JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

DEPARTMENT OF ENERGY (DOE)

JICA-DOE Technical Cooperation Project
On
"Sustainability Improvement of Renewable Energy Development in Village Electrification in the Philippines"

Project Completion Report

July 2009

Tokyo Electric Power Company (TEPCO)

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ABBREVIATION

ANEC	Affiliated Non-Conventional Energy Centers
AREC	Affiliated Renewable Energy Centers
AVR	Automatic Voltage Regulator
BAPA	Barangay Power Association
BCS	Battery Charging Station / Battery Charging System
BEP	Barangay Electrification Project
BOT	Build-Operate-Transfer
CBRED	Capacity Buildings to Remove Barriers to Renewable Energy Development
CeMTRE	Center of Micro-hydro Technology for Rural Electrification
C/P(s)	Counterpart(s)
CPU	Central Philippine University
EC	Electric Cooperative
ELC	Electronic Load Controller
EPIMB	Electric Power Industry Management Bureau
EPIRA	Electric Power Industry Restructuring Act
EUMB	Energy Utilization Management Bureau
DOE	Department Of Energy
IBEKA	Institut Bisnis Dan Ekonomi Kerakyatan
IPP	Independent Power Producer
KASC	Kalinga Apayao State College
LGU	Local Government Unit
MEDP	Missionary Electrification Development Plan
MHP	Micro-Hydroelectric Power
MOA	Memorandum of Agreement
MTPDP	The Medium-Term Philippine Development Plan
NEA	National Electrification Administration
NEF	New Energy Foundation
NGO	Non Government Organization
NPC	National Power Corporation
OJT	On-the-Job-Training
PV	Photoviltaic
PCB	Printed Circuit Board
PCM	Project Cycle Management
PDM	Project Design Matrix
PEP	Philippine Energy Plan
PIOU	Private Investor Owned Utility
PNOC-EDC	Philippine National Oil Company - Energy Development Corporation
PSALM	Power Sector Assets and Liabilities Management Corporation
QTP	Qualified Third Party
RE	Renewable Energy
RRA	Rapid Rural Appraisal
SHS	Solar Home System
SPUG	Small Power Utilities Group
TESDA	Technical Education and Skills Development Authority

APPENDICS and ATTACHMENTS

【Guidelines and Manuals】

1. Manuals and Guidelines for Micro-hydropower (Volume I)
   - MHP-1 Manual for Design, Implementation and Management for Micro-hydropower
2. Manuals and Guidelines for Micro-hydropower (Volume II)
   - MHP-2 Guideline for Selection of Potential Sites and Rehabilitation Sites of Micro-hydropower
   - MHP-3 Project Evaluation Guideline for Micro-hydropower Development
   - MHP-4 Micro-hydropower Plant Site Completion Test Manual
   - MHP-5 Micro-hydropower Operator Training Manual
   - MHP-6 Training Manual for Micro-hydropower Technology
3. Manuals and Guidelines for Solar Photovoltaic Development
   - PV-1 Guideline for PV Project Evaluation
   - PV-2 Manual for Solar PV Training
   - PV-3 Guideline for Application of Photovoltaic Power generation System
   - PV-4 Manual for User Training of Solar PV System
4. Guide on Social Preparation
   - Guide on Social Preparation (BAPA Formulation, Operation and Management)
5. Manuals and Guidelines for Implementation and Monitoring
   - G-1 Manual for Implementation and Monitoring of Renewable Energy-based Electrification Projects
   - G-2 Guideline for Monitoring and Management of Renewable Energy Projects for Rural Electrification

【Poster for Solar PV User's Guide】

- User's Guide for Solar Home System
- User's Guide for Battery Charging System

【Pamphlet for Social Preparation Guidance】

- A Simple Guide on BAPA Management

【DVD for Promotion and Educational Video】

- Sustaining Renewable Energy Projects in the Philippines
- Social Preparation for Rural Electrification (English, Tagalog)

【Software and Manual for MHP Water Turbine Design and Fabrication】

- Cross Flow Design Software
- Axial Flow Turbine Design Software
- Cross Flow Turbine Manufacturing Manual

1 Preface

The Philippine government has a long history to tackle on the electrification since 1960s. The government has positioned rural electrification as the nation's top-priority policy. In order to accelerate it, the government extended programs to such as Accelerated Barangay Electrification Program (ABEP), O'ILAW program, and now they deploy the Expanded Rural Electrification Program (ER-program), which targets 100% barangay[1] electrification by 2008. Now, the target year was extended to 2009. As a result of the government's efforts, the barangay level electrification rate reached approximately 94% as of December 2005. However, the household level electrification rate is reported to be approximately 85%. If urban areas are excluded, the rate falls to 75%, and approximately 2.5 million households have no access to electricity. Therefore, the government has also set another target of 90% household level electrification by 2017.

Most of the barangays and sitios (villages) still unenergized are scattered in remote areas, where they cannot expect the grid will be extended in near future. The only way for them to access the electricity is the independent power supply by Renewable Energy (RE) such as solar Photovoltaic (PV) systems or micro-hydropower (MHP) systems. However, many of rural electrification projects utilizing renewable energy in the Philippines have been failed in sustainable operation, in spite of the efforts made by the Philippine Department of Energy (DOE) and related stakeholders.

DOE, particularly its Renewable Energy Management Division (REMD) should have a responsibility to promote RE-based rural electrification projects sustainably. So, REMD should have sufficient capability to formulate, evaluate, supervise and monitor electrification projects, while Affiliated Non-conventional Energy Centers (ANECs) and Local Government Units (LGUs) should have roles to monitor and support these barangays. However, they are also not furnished enough technologies and knowledge in these fields. Many inappropriate projects had been approved and implemented, and then such projects could not been operated as expected or defective few years after installation. Many of such non-operational systems have been just left abandoned. This is mainly due to technical problems, budgetary problems as well as problems related to social preparation that is activities to let the community be ready to accept and manage the electrification projects. Thus, solving these problems to enhance sustainability of renewable energy projects is a key challenge for the Philippines in terms of promoting rural electrification.

[1] Barangay: Minimum administrative unit in the Philippines. Administrative boundary consists of region, province, city, municipality and barangay in the Philippines.

Under these circumstances, the Philippine government requested Japan to support for sustainability improvement of RE systems in village electrification as a new proposal in FY 2003. In response to the request, Japan International Cooperation Agency (JICA) sent its mission several times to grasp the current situation and future direction of rural electrification in the Philippines, and conducted workshops to develop Project Design Matrix (PDM) to come up with a effective project plan.
After such conceptualization and preparatory activities, JICA finally started the Project in June 2004 to enhance the capacity of key stakeholders who promote and manage the RE- based rural electrification, such as DOE-REMD, ANECs, LGUs, NGO and Centre for Micro-hydropower Technology for Rural Electrification (CeMTRE) and others.

Since the Project started in June 2004, various activities such as training, workshops, seminars, On the Job Training (OJT) through monitoring activities, implementation of pilot and rehabilitation projects have been carried out. During the five-year project duration, some adjustments for effective project operation were made. For example, the mode of cooperation (experts dispatch scheme) and counterparts were changed, and the PDM was changed three times. According the PDM changes, activities and inputs were also changed.

In this project completion report, the project background is firstly described to clarify the positioning of this Project in politics, economy and the society in the Philippines. Secondly, methodology and approaches of the Project are reviewed. Thirdly, project activities and accomplishments are explained. Finally, lessons learned during implementation of the Project are described, and recommendations are made.

2 Project Outline

2.1 Outline

(1) Project Title

The project on "Sustainability Improvement of Renewable Energy Development in Village Electrification in the Philippines" (hereinafter referred to as "the Project")

(2) Duration

From June 2004 to June 2009

(3) Counterpart Agencies

Renewable Energy Management Division (REMD),
Energy Utilization Management Bureau (EUMB),
Department of Energy (DOE)

(4) Project Purpose

The purpose of this Project is to enhance the capability of the target groups for promoting and managing sustainable Renewable Energy (RE)-based village electrification projects.

(5) Target Groups

- DOE-REMD
- DOE-"Visayas Field Office (VFO)" and "Mindanao Field Office (MFO)"
- "Affiliated Non-conventional Energy Centers (ANECs)"
- "Local Government Units (LGUs)", and
- "Centre for Micro-hydropower Technology for Rural Electrification (CeMTRE)".

