA) on September 21, 2000.

CHAPTER 2 VILLAGES IN MYANMAR

2.1 Administrative Regime and Structure

(1) States / Divisions and Population

There are 14 states/divisions in Myanmar and their electrification ratio is shown in Table 1.

The population in Myanmar was 46,400,000 in 1997 of which 75% live in rural areas.

Table 1 Population and Electrification Level in Myanmar

State/Division	No. of District	No. of Township	No. of Village	Poppu-lation	Electrification Level (%)		
					Urban	Rural	Total
Kachin S.	3	18	616	1,202	63.7	9.0	25.0
Kayah S.	2	7	79	246	64.3	50.3	54.1
Kayin S.	3	7	377	1,403	57.6	20.1	24.3
Chin S.	2	9	476	458	92.2	38.6	47.1
Sagaing D.	8	38	1,816	5,180	90.9	42.2	61.4
Tanintharyi D.	3	10	263	1,269	50.3	11.6	31.6
Bago D.	4	28	1,409	4,848	82.1	27.5	46.7
Magway D.	5	25	1,543	4,301	92.5	19.1	36.7
Mandalay D.	7	30	1,567	6,188	65.6	3.2	22.1
Mon S.	2	10	381	2,337	28.8	25.2	27.4
Rakhine S.	5	17	1,041	2,610	41.0	2.3	18.5
Yangon D.	4	45	677	5,295	67.3	9.9	49.9
Shan S.	11	54	1,627	4,629	55.1	13.1	30.5
Ayeyarwady D.	5	26	1,920	6,436	49.7	4.4	8.7
Total	64	324	13,792	46,402	71.6	17.7	37.0

Source:
Number of District and Township: "Myanmar Facts and Figures", Min. of Information (March 2000)
Population in 1997: Statistical Yearbook 2000, Central Statistical Organization (CSO)
Number of Village Tract: "Districts, Townships, Towns, Quarters, Village Tracts and Villages in the States and Divisions", Administration Department, Ministry of Home Affairs
Electrification level: Report of 1997, Household Income and Expenditure Survey, CSO, 1999

(2) Administration Structure in Myanmar

As illustrated in Figure 1, the administrative structure in Myanmar consists of states/divisions at top level, and districts, townships, quarters (or wards), village tracts, and villages at lower level. As of year 2000, the number of districts is 64, townships is 324, and village tracts is about 13,800.

Most of the townships have population over 10,000. Central part of township consists of several quarters (wards). Village tract is a group of various sizes of villages geographically bordering each other. Village tracts is under administrative control of the Chairman of Township Peace and Development Council (TPDC). The Chairman of village tract is selected from among about 4 Village Management Members who are to be elected from Chiefs of all the member villages under the village tract. The Chairman of village tract may also be appointed by SPDC. Depending on the scale of villages, one Village Management Member represents 1,000-2,000 villagers in general.

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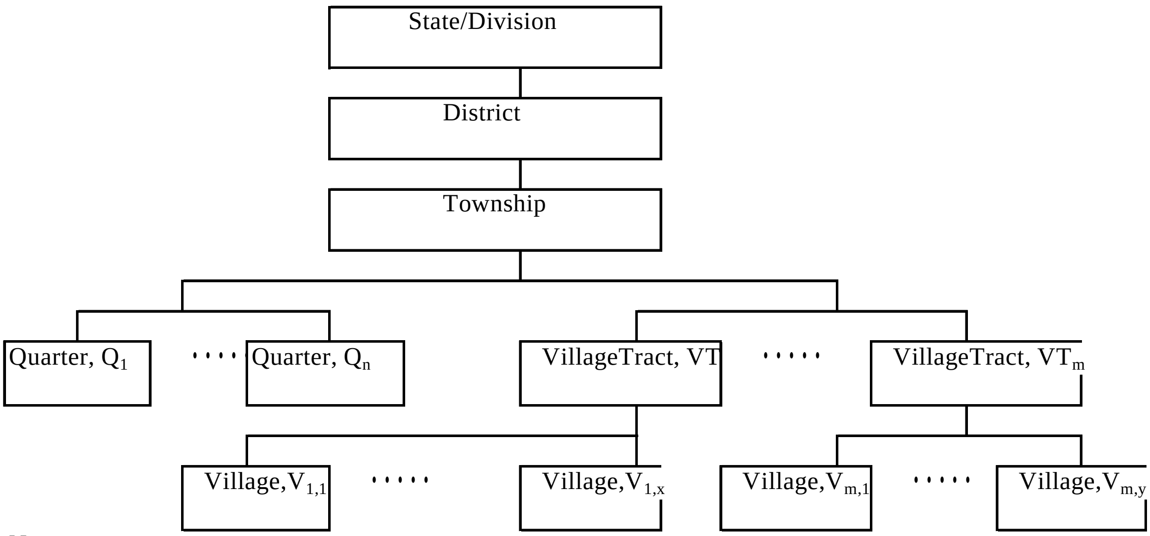


Note:

$Q_1 \cdots Q_n$: The First Quarter to the n[th] Quarter

$VT_1 \cdots VT_m$: The First Village Tract to the m[th] Village Tract

$V_{1,1} \cdots V_{1,x}$: The First Village to the x[th] Village of the First Village Tract

$V_{m,1} \cdots V_{m,x}$: The First Village to the y[th] Village of the m[th] Village Tract

Source: Field Survey

Figure 1 Administration Structure in Myanmar

Members who are to be elected from Chiefs of all the member villages under the village tract. The Chairman of village tract may also be appointed by SPDC. Depending on the scale of villages, one Village Management Member represents 1,000-2,000 villagers in general.

There is no written rule on the terms of the services of the Chairman of village tract and Village Chief. Many of which are unpaid volunteers. The Chairman of village tract usually changes in 3-6 years.

(3) Township Chairman as Core of Rural Administration

Township SPDC are controlled and managed by the District and or Divisional PDC. Township PDC manages township including quarters and village tracts. The Chairman of Township PDC is the center of the rural administration. The Chairman is on volunteer basis.[2]

2.2 Villages in Myanmar

(1) Type and Location of villages

Type of villages in Myanmar is classified into 2 types, "Block Type" and "Line Forming Type"[3]. "Block Type" villages are observed in Upper Myanmar where village locates geographically higher area such as hilly and mountainous land. "Line Forming Type" villages are observed mainly in Lower Myanmar where villages are formed along Road, River Bunk, or Canal.