(6) Target Technology

Micro-hydropower and Solar Photovoltaic technology

(7) Project Experts

Expert dispatch scheme was changed in the course of the Project, and expert team members were slightly replaced year by year. The change of experts is discussed in Chapter 4. The Project Team (hereinafter referred to as "the Team") at the end of the Project consists of the following experts:

a) Leader/ Policy : Jun TAMAKAWA
b) Social Preparation : Nobuki HAYASHI
c) Micro-hydropower Technology : Mitsuru SHIMIZU

d) Micro-hydropower System : Yoshikazu ISHII
e) Micro-hydropower Control : Keisuke KUMIHASHI
f) Photovoltaic (PV) Technology : Koichi IWABU
g) Centralized PV Technology : Fumikazu DOI

2.2 Project Design Matrix (PDM)

The Project Design Matrix (PDM) has been revised three times in the course of the Project execution as under mentioned. The narrative summary of the current PDM is as follows:

1) Overall Goal

Village Electrification Program under Expanded Rural Electrification Program is successfully implemented.

2) Project Purpose

Capacity of the target group (DOE-REMD, ANECs, LGUs, NGOs and CeMTRE) is enhanced to promote and manage sustainable RE based village electrification projects.

3) Output

1. Knowledge and skills on MHP technology are enhanced and transferred.
2. Knowledge and skills on PV technology are enhanced and transferred
3. Knowledge and skills on SP are enhanced and transferred.
4. Policy and Procedure of RE based rural electrification are set-up.

4) Activities

1 Micro-hydropower Technology

1-1 Conduct OJTs at potential and existing sites on site survey, inspection, monitoring and technical advices for O&M;
1-2 Implement a model project and rehabilitation projects;
1-3 Conduct technical training on site survey, planning and designing, ELC fabrication and water turbine manufacturing etc.;
1-4 Hold workshops/seminars;
1-5 Conduct mini-lectures at DOE;
1-6 Prepare manuals and guidelines as listed;
1-7 Prepare water turbine design software and its manuals through capacity enhancement of CeMTRE;
1-8 Expand CeMTRE's functions to selected ANECs and others;

2 PV Technology

2-1 Conduct OJTs at potential and existing sites on site survey, inspection, monitoring and technical advices for O&M;
2-2 Implement rehabilitation projects;
2-3 Conduct PV technical training;
2-4 Conduct mini-lectures at DOE;
2-5 Prepare manuals and guidelines as listed;
2-6 Prepare standard technical specification for bidding;

3 Social Preparation
3-1 Conduct OJTs on social survey at a model project site and other existing project sites;
3-2 Conduct BAPA organization at a model project site and re-organization at existing project sites;
3-3 Hold workshops/seminars on SP and BAPA organization;
3-4 Conduct mini-lectures at DOE;
3-5 Prepare manuals and guidelines for SP;
3-6 Prepare promotion and education materials such as Video;

4 Policy and Procedures
4-1 Review implementation framework and procedures of RE-based rural electrification projects, including review of budget, roles of stakeholders;
4-2 Prepare standard MOA and implementation guideline for DOE-funded RE project;
4-3 Review monitoring framework and develop a monitoring database for RE based rural electrification project;
4-4 Prepare criteria for pre-qualification/accreditation of suppliers/implementers for DOE-funded RE project.

The final PDM including indicators/targets, means of verification and important assumption is shown in Appendix 1.

3 Background of Project Implementation

3.1 Social Situation in the Philippines

(1) Political Situation

The Philippines experienced political and economic chaos until the early 1990's after collapse of Marcos administration by "People's Power" in 1986. It became relatively stable afterwards and is one of the countries where democracy is firmly established in Asia. Since 1990's, the Government of the Philippines has promoted significant privatization and decentralization in many fields. Even after the replacement of Estrada administration to the current Arroyo administration by "People's Power 2" in 2001, the government's policy on privatization and decentralization has been inherited.

(2) Economic Situation

Since the Asian economic crisis occurred in July 1997 spread to the Philippines and the drought caused by El Nino lead to major economic losses to agricultural production, the GDP growth became negative, trade surplus and treasury budget became worse and peso was depreciated. It becomes stable afterwards.

The economic policies such as deregulation, privatization and liberalization introduced by Ramos administration were inherited by Estrada and Arroyo administrations.

(3) Social Situation

The major constraining factors of development specific to the Philippines are the following two points:

1) Existence of rebel force

The reconciliation was established with Moro National Liberation Fronts (MNLF), one of Muslim rebel forces, in September 1996 and Japan and other aid agencies have supported the development of Mindanao southwest area. However, the behavior of some former MNLF soldiers and other Muslim antigovernment groups are still potential destabilizing factors. Moreover, Abu Sayyaf, one of Islamic fundamentalism extremist groups, continues their terror campaign centered on Mindanao west area and the communist force is still an impediment to national reconciliation and peace even though it is apt to be weakened.

2) Geographical conditions and frequent occurrence of natural hazard

The Philippines have about 7,100 islands including 11 major islands. It is also a world-class volcano country and has frequent occurrence of earthquakes. In addition, Visayas and Luzon are in the path of typhoons which cause serious damages such as

torrential rains, windstorms, floods and landslides every year.
The geographical conditions, a lot of solitary islands and mountainous districts, make a national network construction with grid difficult from electric power aspect.

3.2 Situation of Power Sector

After collapse of Marcos administration by People's Power in 1986, Aquino administration was installed and it started to deal with institutional reforms and economic reconstruction. As a result, the Philippines achieved steady economic growth. However, it suffered from a chronic shortage of power supply since the late 1980s and natural disasters such as catastrophic drought and Baguio earthquake happened frequently so the early 1990s was an epoch of power crisis. In order to react to the electric power shortage, the government allowed IPPs (Independent Power Producer) to enter the power generation sector in 1987 and enforced BOT law in 1990. Under the BOT law, it allowed IPPs to construct ambitious projects, set transaction prices high and did not restrict fuels to be used to promote deregulation for power generation business. As a result, the power shortage was solved in 1994. However, the introduction of IPPs with emphasis on solving the power shortage caused escalating price of electricity, increasing of debt of National Power Corporation (NPC) and increasing of government's burden with depreciation of peso by the exchange rate.

The introduction of the principle of competition for the electric power sector and the privatization of NPC were examined over many years to reduce the electricity price and burden of the government as the next agenda of the Philippines after the power crisis. In June, 2001, the Philippines established Power Industry Reform Law (RA9136 or EPIRA) to take a big step toward full liberalization of power industry for the first time among developing countries.
However, main pillars of power industry reform such as privatization of National Power Corporation (NPC) and foundation of wholesale spot market (WESM) were greatly delayed. Under these circumstances, the power crisis in Panay occurred and emergency measures were taken. It is required to develop continuous electric power resources and develop and expand interconnection between major islands. Moreover, the fragilities of electric power transmission capacity and power feeding system that are causes of long-time massive power outage occurred a few times a year over several years are not yet solved. There is fear that strengthening of them will be delayed along with shifting management of power transmission equipment to private companies.

On the other hand, rural electrification has been promoted as a key policy to contribute to poverty alleviation. The government has positioned rural electrification as the nation's

top-priority policy. In order to accelerate it, the government extended programs to such as Accelerated Barangay Electrification Program (ABEP), O'ILAW program, and now they deploy the Expanded Rural Electrification Program (ER-program), which targets 100% barangay electrification by 2008. Now, the target year was extended to 2009. As a result of the government's efforts, the barangay level electrification rate reached approximately 94% as of December 2005 that was 87.1% as of the end of 2002. However, the household level electrification rate is reported to be approximately 85%. If urban areas are excluded, the rate falls to 75%, and approximately 2.5 million households have no access to electricity. Therefore, the government has also set another target of 90% household level electrification by 2017.

Most of the barangays and sitios still unenergized are scattered in remote areas, where they cannot expect the grid will be extended in near future. The only way for them to access the electricity is the independent power supply by RE systems such as solar Photovoltaic (PV) systems or micro-hydropower (MHP) systems. However, many of the rural electrification projects utilizing renewable energy in the Philippines have been failed in sustainable operation, in spite of the efforts made by the Philippine Department of Energy (DOE) and related stakeholders.

3.3 Strategy of the Government of the Philippines

(1) Energy Policy

As stipulated in Electric Power Industry Restructuring Act (EPIRA), DOE shall develop Philippine Energy Plan (PEP) every year and show the energy policy and the strategies. According to 2003-2012 PEP before the start of the Project, the energy policy and the strategies were as follows:

- Securing of Energy Supplies
- Expansion of Access to Energy Service
- Securing of Fair and Reasonable Energy Price
- Clean and Efficient Energy Development and its Infrastructure
- Promotion of Consumer Protection
- Technology Transfer and Personnel Training
- Creation of New Employment Opportunities in the Business Related to Energy

After five years have passed, the current 2007 PEP (2008-2017) Update is an affirmation of the state's commitment to pursue the energy independence agenda under the Government's Five-Point Reform Package. The energy sector's agenda focuses on

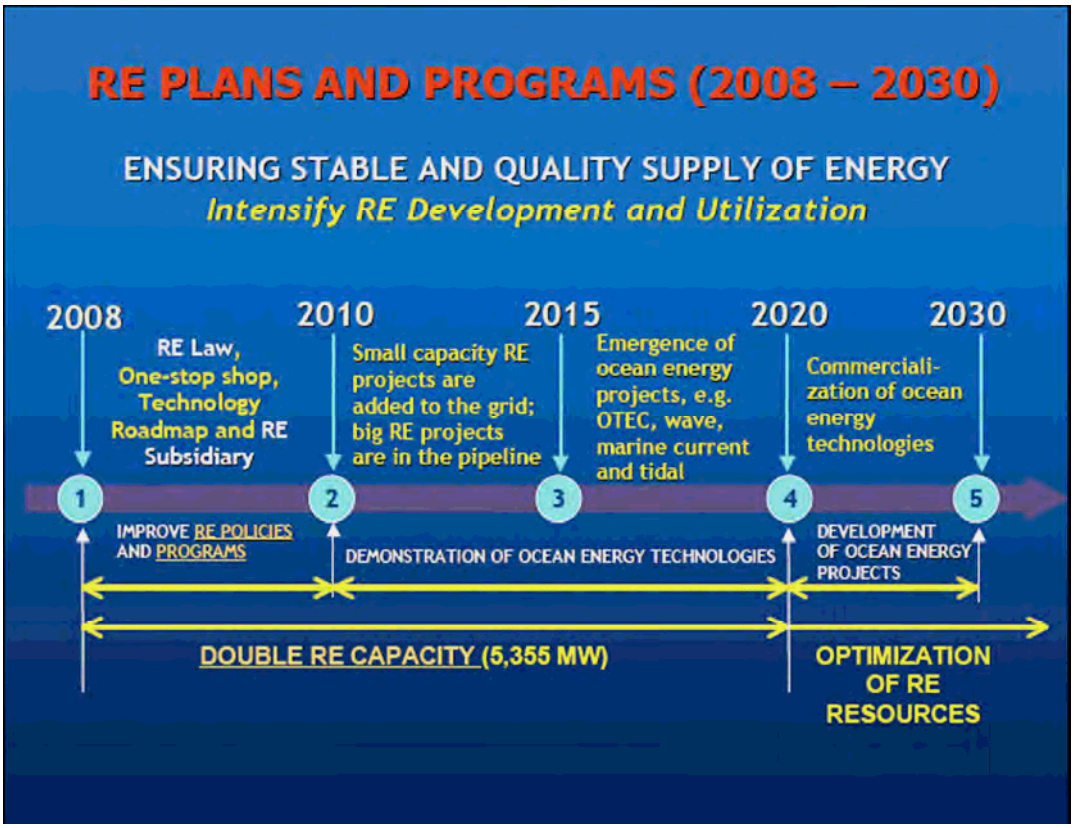
attaining a sustainable 60.0 percent energy self-sufficiency beyond 2010 and promoting a globally competitive energy sector. The first objective is anchored on the effective implementation of the following goals:

- Energy Self-Sufficiency
  - Increase resources of indigenous fossil fuels
  - Aggressively develop renewable energy potential such as biomass. solar, wind and ocean resources
  - Increase use of alternative fuels
  - Strengthen and enhance energy efficiency and conservation program
- Globally Competitive Energy Sector
  - Establish a transparent privatization process
  - Create an investment climate attractive to investors.

⑵ Renewable Energy Policy

1) RE Plans and Programs (2008-2030)

The overall road map of plans and programs of Renewable Energy development is shown below:



Source: DOE-REMD

2) Renewable Energy Act of 2008

In order to promote the development, utilization and commercialization of renewable energy resources such as geothermal, hydropower, wind, solar and ocean, "AN ACT PROMOTING THE DEVELOPMENT, UTILIZATION AND COMMERCIALIZATION OF RENEWABLE ENERGY RESOURCES AND FOR OTHER PURPOSES" was approved by President Arroyo on December 16, 2008 and it was enacted on January 30, 2009. This Act shall be known as the "Renewable Energy Act of 2008".

The outline of the Act is as follows:

a) Scope

- It shall cover the exploration, development, utilization and commercialization of RE resources for the generation, transmission, distribution, use and sale of electricity, and fuel generated from RE resources;
- It shall establish the framework for the accelerated sustainable development and advancement of renewable energy resources, and the development of a strategic program to increase its utilization;
- It clarifies the responsibilities and functions of various government agencies, in coordination with stakeholders and their relationship with the National Renewable Energy Board;
- It gives direction and support to renewable energy developers, suppliers, fabricators/manufacturers authorized to operate in the Philippines.

b) Policy

- Accelerate the exploration and development of renewable energy resources
  - achieve energy self-reliance,
  - reduce the country's dependence on fossil fuels
  - minimize the country's exposure to price fluctuations
- Increase the utilization of renewable energy by providing fiscal and non fiscal incentives;
- Encourage the sustainable development and utilization of renewable energy to effectively prevent or reduce harmful emissions;
- Establish the necessary infrastructure and mechanism to carry out the mandates specified in the Act and other laws.

c) Fiscal Incentives

- Incentives for RE Developers and Suppliers, Fabricators and Manufacturers:
  - Incentives are shown in the next table:

RE Developers (New & Existing)	RE Suppliers, Fabricators, Manufacturers
7 year Income Tax Holiday (ITH)	7 year Income Tax Holiday (ITH)
10 year Duty-free Importation of RE Machinery, Equipment and Materials	10 year Tax and Duty-free Importation of Components, Parts and Materials
1.5% Special Realty Tax Rates on Equipment and Machinery	
7 year Net Operating Loss Carry-Over	
10 % Corporate Tax Rate after ITH	
Accelerated Depreciation	
Zero Percent Value-Added Tax Rate	Zero-rated value added tax transactions
Cash Incentive of Renewable Energy Developers for Missionary Electrification	
Tax Exemption of Carbon Credits	
100% Tax Credit on Domestic Capital Equipment and Services	100% Tax Credit on Domestic Capital Components, Parts and Materials
Exemption from the Universal Charge	
Payment of Transmission Charge	
Hybrid and Cogeneration Systems	Financial Assistance program

- Incentives for Farmers Engaged in the Plantation of Biomass Resources:
  - All individuals and entities engaged in the plantation of crops and trees used as biomass resources such as but not limited to jatropha, coconut, and sugarcane, as certified by the Department of Energy;
  - Within ten (10) years from the effectivity of the Act, duty-free importation and be exempted from Value-Added Tax (VAT) on all types of agricultural inputs, equipment and machinery;

- Tax Rebate for Purchase of RE Components:
  - To encourage the adoption of RE technologies, the DOF, in consultation with DOST, DOE, and DTI, shall provide rebates for all or part of the tax paid for the purchase of RE equipment for residential, industrial, or community use. The DOF shall also prescribe the appropriate period for granting the tax rebates;

d) Non-fiscal Incentives

- Renewable Portfolio Standard (RPS):
  - A market-based policy that requires electricity suppliers to source an agreed portion of their energy supply from eligible RE resources;

- Feed-In Tariff System:
  - Price premium for the wind, solar, ocean, run-of-river hydropower and biomass generated electricity;

- Green Energy Option:
  - ✧ DOE to establish a program which provides the end-users the option to choose RE resources as their sources of energy;

- Net Metering for Renewable Energy:
  - ✧ A system, appropriate for distributed generation, in which a distribution grid user has a two-way connection to the grid and is only charged for his net electricity consumption and is credited for any overall contribution to the electricity grid;

3) Renewable Energy Policy Framework

The DOE's Renewable Energy Policy Framework (REPF), which was launched in May 2003, is geared towards the development of RE resources given their critical role particularly in rural development and off-grid electrification.

REPF aims to:

- Be the number one geothermal energy producer in the world (no.2 in capacity and no. 1 in steam utilization)
- Maintain our status as the number one wind energy producer in Southeast Asia
- Double hydro capacity by 2020 (additional 3,100 MW)
- Expand contribution of biomass, solar and ocean energy by 250 MW

Assumptions of REPF are:

- Enhancement of existing policies and programs
- Realization of higher production targets
- Establishment of market-driven RE industry
- Availability of new international financing schemes, e.g. Clean Development Mechanism (CDM) & Prototype Carbon Fund

The targets of RE development reviewed in 2008 is shown below:

(MW)

RESOURCE	Existing Capacity in 2008	TARGET Capacity	TOTAL in 2020
Geothermal	2,027	1,070	3,097
Hydro	3,367	3,400	6,767
Wind	33	515	548
Solar	6.74	30	35
Biomass	68	200	268
Ocean	0	120	120
Total	5,500	5,355	10,835

(3) Expanded Rural Electrification

In April 2003, DOE terminated O' ILAW Program that accelerated barangay electrification rate and newly established Expanded Rural Electrification Program (ER Program) to integrate rural electrification programs and manage efficiently. The purpose of this program is to build deeper cooperation between public and private institutions in accordance with Articles of EPIRA (or RA9136).