(2) Population movement

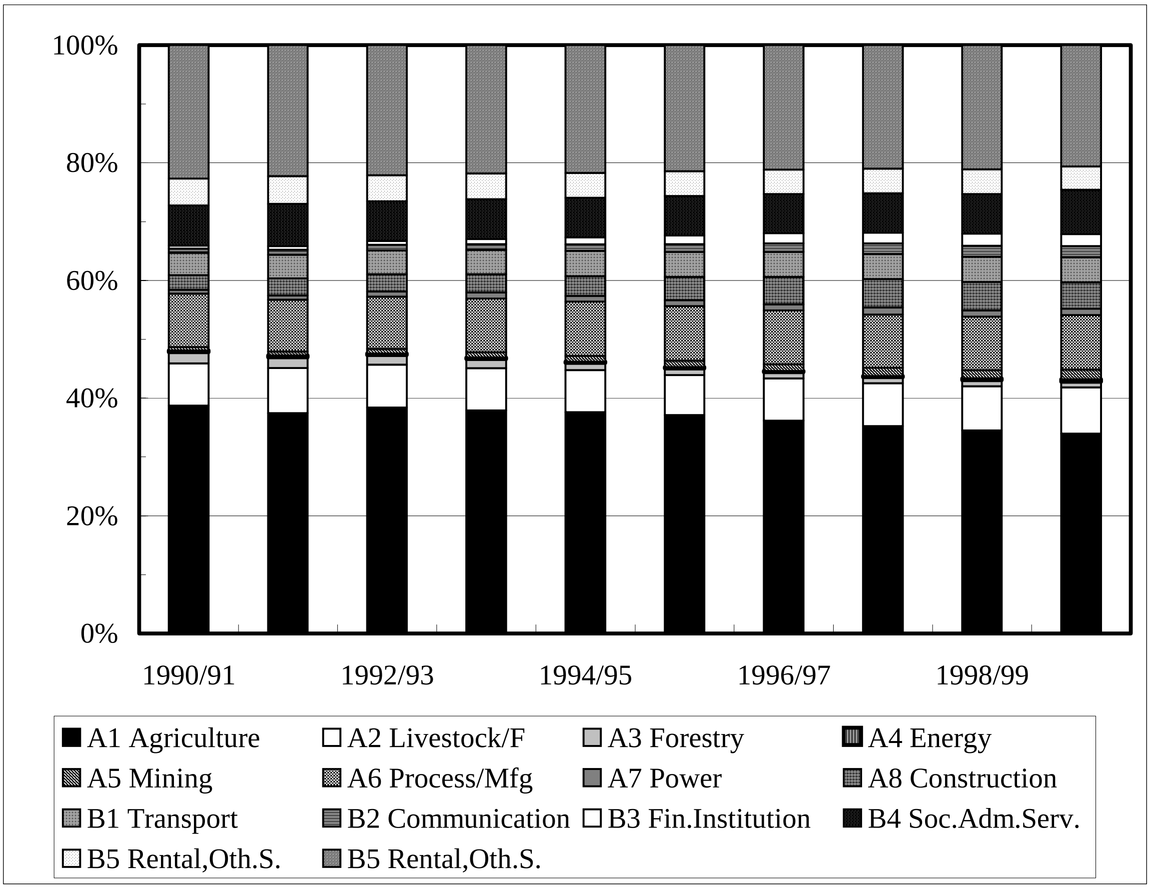
Inflow of people into Yangon was recorded at 410,000 and that of Mandalay was 50,000 (labor force survey 1990). On the other hand, 500,000 people moved from urban to rural areas. The ratio of urban and rural population has been almost unchanged. Such industrialization accompanied by the population movement from rural to urban areas, as had been observed in the Asian countries in the past 20 years, may have not taken place in Myanmar.[4]

2.3 Village Economy in Myanmar

(1) Agriculture as Major Industry

The agriculture sector shared 34% of the GDP at constant value though showing declining trend, followed by the trade sector at 20%, and the processing and manufacturing sector at 9% [1, 5] as shown in Figure 2.

The processing and manufacturing sector shows low growth rate at 0.2 %/year in the last 10 years. [1, 5] Insufficient power supply has been one of the causes of this low growth rate.[6]



Source: The Financial, Economic and Social Conditions for 1997/98 (Ministry of National Planning and Economic Development), and Statistical Yearbook 2000 (CSO)

Note: A: Goods, B: Services, C: Trade

Figure 2 Structural Changes in GDP by Sector

(2) Effect of Market Economy

In Myanmar the land ownership belongs to the Government. The Government provides people with cultivating or utilizing rights of the farming land with registration. The people reportedly cannot sell or pawn such right. However, rental of such rights to other farmers in short period such as only in dry season was observed. For example, when the registered farmer has difficulty to implement the farming plan to follow the notices from the Government, he may rent his land temporarily to those who have appropriate machines and fertilizer. These effects had been observed in the rural area after introduction of the economic policy change from the planned economy to the market economy in 1988.

Though "Purchasing" of the right of land use is observed actually by taking local official's tacit consent, it is told that purchasing such right is illegal officially. [3]

(3) Income and Expenditure Levels

Monthly Income and Expenditure Survey was executed for 25,470 households nationwide including 45 townships both urban and rural in November 1997. The average monthly household income level was K 13,000 for urban and K9,000 for rural. The average monthly household expenditure level was K15,000 for urban and K13,000 for rural. Countermeasures taken to fill the gap of the income and expenditure were not clear. In terms of the monthly rural household expenditure, Tanintharyi Division was ranked at top at K 19,000, followed by Shan State at K15,800, Kachin State at K15,500, and Kayin State at K15,000. All the top 4 states/divisions have international borders.[7]

One of the characteristics of the expenditure is high Engel's coefficient: 68% in urban and 72% in rural.[7]

(4) Expenditure for Fuel and Lighting

The average monthly fuel and lighting consumption in a household was K638 or 4.9% of the whole expenditure and urban areas was K736 or 4.8%. The fuel type for cooking in rural households was firewood at 93%, charcoal at 4 %, and electricity at 1%. Lighting source of rural household was 18 % by electricity, 32% by battery, and 50% by others.[7]

(5) Consumption Expenditure Level in 1999

CSO (Central Statistical Organization) of the Ministry of National Planning and Economic Development surveyed the monthly expenditure in 1999 for 3,240 urban and rural households in the 6 Border townships. Though the surveyed townships were different from those surveyed in 1997, the expenditure was compared with the rural average of those States/Divisions where the 6 townships belong. The Engel's coefficient was at a similar level of 72%. The fuel and lighting expenditure was 1.1 point higher than the previous 3.9%. The monthly expenditure figure was K27,000, being much higher than K15,000 in 1997.[3]

2.4 Village Society in Myanmar

(1) Donation to Monastery

Villagers in Myanmar are devout to religion. Based on the understanding that donation is the most virtuous thing in the human's life, people have habit to donate all the reserve to monastery or monk at the end of each year. They keep the reserve when they need contribution to a village project such as repairing school building, reconstruction of house damaged by fire, etc. There may already be social and cultural background in Myanmar that supports promotion of RE by self-help with contribution of villagers' leadership both in financing and labor force.[8]