RE program integrates electrification efforts of DOE, NEA, NPC-SPUG and PNOC-EDC, asks private companies to join (front-loaded expenditure of ER 1-94 charge), integrates overseas aid projects into programs, sets up a short-term target to achieve electrification target, sets up assigned targets of each institution concerned to achieve the electrification target, and supervises, monitors and evaluates them. Though conventional O' ILAW program focused on barangay level electrification, ER program focuses on not only barangay level electrification but also sitio (village) level or households level electrification and has set up a new target, achievement of 90% household level electrification by 2017.

3.4 Project Related to Targeted Field

(1) Efforts by the Government of Japan

Japan has provided a lot of financial support for energy fields since the first yen loans in 1971, especially for the electric power field such as power generation industry, power line network infrastructure and rural electrification. After the power crisis in 1987, JICA (former JBIC or OECF) has provided financial support for construction and repair of power plants: 52 billion yen for construction of Calaca coal power plant, 10 billion yen for construction of Palinpinon geothermal power plant, 7 billion yen for repair of Tiwi geothermal power plant, 6.6 billion yen for repair of Macban geothermal power plant, 10.7 billion yen for construction of Labo geothermal power plant and 14.5 billion yen for construction of North Negros geothermal power plant.

It has also provided financial support: 2.9 billion yen for expansion of other substations, 2.3 billion yen for infrastructure of power grid, 8.1 billion yen for infrastructure of Leyte Bohol power line connection, 15 billion yen for infrastructure of power line for Luzon system private-sector support and 11.4 billion yen for rural electrification project. Lately, 5.9 billion yen of financial support for the North Luzon wind power project has been decided as a development of domestic clean energy resource. The total amount of financial support from Japan reached 286.6 billion yen for the electric power since the

first yen loans to date. Japan has contributed 8% of entire power generation capacity and 4% of entire power line extension by the yean loans and also contributed greatly to victory over the power crisis in the early 1990s.

On the other hand, Japan has also extended significant number of supports to the energy fields technically through JICA. JICA's supports by Development Study scheme on new power plants and maintenance of existing power plants are such as " Coal-Fired Thermal Electric Power Development Project (1988-1990)", "Kalayaan Pumped Storage Plant Development Project Stage II (1989-1990)", "Rehabilitation / Renovation and Operation / Maintenance Improvement of Power Facilities in Luzon Grid (1990-1992)" and " Feasibility Study on Malaya Power Plant Reliability Improvement Project (1993-1995)". Recently, " F/S on the Transfer of Facilities and Management of the 69KV Transmission Lines and Systems from the National Power Corporation (NPC) to the Private Distribution Utilities (1996-1998)" has been conducted to support the management shift from National Power Corporation (NPC) to the rural electrification cooperative along with structural reforms of power industry.

In addition, "DOE capacity building on development and investigation for structural reforms for power industry (2002-2003)" has been implemented. Moreover, "The Study on the Institutional Capacity Building for the DOE under a Restructured Philippine Electric Power Industry (2002-2003)" has been implemented. This project mainly supports planning of power development for entire Philippines. On the other hand, "The Master Plan Study of Power Development In Palawan Province (2003-2004)" was implemented to support planning of state level power development. Recently, “Study on Assets and Liabilities Management of PSALM and Administration of Universal Charge Funds“ was started in 2009 and now is being implemented to assist Power Sector Assets and Liabilities Management Corporation (PSALM) in its management.

For fields other than electric power, utilization of natural gas gathers momentum with natural gas exploitation in Camago, Malampaya, off-shore of Palawan Island and " Viability Study on Natural Gas Industry Development (M/P) (200-2001)" was implemented as a master plan for development of natural gas industry in the future. Furthermore, “Joint Study for a More Effective and Comprehensive Philippine Energy Plan Formulation (2007-2008)” was implemented to assist the DOE in formulating effective and comprehensive Philippine Energy Plan (PEP).

JICA has also been conducting Technical Cooperation mainly by dispatch of experts for such as geothermal resource development ("Undeveloped geothermal resource development (1997-2001)") and for support of rural electrification ("Rural electrification Utilizing "Mini-/Micro-scale hydropower (2001-2004)"). An individual expert for “Power

Development Plan (2005-2007) was dispatched, and "Project on Capacity Enhancement for the Power Development Plan in the Philippines" was carried out from 2007 to 2008 to supplement the expert dispatch.

⑵ Efforts of Other Countries' Donors and International Institutions

There are many donors from other countries and international institutions, which have supported the power sector of the Philippines. The projects, which were recently implemented or are on going, are listed below.

Donor Name	Project Name	Recipient	Amount (million USD)	Duration
World Bank	Rural Power Project	DBP, DOE	48.36	2003-2012
	Electric Cooperative System Loss Reduction Project	NEA	62.3	2004-2011
	NorthWind Bangui Bay Project	NWPDC	31.4	2004-2012
	Bicol Power Restoration Project	NPC	21.6	2008
UNDP/ GEF	Capacity Building to Remove barriers to Renewable Energy Development (CBRED)	DOE	5.5	2002-
	Palawan alternative rural energy & livelihood support project	Palawan Province	0.75	1999
ADB	Power market and power line maintenance	TRANSCO	40	2002
	Granting of credit guarantee (support of electric power sector privatization)	Government or PSALM	400	2002
	Renewable energy and better living for poor people in Negros Occidental (JFPR project)	DOE	1.5	2003
	Evaluation of consumer impact forecast	DOE	0.72	2000
	Strengthening of rural electrification	DOE	0.75	2000
	Rural electrification project	DOE	0.6	2000
	Competition policy of electric power sector	DOE	0.99	2001
	Restoration/Renewable energy project for rural electrification and better living	DOE	0.45	2003
	Promotion of good administrative management for electric power sector after the reform	DOE	1.15	2003
USAID	Philippines renewable energy project	DOE		2002-
	AMORE （Alliance for Mindanao Off-Grid Renewable Energy Program）	DOE		2002-
Spain	Solar Power Technology Support to Agrarian Reform Communities (SPOTS) Phase I	ARCs	25	2003-2004
	Solar Power Technology Support to Agrarian Reform Communities (SPOTS) Phase II	ARCs	27.1	2005-2008

4 Methodology and Approach of the Project

4.1 Issues on RE-based Rural Electrification Projects

(1) Status of Existing RE Systems before start of the Project

To understand the current status of existing systems, a systematic monitoring or follow-up check was required. However, the DOE had limited resources in implementing such activity. Isolated RE system installations had not been monitored adequately. The community-based project administration, including Operation and Maintenance (O&M), were not adequately supervised because of mainly accessibility problems. Findings on status of rural electrification projects with RE installations before start of the Project was as follows:

1) MHP Systems

There were 106 micro-hydropower systems as of the end of 2002. Ninety-two (92) of these installations were used for electrification purposes and the rest were designed for non-power applications, such as rice milling and coffee processing. Among those for electrification purposes, 37 MHP systems had capacities of 1kW or lower and only 17 had 10kW or higher. Therefore, in most installations, power supply was insufficient.

About 50% of the installations were not fully operational due to problems, such as low power output and low voltage, and some 19 systems were not operable. In addition, in some operable systems, the water turbine were utilized in direct applications without a generator and were not normally operated as power sources.

The problems encountered on the above RE projects had both technical and management factors. The technical factors include inadequate planning (insufficient of flow measurement, topographic survey and social survey), excessive design and/or lack of sufficient power generation obtained. In addition, low-cost generators without controllers and protection equipment, and locally-fabricated water turbines with unsatisfactory quality were often used leading to frequent breaks down.

Lack of or insufficient budget and high subsidies (sometimes total grants) were among the management factors. Insufficient budget leads to introduction of low quality equipment and poor facilities, and high subsidies lead to cense of dependency. The beneficiary communities did not have the sense of ownership such that recipients consider the supplied power was also free resulting to minimum collection of electricity

charges or lack of it. Therefore, the fund for normal maintenance or troubleshooting could not be secured in many cases.

The importance of community organization was recognized as a sustainability factor for such projects. The Barangay Alternative Power Association (BAPA) was introduced in the DOE's Barangay Electrification Program , the grass-root grant projects and demonstration projects (joint implementation with New Energy Foundation (NEF) of Japan).

2) PV system

The use of solar PV systems, such as Solar Home System (SHS) and Battery Charging Station (BCS) were widely used in rural electrification program. Some 620 barangays were energized with solar PV applications from 1999 to 2002. Since solar system applications can be easily installed and serve 10 to 30 households that satisfy criteria of barangay electrification, foreign contributions and supports abound for the introduction of such technology. However, there was no monitoring implemented and no compilation of data showing current operational status.

According to site survey and interviews, numerous solar systems / equipment had broken down (perhaps with battery problem) and left derelict after the introduction. In addition, some recipients had considered these equipment as personal properties and have transferred the same out of the respective barangays. There is a big gap between the capacity and willingness to pay of the beneficiaries, and electricity charges were not collected to maintain and replace the equipment. In one highly subsidized installation of a centralized PV system, many beneficiary members had discontinued receiving the services due to extremely high electricity charge. Moreover, the generated electricity was not properly utilized or some installations were not used beneficially.

⑵ Issues on RE-base Rural Electrification Projects

Before and in the course of Project execution, the following issues on RE-based rural electrification projects were identified:

1) Issues related to stakeholders' technical capability

- The lack of appropriate knowledge on RE-based electrification projects of stakeholders poses problems in rural electrification. The proposed projects generally lack the necessary field investigation on available renewable energy potential, topographic survey, local skills and capability of implementers. In

some cases, the equipment is insufficiently designed to meet the demand or the equipment cannot generate the expected output. Most equipment breakdown due to quality problems. Therefore, capacity building of project developers is important on this issue.

- On the other hand, cheap domestic water turbines and generators made in China are often used in project installations. The locally-fabricated water turbines are often not reliable qualitatively with low performance and low efficiency and cannot maintain the designed output. The most commonly used generators from China have poor quality and sometimes end-of-life-used generators are used. These equipment breakdown easily and such problems could be attributed to limited project funds. It is therefore necessary to guarantee a minimum quality of equipment by training local manufactures in the Philippines and introducing an authentication / standardization system to ensure sustainability of the project.
- Identified status of technical capability of stakeholders are as follows:
  - As regular activities for Barangay Electrification Program (BEP), REMD staff conducts site visits four to five times from project identification to project completion. The purposes of the site visits are to conduct Rapid Rural Appraisal (RRA), BAPA formulation, inspection of equipment, supervision of construction, commissioning, and hand over. Furthermore, REMD staff conducts evaluation of proposals from project proponents. In case that project proponents have insufficient capability to prepare project proposals, REMD staff assists proposal preparation. Also, REMD staff assists bidding process for PV equipment for BEP. However, it seemed that technical capability of REMD staff for RE development was insufficient or very limited to carry out the abovementioned activities.
  - Since LGU engineers seldom possess knowledge and experience related to the technology used for electrification projects, they have insufficient capability to prepare project proposals and to conduct social preparation. Therefore, ANECs could normally assist the LGUs in project formulation and implementation. However, even proposals from ANECs have lack of information and contain misconceptions, thus the REMD staff is forced to modify them.
  - When inspected the existing RE systems, improper installation was found in many facilities. Many of installers currently involved in the RE projects have insufficient technical skills and knowledge.

2) Issues on community organization for operation and maintenance of RE systems

- One factor on sustainability of independent RE installations is the proper operation and maintenance of the facilities. The community beneficiaries are not properly organized and trained to manage and administer such projects. There were no sufficient fund generation from collection of electricity charges, which should be used for the procurement of spare parts and payment of the operators' salaries, among others. The operators are likewise not sufficiently trained leading to poor operation and maintenance of the facilities and equipment.
- To solve these problems, DOE started to establish an O&M organization called BAPA (Barangay Alternative Power Association) at the start of the project and the diffusion of this method is now required.
- On the other hand, insufficient electricity charge collection results from the lack of willingness to pay such charges on the misconception that electricity services are added burdens even though the beneficiaries have enough capacity to pay. This is caused by insufficient explanation/ consultation on necessity of tariff payment. Therefore, such consultation activities so-called as "Social Preparation" should be sufficiently conducted through the project implementation.
- In order to increase beneficiaries' capacity to pay, integration of livelihood activities and introduction of consumptive end-use of electricity should absolutely be enhanced in rural electrification. The participation and cooperation of LGUs are likewise important in such concept.
- Issues on BAPA formulation and its management are as follows:
  - ✧ During formulation of a BAPA, necessary trainings for BAPA officers were insufficient or seldom conducted.
  - ✧ As for electricity tariff setting, explanation on the necessity of tariff collection to consumers was insufficient. Tariff setting was normally based on the beneficiaries' willingness to pay and capacity to pay; the necessary expenses for operation and maintenance were not taken into consideration in many cases. Therefore, the total revenue collected from consumers was small and used only as an honorarium for BAPA officers and consumables. Unfortunately, a lack of funds prevents BAPA from making necessary repairs when they are needed.
  - ✧ In some barangays where communication between BAPA and consumers was insufficient, some consumers did not pay their electricity charges and the BAPA could not properly operate the system or manage itself.

- ✧ Many of BAPAs did not conduct basic bookkeeping and accounting.
- ✧ User trainings have insufficiently been conducted in Solar Home Systems (SHS) and Battery Charging Station (BCS) projects.
- ✧ In the case of barangays that were electrified by BCS, the BAPA is managed relatively well if the main income of the barangay comes from fishing. This is because consumers can use electricity not only for lighting but fishing as well so that they can earn money. It becomes an incentive to maintain the system. On the other hand, in barangays where electricity is used only for lighting, the BAPA could not managed well and has trouble collecting electricity charges because consumers feel they receive little benefit from electricity.

3) Issues related to policy and program of RE-based rural electrification

a) Project formulation process of RE rural electrification

- ➢ Target barangays to be electrified under the Barangay Electrification Program (BEP) of the DOE are selected by the Expanded Rural Electrification Program-Team (ER-Team). a separate unit headed by DOE Undersecretary. The ER-Team serves as the clearinghouse for the target barangays and several units with specific task conduct the implementation. However, the clearinghouse has the difficulty of monitoring huge activities and the database of un-electrified barangays sometimes is the cause of the problem. Moreover, political involvement sometimes intervenes the selection process even though some barangays are not ready to accept electrification. This is known as the "Supply-side-approach (SSA)". Selection based on strong requests and efforts of the beneficiaries, known as the "Demand-Side-Approach (DSA)" or the "Bottomed-Up-Approach (BUA)", is seldom made.
- ➢ Once the barangays targeted for electrification have been selected, the REMD staff is dispatched to the target areas. They conduct Rapid Rural Appraisal (RRA) in which, RE potential and socio-economic conditions are surveyed. At the same time, they supposedly conduct what is known as "social preparation" to make beneficiaries recognize their own needs, possible living standard improvements, and their responsibilities after electrification. However, social preparation conducted by REMD staff was insufficient due to staffing limitations.
- ➢ REMD staff mainly prepares project proposals for BEP projects. Even in some cases that proponents or project implementers submit proposals, the proposal descriptions are insufficient. Therefore, the REMD staff finally has to review the proposals based on the results of the RRA. This occurs for the following reasons; i) proponents, which are normally Local Government Units

(LGUs), possess insufficient technical capability in the development of RE systems; ii) a standard proposal format has not been introduced to the stakeholders; and iii) proposal requirements are not concretely clarified.

- Proposals are sometimes approved even though the proposals are described insufficiently. This is caused by the pressure to immediately achieve electrification targets. Therefore, the REMD's evaluation process does not always function properly.
- The REMD comprehends very few of the project plans in detail before implementing the projects.

b) Responsibility of LGUs

- Municipality LGUs (M-LGUs) and Provincial governments provide financial assistance as counterpart funding for implementation of RE electrification projects. However, most of them do not have the responsibility of monitoring these projects after completion. It is expected that M-LGUs are in the position to assist the projects. Most of them usually have no sense of ownership and no responsibility to operate and manage the installed systems. Therefore, M-LGUs seldom monitor the systems and BAPAs. The functions and responsibilities of M-LGUs in MOAs are insufficient especially in instituting, monitoring, management and reporting to funding agencies.

c) Budget for RE rural electrification

- As for micro-hydropower projects, there are few projects whose budgets meet the necessary project costs. Since the budget per a barangay's electrification was fixed and minimized, projects were implemented within the budget. As a result, equipment and materials were selected and procured according to the budget, and projects were sometimes suspended without the completion of necessary work.
- As for ANECs' activities, ANECs cannot execute required activities due to under-budgeting or delayed release of the budget. Furthermore, in some cases, ANECs never received the final 10% of the total project payment due to improper liquidation procedures.

d) Monitoring of RE projects and database

- The DOE should monitor the operating condition after the installation as long as the electrification project is sponsored by the national budget and feedbacks / experiences from past projects are important for further promoting rural electrification. For that purpose, it is necessary to develop a reportorial system, monitoring system and database relating to the RE installations. By achieving these, it is expected that the installed power facilities are maintained

properly and the organizational operation is implemented properly.