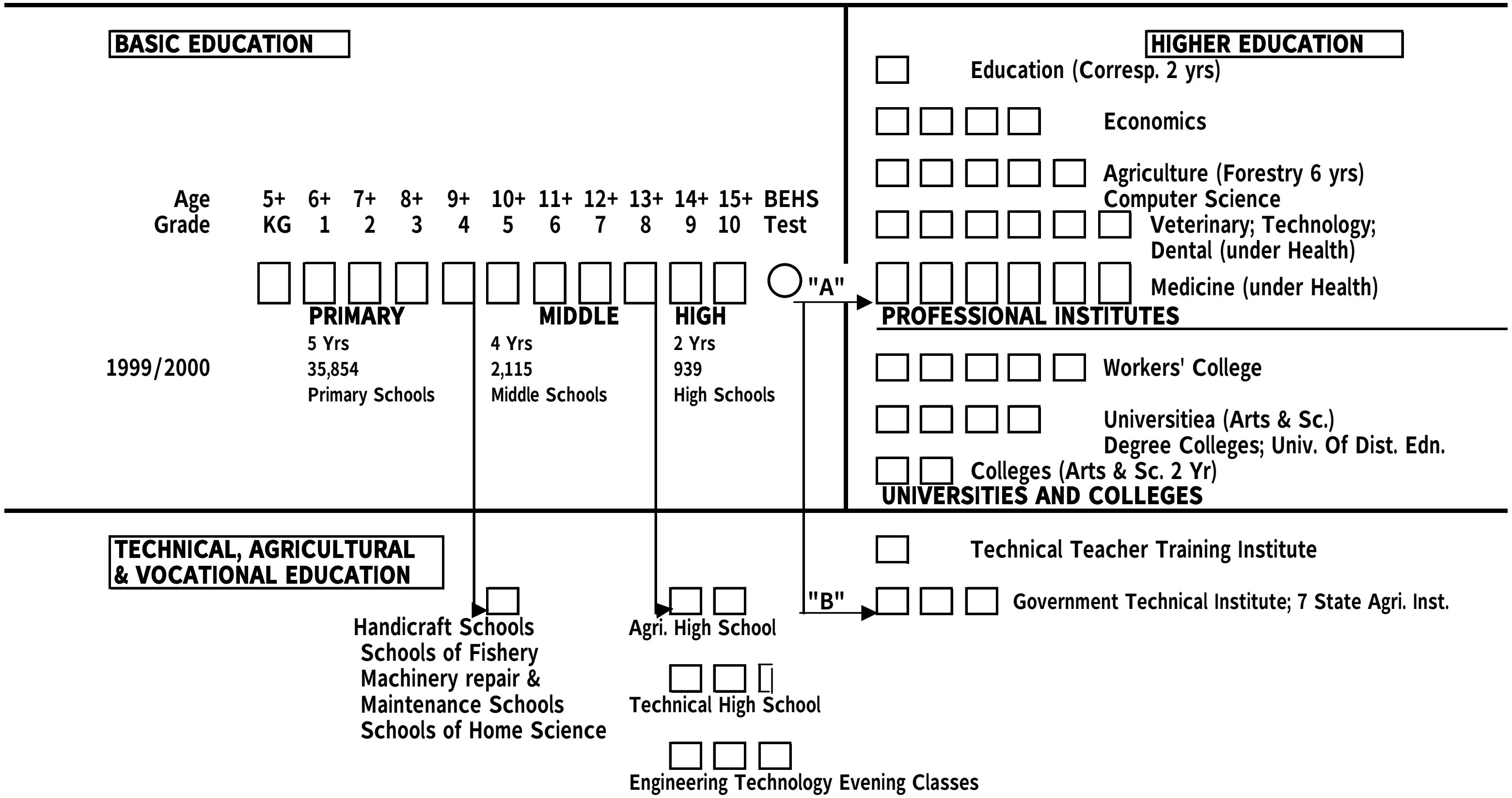
(2) Average Education at Primary School

The Government implements the education system in 3 courses: basic, higher, and the vocational education. The basic course starts from entering kindergarten at 5 year old, followed by 5 years for primary school, 4 years for middle, and 2 years for high school, resulting in total 11 years education. This is often referred to as 5-4-2 system. Those children who cannot attend primary school may get education from private monastic school system which is provided free of charge by monks in monasteries. Myanmar keeps this education system since long years ago. There is a record showing 31 such schools were operated in 1867. In addition, the Ministry of Social Welfare, Relief and Resettlement provide night schools.

The 11 years education is referred to by continuous "Grade" from the first of primary school to tenth (first grade of high school). The Government provides the national examination called BEHS (Basic Education High School) to the students before graduation of high school. The students passed the BEHS examination are graded "A" who are entitled to receive higher education at Universities or Institutes, and "B" to receive higher education for teacher training, Government Technical Institute, etc. [9]

According to the Household Income and Expenditure Survey (1997), 70% of villagers completed primary school, 16% non-educated at all, 9% middle school completed, 3% high school completed. The higher education completed was at 1%, and vocational education 0.2%. [7]

Education system is illustrated in Figure 3. [9]



Note: Education Colleges (Grade1, and 2) are not shown. Institute of Education accepts graduate teachers only.
Institute of Foreign Languages accept only graduates who are in-service personnel; some overseas scholars are accepted to study Myanmar.
Source: Education in Myanmar. Ministry of Education, August 1992, Basic Education in Brief, Dept. of Basic Education, July 1994 with slight modification by recent figures.

Figure 3 Education Systems in Myanmar

(3) Medical and Healthcare

The Government provides medical and healthcare services in three stages. The primary stage consists of Station Hospital (SH), Rural Health Center (RHC), Sub Center (SC) under RHC, and Maternal and Child Health Center. The second stage consists of District Hospital (DH) and Township Hospital (TH). The tertiary stage consists of General Hospital and Specialized Hospital. The District Hospital and Township Hospital are the center of rural medical and healthcare services. There are 1,402 RHC nationwide, equivalent to 17 times the primary and secondary service facilities in urban areas. However, the number of RHC may be small compared with the number of primary school estimated at around 26,000.[10]

(4) Existing Organization in Villages

Though some of following organizations exist in villages, it is necessary to establish the independent organization for promotion of rural electrification.

Organization

- Fire Brigade, Fire Station, Village Fire Association
- MALITIA (Regional Ethnic Military Group)
- Myanmar Maternal and Child Association (MMCWA)
- PTA
- Renewable Energy Users Union
- Red Cross
- Social Welfare Committee
- Trustee
- Versus Player (Chanting holy group for choir on Sabbath days)
- Village Buddhism Organization
- Village Electricity Committee (VEC), Village Electricity Committee Association (VECA)
- Village Peace and Development Council (VPDC)
- Village Police, Village Police Association (VPA)
- Village Union Solidarity Development Association (VUSDA)
- Versus Player
- Village Water Supply and Distribution Committee (VWSDCA)
- Youth Power Organization

CHAPTER 3 VILLAGE SURVEY

3.1 Objectives

The objective of the Socio-economic Survey in Rural Myanmar covering households both electrified and un-electrified villages is to understand general living conditions of rural villagers, economic conditions including willingness to pay (WTP) for electricity, and measures requirement for participation of villagers to sustainable operation and maintenance of the rural electrification system by Renewable Energies.

3.2 The Village Survey Executed

(1) Nomination Procedure for Selection of Sites to be Surveyed

The JICA Study Team has adopted following criteria for selection of sites to be surveyed. 1) Security for survey team, 2) combination of agricultural type and rural average household Income by states/division base is the major criteria as Myanmar is an agriculture country. It is necessary to find areas having relatively high possibility of Mini-hydro power. 3) Importance of border area, and 4) area-wise potential for Mini-hydro power.