- A lot of independent RE-based systems have been installed with financial support from DOE, NEA, NGOs and overseas donor agencies. However, the current situation such as operating and maintenance conditions after the installation is understood very little. This is because DOE has not monitored the implemented projects diligently due to lack of or limited resources and the following reasons.
  - A mechanism that requires BAPAs and/or M-LGUs to report to the DOE periodically has not been established so far.
  - ANECs have the role and responsibility of monitoring the existing RE systems. ANECs submit monitoring reports once or twice a year to REMD. However, the reporting frequency and the content are diverse because monitoring report guidelines have not been prepared. ANECs' activities depend on situations in areas where ANECs are located and sometimes project leaders.
  - Paper-based ANEC monitoring reports have been stored in the REMD. However, REMD does not fully evaluate and analyze the reports. These documents do not serve the function of a database.
  - REMD also directly conducts monitoring of the existing RE systems via site visitation. After conducting such site visits, monitoring data is scattered because it is not properly managed. Therefore, it is difficult to find detailed data of specific RE projects later on.
  - A monitoring system using mobile phones has been proposed and BAPA's in Antique Province have received instruction on this system. However, establishment of the program has not been realized because consumers do not feel there is a necessity for reporting when operation of the systems is functioning well.

e) Issues on the application of guidelines and manuals

- REMD has prepared a "Project Implementation Manual", which prescribes DOE' procedures and related rules for DOE funded projects, including BEP projects. The manual is applied to mainly solar PV projects. However, the guidelines are partially introduced in actual implementation.
- As for micro-hydropower projects a "Guide on Micro-Hydro Development for Rural Electrification" was prepared by the DOE in March 2004 in cooperation with a former JICA expert. It outlines procedures of rural electrification projects using micro-hydropower systems and describes the roles and responsibilities of related stakeholders. If REMD and stakeholders had complied with the guide, the problem prevention system and problem-solving system would have been established and necessary technical and social data accumulated in the

REMD. In fact, stakeholders have not complied with the procedures so far, and monitoring data of existing micro-hydro systems has not been arranged.

f) Manpower of REMD Staff

- REMD is mandated to carry out abovementioned activities for a good many of BEP projects. On the other hand, the number of staff members of the Project Development Section of REMD involved in the abovementioned activities is just eight, including non-technical personnel. Therefore, it is physically and technically difficult for the limited REMD staff to execute all BEP projects and other foreign-assisted projects.

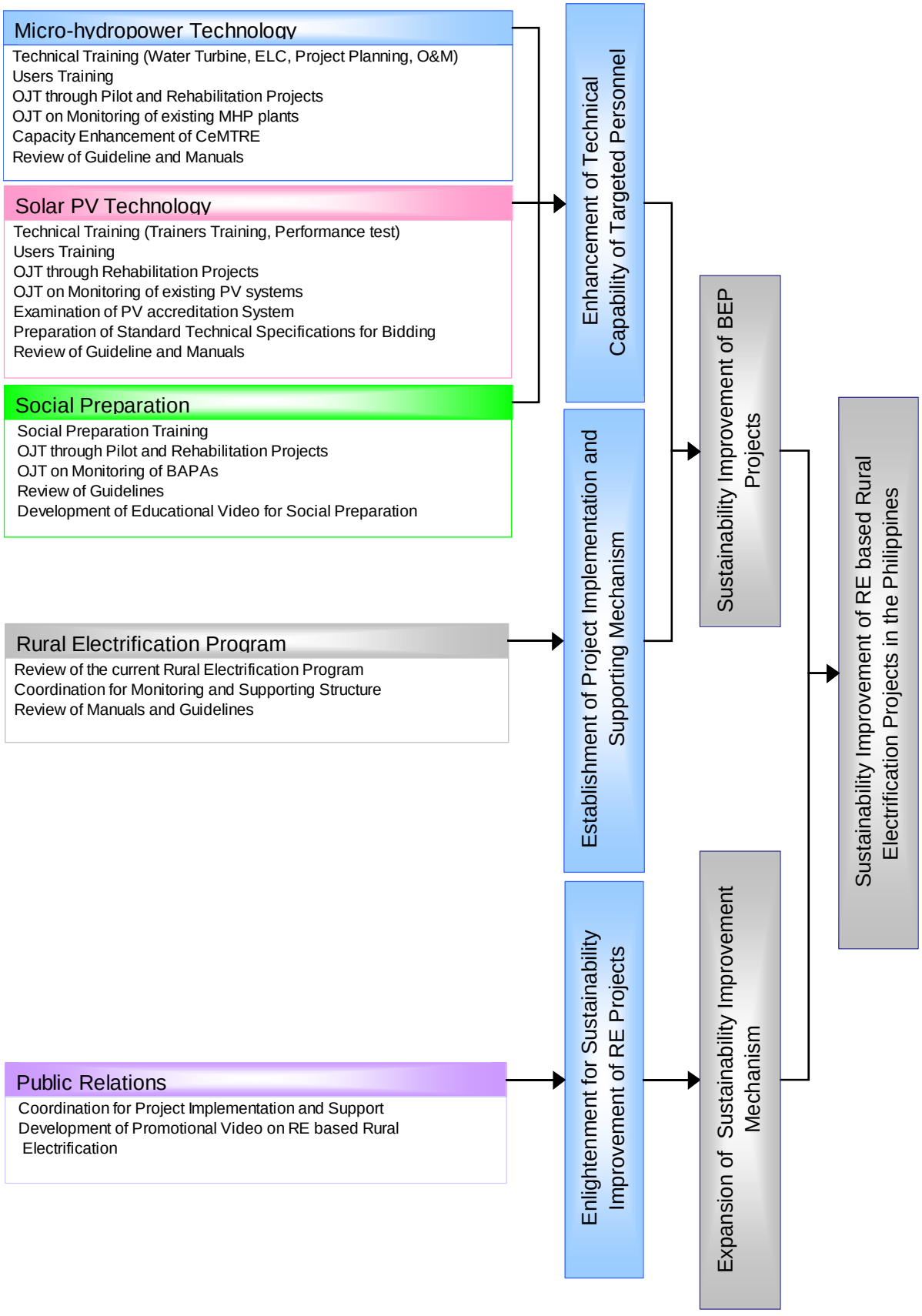
4.2 Project Strategy and Approach

For effective implementation of this Project, the following strategy and approaches were taken:

(1) Technical Cooperation Subjects of the Project

There are renewable energies such as photovoltaic, micro-hydropower, biomass, biogas, wind power and hybrid. The micro-hydropower and photovoltaic have been established technically as individual power sources for village electrification. The purpose of this Project is to cultivate planning and implementation abilities of DOE and ANECs for village electrification, while utilization of established technologies and improvement of substantial household level electrification are required. Therefore, renewable energies that are not developed in the Philippines such as centralized photovoltaic, wind power, biogas and hybrid are not considered as priority subjects. So, the Project focuses on Micro-hydropower (MHP) systems and PV systems of Battery Charging Systems (BCS) and Solar Home System (SHS).

(2) Implementation Flow



(3) Subjects to be solved and Approaches

1) Micro-hydropower Technology

Interviews with stakeholders such as DOE, LGUs, ANECs, NGOs, and site surveys at the existing MHP plants were carried out in the 1st and 2nd years of the Project in order to identify problems on rural electrification projects using micro-hydropower. The identified issues are as follows.

Items	Issues
Planning	➢ Technically improper project proposals are approved and implemented because both of planners and evaluators have insufficient knowledge and skills on micro-hydropower technologies, ➢ Operation of some micro-hydropower plants is suspended due to improper planning, ➢ Counterparts are not well familiar how to use instruments and how to evaluate collected data, which are necessary for problem prevention. ➢ The documents such as project proposal, drawings, project cost estimates with breakdown and other basic data have not been prepared before starting of the project.
Civil Structures	➢ Persons who design civil structures do not have enough knowledge on required functions of the civil structures. ➢ Persons who design do not know the basic technology for designing civil structures. ➢ Site survey, particularly measurement of the head and the river flow rate, is insufficient. ➢ Budget for the MHP projects is insufficient. These issues lead the following problems. (1) Outputs from the power plants are lower than designed output. (2) Because of sedimentation, power plants cannot be operated. (3) The structures/equipments are damaged at early operating stage. (4) Because of budget shortage, construction of the project cannot be completed.