Selected areas are South and North areas of Shan State and Kachin State.

(2) Rural Households Surveyed

Sub-Contracted Survey Team leaded by Professor U Myat Thein, retired Rector of Institute of Economics Yangon, and his associates surveyed 1,348 Households with 956 un-electrified and 392 electrified households in the designated 3 areas. Number of villages surveyed is 27 consists of 21 un-electrified and 6 electrified villages.

Survey Team used interview survey to household head by questionnaire prepared by the Study Team. Survey team interviewed 112 village leaders in parallel to get the wide-range information. Survey was implemented in May to August 2001. The result of the survey is referred to VSS2001 hereinafter.

3.3 Results of Village Survey

3.3.1 Current Status of Rural Electrification in Survey Areas

The difference in electrification level is very large between urban areas and rural areas as shown in Table 1. According to Household Income and Expenditure Survey by Central Statistical Organization (CSO), 37% of the households in

Myanmar have access to electricity while 24% depend on battery lighting. In urban areas (quarter/ward), 72% have electricity and 10% use batteries. In rural areas (village tract) 18% have electricity and 32% use batteries. Among the urban areas, Magway Division has the highest percentage (93%) of households with electricity. Among the rural areas, Rakhine State has the lowest percentage (2%) with electricity.

3.3.2 Potential Demand for Electricity in Rural Areas

(1) Household Demand upon Electrification (First Step)

It is assumed that each household will have 3 lighting in total 90 W and one small radio of 10 W. In addition, 50% of the households would have one TV of 60 W. These will be 130 W power demand in total in a household. Taking into consideration the ratio of concurrent use, the net demand was estimated at 120 W.

(2) Household Demand with Rice Cooker (Second Step)

It is assumed 15% of households will have 600 W electric cooker several years after the electrification (Second Step). According to VSS2001, villagers have preference to “rice cooker” as future appliance and they wish to buy it with the second priority after lighting. With the rice cooker, the net household demand will increase to 160 W.

With the unit demand as estimated above, the order of electricity demand for RE is forecast as shown in Table 3 by State. The gross demand for new lighting is in the order of 700 - 930 MW, which is in the similar order to the supply scale of the Interconnected Grid at present.

Table 2 Electrification Demand for Rural Electrification by State/Division

No.	State/Division	Population 1983 Census			Population in 1997		Rural House-holds	Power Demand	
		Urban	Rural	Total	Total	Rural		Upon RE	After several years
		1,000	1,000	1,000	1,000	1,000	1,000	MW	MW
		1	2	3	4	5	6	7	8
1	Kachin State	181	638	819	1,202	936	156	19	25
2	Kayah State	42	118	160	246	181	30	4	5
3	Kayin State	105	528	633	1,403	1,170	195	23	31
4	Chin State	54	315	369	458	391	65	8	10
5	Sagaing Division	530	3,295	3,825	5,180	4,462	744	89	119
6	Tanintharyi Division	216	698	914	1,269	969	162	19	26
7	Bago Division	740	3,060	3,800	4,848	3,904	651	78	104
8	Magway Division	493	2,750	3,243	4,301	3,647	608	73	97
9	Mandalay Division	1,214	3,364	4,578	6,188	4,547	758	91	121
10	Mon State	473	1,207	1,680	2,337	1,679	280	34	45
11	Rakhine State	304	1,742	2,046	2,610	2,222	370	44	59
12	Yangon Division	2,706	1,260	3,966	5,295	1,682	280	34	45
13	Shan State	658	2,432	3,090	4,629	3,643	607	73	97
14	Ayeyarwady Divisio	742	4,252	4,994	6,436	5,480	913	110	146
	Union Total	8,458	25,659	34,117	46,402	34,913	5,819	699	930

Source: Forecast of JICA Study Team, with population data by Statistical Yearbook 2000, Central Statistical Organization, Yangon, Myanmar, 2000, Ministry of National Planning and Economic Development

Note: (1) Average family size was assumed at 6.

(2) Rural population 1997 was assumed based on total population in 1997 and rural population ratio in 1983.

(3) Column 7 shows demand just after electrification when unit demand is forecast at 120 W per household.

(4) Colume 8 shows demand after several years when electric appliances other than lights are introduced to increase the average unit demand to 160 W per household.

3.3.3 Ability and Willingness to Pay

(1) Income and Expenditure level in 2001

A village social survey was executed under the Study in order to get the latest data / information regarding the living conditions, villagers' needs for electricity, and their will for electrification. The survey was executed in May-August 2001. It was executed in Southern Shan, Northern Shan, and Kachin State.

The number of household surveyed is 1,348 in total of un-electrified (956) and electrified (392) households. Table 3 shows income and expenditure.

Table 3 Income, Expenditure, Saving, and Donation

(Units: Kyat/year/Household)

Items	Un-electrified	Electrified	Average
1. Income	266,000	380,000	289,000
2. Expenditure	227,000	310,000	244,000
3. Saving	39,000	70,000	45,000
4.Donation	10,200	15,300	11,300
5. Per Capita Expenditure	40,000	43,700	40,600

Source: VSS2001

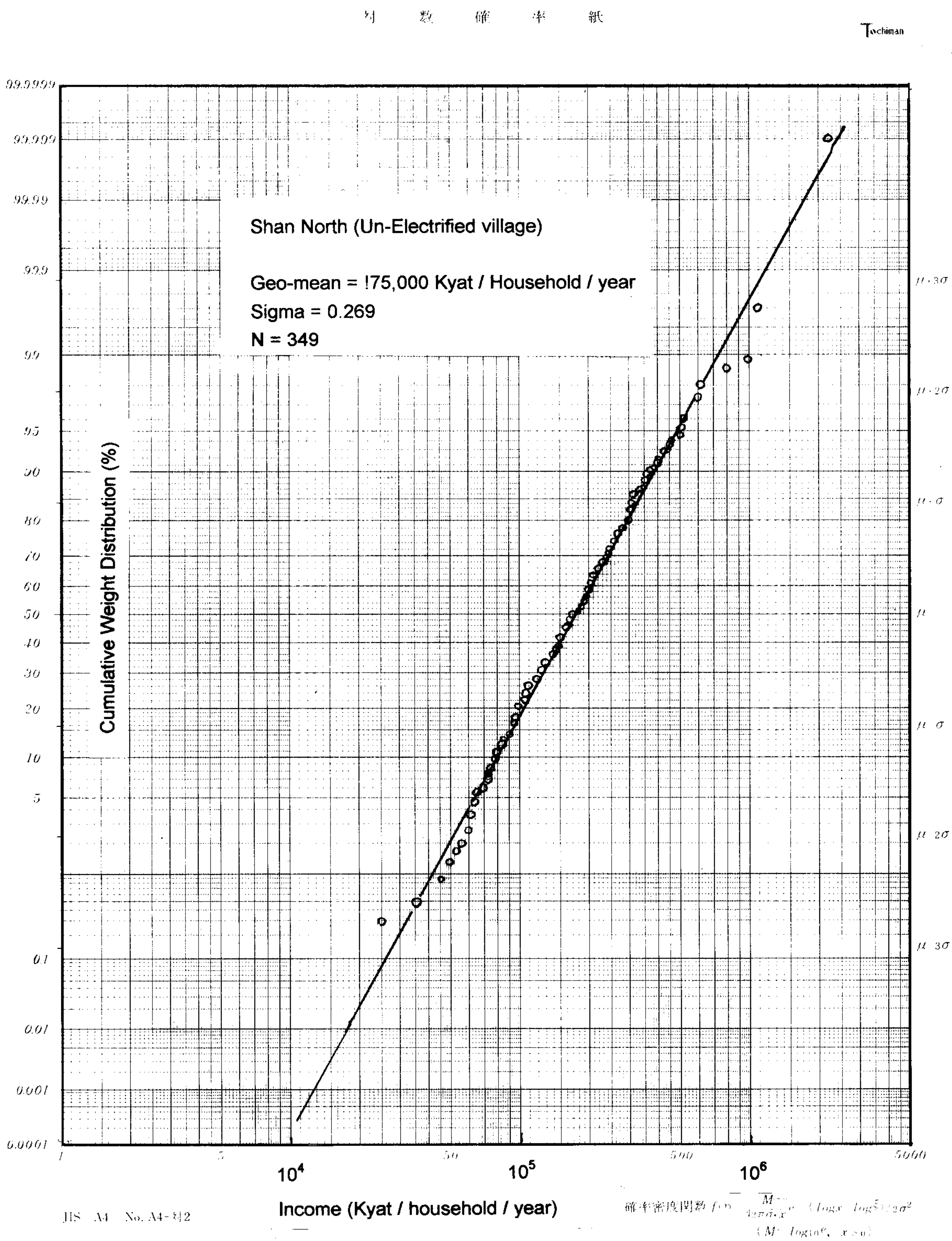
The income level in electrified villages was higher than that of un-electrified villages for all the 3 areas surveyed. It was K380,000 in electrified and K 270,000 in un-electrified villages on an average, resulting in an overall average at K290,000 a year. The average per capita expenditure was K41,000 per year (K44,000 in electrified and K40,000 in un-electrified).

(2) Logarithmic Normalized Probability Equation for Annual Income Distribution

As shown in Figure 4 for the example case of Un-Electrified village of Shan State North area, we can apply Logarithmic Normalized Probability Equation Function, expressed as follows, on accumulated distribution of household income during the range of 1% and 99% by drawing straight line.

Probability Density Function $f(x) = \dfrac{1}{x\sqrt{2\pi}\ \sigma} \quad e - \dfrac{(\mathrm{Log}x - \mu)}{2\sigma^2} \quad \cdots$ (1)

Where, x is annual household income (Kyat / household), μ is average household income (logarithmic value), σ is a standard deviation, and π is the circular constant.



Source: VSS2001

Figure 4 Cumulative Household Annual Income Distribution

Table 4　Parameters of Household Income Distribution Equation

Area surveyed	South Shan		North Shan		Kachin		Un-	Electrified	Total
Electrification	U-E	Electrified	U-E	Electrified	U-E	Electrified	Electrified		
Average (Kyat)	240,000	310,000	219,000	390,000	346,000	437,000	266,000	380,000	289,000
Geo-Mean (Kyat)	190,000	230,000	175,000	290,000	270,000	320,000	210,000	270,000	220,000
Sigma	0.334	0.296	0.269	0.316	0.285	0.334	0.280	0.316	0.281
Source:VSS2001									

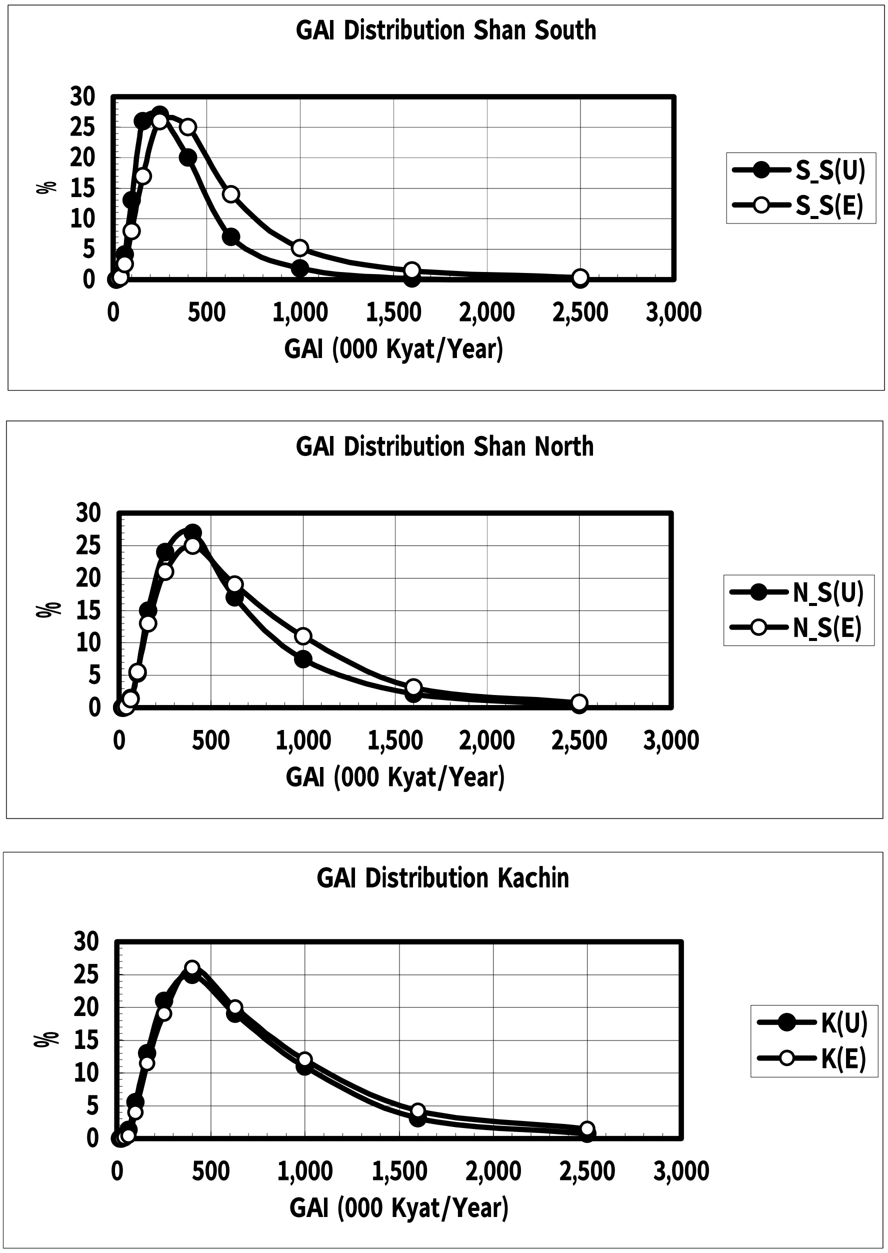


Figure 5　Household Annual Income Distribution by Area and Electrification Status

Table 4 shows parameter of household income distribution function for 6 groups classified by areas, and electrification status. Geo-Mean value shows the Household Income where the maximum of the differential distribution curve as shown in Figure 5.