Electro-mechanical Equipment	➢ Designing skill of each ANEC was not established and was lacking in reliability and certainty, therefore the expected output and efficiency could not be obtained. ➢ Some power plants are not equipped with controllers; therefore frequency and voltage fluctuate significantly in response to change of demand. ➢ In the case that some power plants are equipped with imported controllers, implementers cannot properly maintain or repair them when necessary. ➢ Some ANECs refurbish commercial productions and apply them to power plants as Automatic Voltage Regulator (AVR). However, the design and fabrication technologies are not established theoretically and the function of equipment to stabilize electricity quality is not validated.

Taking into account the above problems, the following activities were employed so as to settle micro-hydropower technologies and improve the sustainability of existing and future MHP projects for rural electrification.

- Lecture on basic theory related to hydropower
- Lecture on how to use instruments
- Workshop on micro-hydropower technologies
- OJT on micro-hydropower technologies
- Manufacturing training for micro-hydropower equipment
- Implementation of micro-hydropower rehabilitation project
- Implementation of micro-hydropower pilot project
- Other activities

Contents of the activities were adjusted continuously in line with enhancement of the counterparts' ability and the circumstances surrounding. The activities implemented throughout five years are summarized as follows:

	June 2004 – June 2006	July 2006 – June 2009
① Lecture on basic theory	➢ Lecture on generation plan ➢ Lecture on electrical basic theory	➢ Implementation of short lectures
② Lecture on how to use the instruments	➢ Lecture on hydrological survey ➢ Lecture on how to measure head and discharge ➢ Lecture on how to measure electrical characteristics	➢ Implementation of short lectures on how to use the instruments

③Workshop		➢ Workshop on design, implementation, and O&M ➢ Workshop on turbine manufacturing
④OJT	➢ OJT on monitoring for existing facilities	➢ OJT on site selection and evaluation for rehabilitation projects ➢ OJT on commissioning and completion tests ➢ OJT on monitoring for existing facilities
⑤ Training for manufacturing of hydropower equipment		➢ Turbine manufacturing training ➢ ELC fabrication training
⑥Rehabilitation project		➢ Planning, implementation, and monitoring of the project
⑦Pilot project		➢ Planning, implementation, and monitoring of the project
⑧Other activities	➢ Establishment of manuals and guidelines	➢ Establishment and revision of manuals and guidelines

(June 2004 – June 2006)

Numbers of lectures and OJT on hydrological study and analysis, river flow and head measurement, basic electrical theory, and operation data measurement were conducted to enhance the capacity of the counterparts. Additionally, seminars and workshops helped a wide range of people concerned to deepen their knowledge and skills on hydropower technologies. These activities enabled the counterparts to properly measure and monitor the conditions of power plants using instruments, and consequently the counterparts became capable in identifying the problems of the present situations of the MHP plants.

However, manufacturing technologies for turbines and controllers were not included so much in these lectures and seminars because the theory of hydropower electrics and turbine design was focused to improve the theoretical technology in these years. Since the theory of the hydropower was mainly studied, practical manufacturing technique/technology were not progressed in these two years.

In the late of the second year, it was concluded that the counterparts could acquire the knowledge on basic theory concerning hydropower equipment. Afterwards, the Team shifted its focus to activities to develop the ability to design and manufacture hydropower equipment. In this connection, a preliminary study was conducted on March of 2006 in order to evaluate the possibility of technical transfer from IBEKA that is a NGO in Indonesia and have abundant experience in micro-hydropower development. A mission

consisting of Japanese experts and the counterparts was sent to Indonesia and realized the technical level by exchanging opinions with the local engineers and inspecting local workshops for equipment manufacturing. A road map showing strategies after the 3rd years was drafted based on the result of the mission.

(August 2006 – June 2009)
From the third year, the workshops on MHP technology were also held in rural area in order to spread the appropriate technologies to local stakeholders such as LGUs and ANECs. Furthermore, rehabilitation projects and pilot project of MHP were implemented in order to provide OJT on the appropriate technology to C/P through actual activities.

As for electrical and mechanical technology of MHP, the 3rd year was started with the main subject of enhancing the turbine manufacturing technology and stabilizing the generating frequency/voltage, both of which were the important issues identified in the first and second years. Though purchasing turbines, generators and the auxiliaries from foreign countries is the easiest way to obtain a certain level of quality of equipment, it makes project cost high and O&M difficult. In consideration of budgetary limitation and easiness of O&M, it was necessary to own approaches to solve the issues in the Philippines. The following directions were taken to meet the various requirements:

- Technical transfer on turbine manufacturing from Indonesia would be promoted to acquire the established knowledge and skills on designing and manufacturing of water turbines. The Crossflow type turbine would be focused as a main subject taking into account the high applicability to micro-hydropower projects for rural electrification.
- Technical transfer on fabrication of electronic controllers (ELCs) from Indonesia would be promoted to acquire the established knowledge and skills on designing and manufacturing of ELCs, which is a controlling part of the dummy load governing system.

According to the direction, "Turbine manufacturing training" and "ELC fabrication training" were implemented from the 3rd year, inviting the engineers of IBEKA as trainers.

As for turbine manufacturing technology, workshops and seminars were also held as a part of enlightenment activities for exchanging opinions about the present situations and problems.

2) PV Technology

The photovoltaic power generation system (PV system) has features such as simple structure, easy installation, short installation time and small geographical restriction, and it is a tool suited for accelerating the rural electrification projects. On the other hand,

since the rural electrification projects are implemented at remote areas, it is difficult to dispatch a full-fledged technician for system management and to supply service such as rapid fixing and replacement of parts when the system becomes defective. Therefore, under the BEP, the BAPAs are expected to handle the operation and management of the RE systems, and ANECs (now, called as ARECs) and LGUs are the ones who provide technical support to the BAPAs for O&M of the systems.

Although PV systems, mainly BCSs, had been installed in about 350 Barangays from 1999 to 2003 under the BEP, most of them had problems such as low quality of equipment, wrong installation work, failure of battery and equipment and lack of fund for O&M because of uncollected electricity charges. And these problems lead to a decrease in the number of users, and failed PV systems had been left abandoned. In addition, monitoring of installed PV systems had not been adequately conducted, and even DOE could not comprehend the status of PV systems after those installations.

DOE concluded that these failures were caused mainly by the implementation structure that all installation works except procurement of PV module would be done by ANECs and LGUs. Therefore DOE changed the implementation structure as listed below and prepared the BEP implementation manual in 2004.

- DOE has responsibilities for procurement and installation of PV systems.
- LGU has responsibilities for soft components such as BAPA formulation, BAPA training , and monitoring

To make the electrification project successful, all of technical, organizational and institutional aspects should meet their requirements. In concrete, facilities should be technically supported, O&M should be properly carried out, and BAPA formulation and BAPA management including tariff setting should be appropriately conducted. In other words, the project falls into failure if there is a problem on any of them. Especially, PV systems require each user to maintain batteries by themselves. Therefore, not only providing technically supported RE systems but also providing soft components such as user training, troubleshooting, and monitoring is important.

In consideration of the situation, technical issues in the BEP using PV system until 2003 and activities to improve them are shown in the following table.

Item	Issues	Activities
Facility	➢ There were problems on the specification of installed PV system, and nobody could evaluate the specification. ➢ Although many cheap products made by local manufacture were introduced, it broke down earlier due to low quality. ➢ There was no confirmation of specification and quality of materials when they were delivered, and there was no protection against introduction of bad products.	➢ Establishment of standard specification ➢ Capacity building of persons in charge ➢ Review contractor selection method ➢ Proper inspection of delivery products ➢ Capacity building of local manufacturers ➢ Introduction of inspection and certification system for products
Installation	➢ Quality of installation work was not good ➢ There was no standardized inspection items ➢ There were inadequate inspections for installation	➢ Upskilling of installers ➢ Standardize inspection items ➢ Capacity building of inspectors
O&M of PV system	➢ Training to BAPA technicians was not insufficient ➢ User training had not been conducted ➢ User manual had not been distributed	➢ Conduct training for BAPA technicians ➢ Conduct user training ➢ Develop user manual
Project management	➢ There was no periodic monitoring ➢ There were no fixed monitoring items ➢ There was no arrangement of installation record and survey record ➢ There was no measures taken against high-frequently occurring problems	➢ Establish monitoring system ➢ Fix monitoring items ➢ Capacity building of monitors ➢ Data sharing
Evaluation	➢ There was no project evaluation ➢ Issues and improvements of previous project were not clear	➢ Establishment of project evaluation method ➢ Ability improvement of evaluators

As for the above mentioned issues on rural electrification project using PV technology, not only DOE but also donors and related organizations started activities to improve the issues. Capacity Building to remove barriers of Renewable Energy Development (CBRED) developed an action plan on establishment of a certification system for PV products and companies, and provide and technical supports to local manufactures. DOE reviewed the project implementation method by preparing the implementation

manual for the BEP. Therefore in this project, the Team selected and conducted the following five activities related PV technology that were intended to establish and disseminate PV technology in cooperation with the related organizations.