The Logarithmic Normalized Probability Equation Figure for household income is useful to evaluate electricity affordability of villagers in future after setting up the minimum affordable income level.

(2) Willingness to Pay

Willingness to Pay (WTP) for RE is measured for two categories of payments: the initial connection fee to recove+r initial capital costs, and monthly payments to recover monthly O&M expenses. Table 5

presents average WTP and actual payments for electricity.

Table 5 Willingness to Pay and Actual Payments

(Unit: Kyat)

Items	Payments	Un-electrified Villages	Electrified Villages	Total
WTP	Initial	9,100	15,500	10,400
	Monthly	520	750	570
Actual payments	Initial	-	23,500	-
	Monthly	-	370	-

Source: VSS2001

The average WTP for initial connection fee was K9,100 in the non-electrified villages and K15,500 in the electrified villages with overall average at K10,400. The actual payment was K23,500 which exceeds WTP of K15,500. However, the people in the electrified villages appreciate these payments as appropriate value. WTP for monthly payments was K570 per month on an average.

(3) Ability to Pay (ATP)

The WTPs for the initial connection fee and one year monthly payments are presented in Table 6 together with household income, expenditure, and saving for both the un-electrified and electrified villages.

Table 6 Ability to Pay

(Unit: Kyat)

Items	Un-electrified Villages	Electrified Villages
WTP for initial connection fee and one year monthly payments	13,500	24,400
Annual income	266,000	380,000
Annual expenditure	227,000	310,000
Saving	39,000	70,000

Source: VSS2001

The saving is much greater than the WTPs. The ceiling of ATP in the surveyed area is about US80 (K39,000) in the un-electrified villages and US$140 (K70,000) in the electrified villages.

3.3.4 Prospects for Community Participation

Not as the participatory development, which is the world trend sounding soft and sometimes mistreated as accessories of development projects, small scale RE in Myanmar can make progress only if it is fully implemented under the leadership of the villagers themselves. Those RE schemes by the Grid extension and construction of small hydros will be continued by MEPE also in the future. However, if we depend on the RE schemes only by MEPE, it will be required for the villagers to wait until the Interconnected Grid and local isolated power systems satisfied with sufficient generation capacity, that is, until when the present load shedding will become unnecessary. Even with an optimistic assumption that RE ratio be improved at 2% per year, it would take more than 40 years for the transmission and distribution networks to reach most of the local towns and villages country-wide.

Accordingly, it will be prerequisite for the villagers and VECs to implement RE schemes on self-help basis in parallel with those RE schemes directly implemented by MEPE. There may be the following options for RE schemes by the villagers:

- Installation and management of village electrification schemes by the villagers (VEC) using:
  - Rice husk (biomass) gas engine;
  - Pico hydro (300 W to 5 kW);

- Micro hydro (<100 kW) with financial and technical assistance from external sources such as NGOs;
- Solar-wind BCS with financial and technical assistance from external sources such as NGOs and aid agencies:

- O&M of small hydropower stations and management of isolated power systems being entrusted by MEPE;
- Advice from foregoing electrified villages to Village Electrification Schemes of non-electrified villages;
- Contribution to the RE Fund from the monthly installments of VECs which implemented its Village Electrification Scheme with financial support from such Fund.

According to VSS2001, the majority (57.8%) of the villagers out of the 1,348 households showed their positive will to participate, 33.2% neutral, and 9% negative. Of the positive reply, their participation ways are 1) as a member of VEC at 32.4%, 2) as a money collector at 14.9%, 3) as a maintenance team member at 14.3%, 4) by paying tariff without delay at 14.0%, and so on. The negative opinion showed the reason as 1) too busy at 43.2%, 2) too old at 33.1%, 3) lack of males in the household at 13.6%, and 4) illiteracy at 8.5%.

3.4 Village Features by State

3.4.1 Shan State

As there is no statistical figures for Northern, Southern, and Eastern areas of Shan State, characteristics of Shan State is described as a whole.

Population of Shan State in 1997 was 4,629,000. There are 54 townships including State Capital, Taunggyi, in Shan State consisting of 23 townships in Southern area, 24 in Northern area, and 7 in Eastern area, respectively. Urban Population Ratio in Shan State is reported at 21.3%, while 78.7% in Rural by Census in 1983.

For race composition of villages surveyed in Shan South area is all Shan, while major race in North area is Shan at 73%, followed by Chinese at 15%, Kachin at 10%, and Burma at 3%.

Shan State produces wide variety of agricultural products in Shan Plateau in 1997/98 such as tea with 61,000 tons covers 95% of the Union production, potato 159,000 tons or 68.5%, coffee 1,020 tons or 55%, seed maze 107,000 tons or 35%, all occupies top share. All of sugarcane with 874,000 tons or 17%, wheat 12,000 tons or 13%, and maze for general purpose at 269,000,000 tons or 11%, are third ranked. Other agricultural products are paddy 997,000 tons or 5%, groundnuts 23,000 tons, sunflower 2,000 tons, sesame 2,000 tons, and coconut 356,000 tons.[11]

30 km South West of the State Capital, Taunggyi, there is a famous Inle Lake, with long and slender shape having 22 km length of North-South direction and 12 km width of east-west direction on 1,328 m above sea level. Inle Lake is famous for good scenery and fishery. Nyaung Shwe township locates at the Northeast edge of the lake. Nyaung Shwe township having 8 quarters governs and controls surrounding 35 village tracts consist of 408 villages surrounding the Lake. Total population including Nyaung Shwe township, 12500, is 153,000. Electrification ratio of the township is 52%, while 0.4% for surrounding villages.

There are 3 sites of production of Ruby and Spinel in Shan State: Mountain area of southern side of Manket village (Northern area), near Hsopteng village at the right bank of Thanlwin River near Kayah State border (southern area), and area around Mong Hpen village near China border (eastern area).

3.4.2 Kachin State

Kachin State is one of the important border areas adjoining to India and China in the northernmost part of Myanmar. Population of Kachin State is 1,202,000. Race composition of villages surveyed in Kachin State is Kachin at 55%, Shan at 17%, "Other" at 16%, and Burma at 12%. There are 18 townships including State Capital, Myitkyina. Urban population dwelling ratio in Kachin State is reported at 22.1%, while in rural at 77.9% by Census in 1983.

Agricultural product in Kachin State in 1997/98 was Paddy, 324,000 tons a year or 2% of whole Union, maze seeds at 30 million tons or 1.2% at 6th rank, sugarcane 177,000 tons or 3.5%, groundnut 12,000 tons or 2.3%, sesame 1,000 tons or 0.3%, soy beans 5,000 tons or 6.8%, potato 8,000 tons or 3.4%, coconut 585,000 tons or 0.2%, and coffee 80 tons or 4.3%.[11]

Kachin State produces Diamond, Ruby, Spinel, and Toppers. The amount of Jade production in 1999/2000 was 5,243 tons.

CHAPTER 4 ASSESSMENT OF DEMAND FOR RURAL ELECTRIFICATION

4.1 Methodology

According to the Village Social Survey conducted by hearing of 1,348 households under the Study in May-August 2001 (VSS2001), the priority in the household basic needs is ranked at 1) health, 2) electricity, 3) money, 4) education, and 5) food. It is notable that the electricity is ranked at higher than money, education, and food.

Electricity demand is forecast by grouping consumers into four types, that is, household, public, business, and industry.

The electricity demand P_D of village interest is forecast by the following equations:

$$P_D = P_H + P_P + P_B + P_I \cdots\cdots(2)$$

$$P_x = n_x \, W_x \, C_x \, A_x \,/\, 1{,}000 \qquad \cdots\cdots(3)$$

Where,

Where,	P	:	Electricity demand in kW, where suffix H denotes for household, P for public, B for business, and I for industry
	n_x	:	number of consumers of x sector
	W_x	:	Unit consumption of x sector in W
	C_x	:	Ratio of concurrent use of x sector in the peak time
	A_x	:	Affordability ratio of x sector

Household demand of electricity is assumed by 2 steps as described in 3.3.2. That is, assumed net demand per household for the first step is 120 W by taking consideration of the ratio of simultaneous use. Demand of second step is assumed at 160 W.

4.2 Household Affordability of Electricity

Some households may not be able to access electricity due to their low income. Field survey suggested that the borderline may be around K100,000 a year. The database of household income obtained through the VSS2001 gave the percentage of households having higher income than K100,000 as shown in Table 7. If the cost per household is assumed at K100,000, about 88% of the households on an average would enjoy receiving power upon the electrification of their village while 12 % could not afford it.

Table 7 Household Affordability to Electricity

(%)

Description	Shan South	Shan North	Kachin	Total
Un-electrified	86	82	93	87
Electrified	89	93	94	92
Average	87	84	93	88

Source: VSS2001

4.3 Unit Consumption Demand

Unit consumption demand of each sector was assumed based on the field survey as presented in Table 8.

Range of unit consumption by categories obtained from the survey is shown below.

Table 8 Consumption Demand of Each Sector

	Nighttime (W)	Daytime (W)
Household:	120 (First step)-160 (Second step)	20 (First step)-45 (Second step)
Public:	230-530	65-1,270
Business:	1,070-5,600	905-4,900
Industry:	0	1,200-5,600

4.4 Electricity Demand Forecast for Rural Electrification

Unit Consumption demand of Household, Public Institute, Business, and Industry were obtained based on the Field Survey.

Potential demand for Heho area covering Nyaung Shwe township and surrounding 35 village tracts covering 153,000 population, for example, was estimated at 3,200 kW at nighttime and 1,700 kW at daytime for the first step of household electrification, while 4,100 kW at nighttime and 2,300 kW at daytime for the second step of household electrification, respectively.

Estimated potential demand for Nam Lan village consists of 12,000 population was at 270 kW (nighttime)-250 kW (daytime) for the first step household electrification and at 350 kW (nighttime)-310 kW (daytime) for the second step household electrification.

The gross demand for Rural Household Electrification in whole Myanmar was estimated in the range of 700-930 MW, which is in the similar order to the supply scale of the Interconnected Grid at present.

Table 9 Estimated Unit Power Demand (1/2)

		Nighttime				Daytime			
Object	Affordability ratio, %		Watt	Simul-taneous use, %	Watt		Watt	Simul-taneous use, %	Watt
		Step 1: After commission							
1. Household		a. 3 Lights	90	100		a. 3 Lights	90	15	
Shan South	87	b. Radio	10	30		b. Radio	10	15	
Shan North	84	c. TV (60w)	30	85		c. TV (60w)	30	15	
Kachin	93	Ownership ratio				Ownership ratio			
Total (Un-Ele	87	50%				50%			
ctrified)		Total	130	90%	118	Total	130	15%	20
		Steo 2: After several years with rice cooker							
Total (Electri-	92	Step1	130	90			130	15	
fied)		d. Rice Cooker	90	50		d. Rice Cooker	90	30	
Total	88	Ownership ratio				Ownership ratio			
		15%				15%			
		Total	220	70%	163	Total	220	20%	44
2. Public									
2.1 Street Lig	100	1. 40w Tube 10/Place	50	100	2,000				0
2.2 Temple	100	1. Light 20wTubex30	600	67		1. Light 20wTubex30	600	0	
		2. TV 1x60w	60	50		2. TV 1x60w	60	0	
		3. Fan 4 x 60w	240	20		3. Fan 4 x 60w	240	50	
		4. Refrigerator(100w)	100	50		4. Refrigerator(100w)	100	100	
		5. A/C:1x1KW	1,000	0		5. A/C:1x1KW	1,000	50	
		Total	2,000	24%	528	Total	2,000	40%	720
2.3 Hospital	100	1. Outer light				1.Outer light			
		20w Tube x 1	20	100		20w Tube x 1	20	0	
		2. Inner light				2. Inner light			
		40w Tube x 5rooms	200	50		Night demand x 50%	200	25	
		3. Refrigerator				3. Refrigerator			
		130w x 1	130	100		130w x 1	130	100	
		Total	350	70	250	Total	350	51%	180
2.4 Clinic	100	1. Outer light				1.Outer light	20	0	
		20w Tube x 1	20	100					
		2. Inner light				2. Inner light			
		40w Tube x 4rooms	160	50		Night demand x 50%	160	25	
		3. Refrigerator				3. Refrigerator			
		130w x 1	130	100		130w x 1	130	100	
		Total	310	74	230	Total	310	55%	170
2.5 High School	100	1. Outer light	20			1.Outer light	20	0	
		20w Tube x 1							
		2. Inner light	5,760			2. Inner light	5,760	20	
		Class room (36)				For cloudy, rainy day			
		40w Tube x 4 x 36				use: 5,760x20% use			
		3. Head Master room				(50days/250days/year)			
		40w Tube x 1	40			3. Head Master room	40	20	
		4.Copy machine				4. Copy machine			
		300w x 10%	300			300w x 10%	300	10	
		5. Computer room				5. Computer room	80	100	
		40w x 2	80			40w x 2			
		Total	6,200	0	0	Total	6,200	20%	1,270
2.6 Middle School	100	1. Outer light	20			1.Outer light	20	0	
		20w Tube x 1							
		2. Inner light	1,280			2. Inner light	1,280	20	
		Class room (8)				For cloudy, rainy day			
		40w Tube x 4 x 8				1.280x20%			
		3 Head Master room				(50days/250days/year)			
		40w Tube x 1	40			3. Head Master room	40	20	
		4 Copy machine	300			4. Copy machine	300	10	
		300w x 10%				300w x 10%			
		Total	1,640	0	0	Total	1,640	18%	290

Source: Field Survey

Table 9 Estimated Unit Power Demand (2/2)

		Nighttime				Daytime			
Object	Affordability ratio, %		Watt	Simul-taneous use, %	Watt		Watt	Simul-taneous use, %	Watt
2.7 Primary School	100	1. Outer light	20			1.Outer light	20	0	
		20w Tube x 1				2. Inner light			
		2. Inner light	320			For cloudy, rainy day	320	20	
		Class room (8)				use:			
		40w Tube x 8				(50days/250days/year)			
		3 Head master room	40			3. Head Master room	40	0	
		40w Tube x 1							
		Total	380	0	0	Total	380	17%	65
3. Business									
3.1 Restaurant		1. Inner light	160	100		1. Inner light	160	0	
		40w Tube x 4							
		2. 21" CTV (95w)	95	100		2. 21" CTV (95w)	95	100	
		3. Refrigerator				3. Refrigerator			
		130w x 1	130	100		130w x 1	130	100	
		4. Rice Cooker				4. Rice Cooker			
		600w x 2	1,200	30		600w x 2	1,200	30	
		5. Hot plate				5. Hot plate			
		800w x 2	1,600	20		800w x 2	1,600	20	
		Total	3,185	30	1,070	Total	3,185	30	905
3.2 Guest House	100	1 Tube	4,400	50		1 Tube	4,400	20	
		20w x 22 room				20w x 22 room			
		2. 20w x 2 Toilet	40	20		2. 20w x 2 Toilet	40	20	
		3. Refrigerator	130	100		3. Refrigerator	130	100	
		130 w x1				130 w x1			
		4 Fan 60w x 4	240	50		4 Fan 60w x 4	240	50	
		5 21"TV	95	100		5 21"TV	95	100	
		95w x 1				95w x 1			
		Total	4,905	50%	2,550	Total	4,905	30%	1,230
3.3 Hotel	100	All facilities for 22 rooms/Hotel	7,000	80&	5,600	All facilities for 22 rooms/Hotel	7,000	70%	4,900
4. Cottage or Household Industry									
4.1 Rice Mill			5,000	0%	0	1. Motor	5,000	80%	4,000
4.2 Oil Mill			7,000	0%	0	1. Motor	7,000	80%	5,600
4.3 Powder Mill			5,000	0%	0	1. Motor	5,000	80%	4,000
4.4 Sugarcane Processing			5,000	0%	0	1. Motor	5,000	80%	4,000
4.5 Saw Mill			5,000	0%	0	1. Motor	5,000	80%	4,000
4.6 Paper Mill			5,000	0%	0	1. Motor	5,000	80%	4,000
4.7 Tofu Manufacturing			4,000	0%	0	1. Motor	4,000	80%	3,200
4.8 Noodle Mill			7,000	0%	0	1. Motor	7,000	80%	5,600
4.9 Furniture Manufacturing			5,000	0%	0	1. Motor	5,000	80%	4,000
4.10 Iron Work (including car, Trawlergyi, b etc.repair shop)			4,000	0%	0	1. Motor	4,000	80%	3,200
4.11 Battery Charge Station (BCS)			1,500	0%	0	1. Motor	1,500	80%	1,200
4.12 Weaving			5,000	0%	0	1. Motor	5,000	80%	4,000
4.13 Water Pump			200	0%	0	1. Motor	200	80%	160

Note: It is assumed 15% of household will have 600 W Rice Cooker certain years after electrification.
For Namlan Village, 2 Saw Mills have total 4 machines at 20kW

Source: Field Survey

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

5.1.1 Features of Rural Villages

- Administrative structure in Myanmar is state/division, district, township, village tract, and village. 75% of population lives in rural areas.
- Agriculture is the main industry for village economy. Average rural household annual expenditure was K110,000 in 1997 and K320,000 in 1999 for 6 townships in border areas. It was observed nearly unchanged high Engel's coefficient at 72%. Annual rural household income of villagers surveyed in 2001 was K290,000. Income for un-electrified was K270,000 and for electrified is K380,000.
- Villagers are deeply devout to religions. Based on the understanding that donation is the most virtuous thing in the human's life, people have a habit to donate all the reserve to monastery or monk at the end of each year. Majority at about 70% of villagers completed primary school, 16% non-educated, 9% Middle School Leaver, and 3% completed High School.

5.1.2 Villagers' wants for Electricity, Willingness to Pay, and Ability to Pay

- As Rural Electrification ratio is quite low at 7.6% on the average in 1997, villagers surveyed in 3 areas at Shan State North, Shan State South, and Kachin State showed the priority in the household basic needs ranked as 1) health, 2) electricity, 3) money, 4) education, and 5) food. It is notable the electricity is ranked higher than money, education, and food.
- Average willingness to pay for initial connection fee was K9,100 in un-electrified villages and K15,500 in electrified villages with overall average at K10,400. However, people in electrified villages appreciate these payments as appropriate. WTP for monthly payment was K570 per month in average.
- Ability to pay, ATP, was judged by comparison of the WTPs for the initial connection fee and one year monthly payments are compared with saving. Necessary payment was K13,500 with saving at K39,000 for un-electrified village. K24,400 was necessary payment against saving at K70,000 for electrified village in average. It is judged that villagers may increase their WTP.

5.1.3 Potential Demand for Electricity in Rural Electrification

Unit consumption demand of household, public institute, business, and industry were obtained based on the field survey.

Potential demand for Heho Falls covering Nyaung Shwe township and surrounding 35 village tracts covering 153,000 population, for example, was estimated at 3,200 kW at nighttime and 1,700 kW at daytime for the first step of household electrification, while 4,100 kW at nighttime and 2,300 kW at daytime for the second step of household electrification, respectively.

Estimated potential demand for Nam Lan village, consists of 12,000 population, was at 270 kW (nighttime)-250 kW (daytime) for the first step household electrification and at 350 kW (nighttime)-310 kW (daytime) for the second step household electrification.

The gross demand for rural household electrification in whole Myanmar was estimated in the range of 700-930 MW, which is in the similar order to the supply scale of the Interconnected Grid at present.

5.2 Recommendations

5.2.1 Strengthening measures for promotion of Rural Electrification by Renewable Energy

Followings are the recommendation at random order for promotion of rural electrification by renewable energies.

(1) Finance Sources

To find various finance sources for the initial necessary fund

(2) “Well-being” classification system

Adoption of “Well-being” classification system is a system that villagers who are better-off pay more initial payment. Also, villagers who will use many types and number of appliances are to pay more. This system as shown below is already implemented in Song Phoo village, Taunggyi township, Kekku village tract in Shan State South area.

Table 10 “Well-being” Classification System

Group	A	B	C	D	E
Well being	Quite Well-off	Fairly Well-off	Average	Below Average	Destitute
Initial Payment WTPI (K)	40,000	20,000	6,000	3,200	1,200

(3) Subsidy System

To introduce Subsidy system for promotion of electricity driven cooking device to reduce firewood consumption.

(4) Supply / Demand Balance

To study Supply/Demand balance in advance including sequential electricity cut-off system in case of emergency. Public relation of this system to people/organization concerned is required.

(5) Connection System

To prohibit plural customers to connect one meter.

(6) Training

To prepare and give training/knowledge to villagers how to use electricity.

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