- Training for PV engineers
- OJT by PV site monitoring
- Solar PV rehabilitation project
- Additional training for qualified trainers
- Other activities

These activities were conducted with reviewing the contents of each activity in accordance with improved level of counterpart's capacity and surroundings. Activities during five (5) years are shown as follows:

(2004/6～2006/6)
The Team selected and conducted problem identification and technical training to core stakeholders (DOE-REMD (C/P) and selected ANECs and LGUs) for the first two (2) years in consideration of the follows:

- Identification of the problems at existing PV sites and solutions
- Improvement of basic knowledge and skills of the counterparts.
- Countermeasures against flooding of low quality products

(2006/8～2008/3)
The capability of C/Ps was improved by activities during the first two (2) years, and the eight (8) REMD staff were registered as qualified PV trainers. In order to disseminate PV technology with project implementers through these trainers, the Team decided to continue the solar PV trainers' training and the OJT through PV site monitoring.
Also, the Team selected and conducted the following activities against issues related to user side.

- Training for BAPA technicians and users
- Development of user manual

In addition, the Team conducted the rehabilitation projects to improve C/P's capability through the actual projects.

	2004/6 ～ 2006/6	2006/8 ～2008/3	2008/4 ～ 2009/6
1) Training for PV engineers	➢ Conduct preliminary training ➢ Plan and conduct solar PV trainers' trainings	➢ Conduct solar PV trainers' trainings	➢ Plan and conduct solar PV engineers' trainings ➢ Develop training materials and instruct how to use
2 OJT by PV site monitoring	➢ Conduct OJT by monitoring ➢ Arrange monitoring items	➢ Conduct OJT by PV site monitoring ➢ Conduct OJT on user training ➢ Arrange periodic monitoring items * Conduct OJT on user training ➢ Arrange periodic monitoring items	➢ Conduct OJT by PV site monitoring
3) Solar PV rehabilitation project		➢ Plan and implement a rehabilitation project (BCS) ➢ Develop user manual for BCS	➢ Plan and implement a rehabilitation project (SHS) ➢ Conduct monitoring and project evaluation ➢ Develop user manual for SHS
4) Additional trainings for qualified trainers			➢ Conduct training on performance test of PV equipments ➢ Conduct PV rehabilitation at DOE
5) Other activities	➢ Review standard specification of BCS ➢ Provide technical assistance for draft of technical standard made by CBRED	➢ Provide technical assistance for draft of technical standard made by CBRED ➢ Draft manuals & guidelines	➢ Review contractor selection method of BEP ➢ Review standard specification of SHS ➢ Finalization manuals & guidelines

(2008/4～2009/6)

Through the solar PV trainers' trainings which were conducted six (6) times over three (3) years, twenty five (25) persons, mostly DOE engineers, were registered as qualified PV trainers. The Team concluded that the aim to establish basic knowledge

and skills to central engineers was achieved. Therefore the Team decided to focus the dissemination of PV technology to the local level as the next stage. Also for the qualified PV trainers, the Team decided to provide the additional activities to reconfirm and improve their knowledge and skills learned. In addition, the Team selected and provided the following activities in accordance with the situation that the PV system adopted in the BEP would tend to be shifted from BCS to SHS.

- Review of standard specification
- PV rehabilitation project

3) Social Preparation

Social preparation under the Barangay electrification utilizing renewable energy means;

1) DOE, AREC, LGU and/or the proponent/implementer conducts study to check the institutional organizational aspect, management capability of the community beneficiary, and
2) For the sustainability and independence of the renewable energy project, DOE, AREC, LGU and/or the proponent/implementer supports and/or assists the beneficiaries until they become financially, institutionally, organizationally and technically independent.

On the whole, all the players for RE project must take into consideration; a) community beneficiaries' participation in RE project planning, implementation, and management, b) building a sense of ownership among beneficiaries, c) activating and/or reactivating BAPA management, and d) establishing the support system for BAPA. On the other hand, most of the counterpart of REMD personnel understood the importance of social preparation, however, such social preparation were neglected in many past projects due to the haste to accomplish 100 % of Barangay electrification, and the limited time and the costs. The common issues on social preparation are as follows.

a) Issues on social preparation and BAPA formation for RE project

[Training for BAPA]

- The operators are likewise not sufficiently trained leading to poor operation and maintenance of the facilities and equipment.
- During formulation of a BAPA, necessary trainings for BAPA officers are insufficient or seldom conducted.
- User trainings have insufficiently been conducted in Solar Home Systems (SHS) and Battery Charging Station (BCS) projects.

[BAPA Management]

- One factor on sustainability of independent RE installations is the proper operation and maintenance of the facilities. The community beneficiaries are not properly organized and trained to manage and administer such projects.
- In some barangays where communication between BAPA and consumers is insufficient, some consumers do not pay their electricity charges and the BAPA cannot properly operate the system or manage itself.

[Financial Management of BAPA]

- Many BAPAs do not conduct basic bookkeeping and accounting.
- There were no sufficient fund generation from collection of electricity fees / charges, which should be used for the procurement of spare parts and payment of the operators' salaries, among others.
- Insufficient electricity charge collection results from the lack of paying capacity of the beneficiaries / community residents. This is aggravated by the lack of willingness to pay such charges on the misconception that electricity services are added burdens.
- As for electricity tariff setting, explanation on the necessity of tariff collection to consumers is insufficient. Tariff setting is normally based on the beneficiaries' willingness to pay and capacity to pay; the necessary expenses for operation and maintenance are not taken into consideration in many cases. Therefore, the total revenue collected from consumers is small and used only as an honorarium for BAPA officers and consumables. Unfortunately, a lack of funds prevents BAPA from making necessary repairs when they are needed.

[Noticed]

- In the case of barangays that were electrified by BCS, the BAPA is managed relatively well if the main income of the barangay comes from fishing. This is because consumers can use electricity not only for lighting but fishing as well so that they can earn money. It becomes an incentive to maintain the system. On the other hand, in barangays where electricity is used only for lighting, the BAPA could not managed well and has trouble collecting electricity charges because consumers feel they receive little benefit from electricity.
- Integration of livelihood activities and introduction of consumptive end-use of electricity become absolutely indispensable in rural electrification. The participation and cooperation of LGUs are likewise important in such concept.

b) Methodology and approach of social preparation

In the words of "Social Preparation", people tend to imagine in many ways that are "Organization", "Management", "Socio-cultural", "Social environment", "Political",

and "Financial". However, the scope of social preparation under the Barangay electrification is all activities to make BAPAs capable in O&M and management the renewable energy system.

In order to realize capability of counterparts (C/Ps) on Social Preparation, Japanese expert and the C/Ps discussed what abilities the counterparts are required and what the C/Ps have to do as social preparation activities. And the following approaches were selected.

- The C/Ps of REMD understand the process of social preparation include BAPA formation through the lecture of JICA expert.
- Spend more time for social preparation (social preparation activities require to be patient and flexible in repeatedly disseminating information and conducting consultations until the beneficiaries fully understand the benefits of the project and their responsibilities).
- The C/Ps gain the experience of proper social preparation and BAPA formation through the OJT and the workshops/seminars and the C/Ps has confidence.
- The C/Ps transfer the knowledge and skill that they learned from this project to the other REMD staff, ARECs and LGUs.
- Development of guidebook for social preparation and BAPA formation and management

Following table shows the actual activities for five (5) years project periods.

	2004/6 ～ 2006/6	2006/7 ～ 2008/3	2008/4 ～ 2009/6
1) OJT on social survey	➢ Introduce the tool s of social survey ➢ OJT on social survey	➢ OJT on social survey at the existing site ➢ OJT on social survey at new project site	➢ OJT on social survey at the PV rehab site ➢
2) OJT on BAPA formulation	-	➢ OJT on BAPA formation at the existing project sites ➢ OJT on BAPA formation at new project site	➢ OJT on BAPA strengthen at the MHP rehab site ➢ OJT on monitoring at the PV rehab site
3) Hold Workshops/Seminars	➢ Awareness of present correspondence of BAPA strengthen ➢ Awareness of present role and responsibilities	➢ Social preparation (Manila) ➢ Social preparation and BAPA formation (Kalinga, Ifugao, two	➢ Social preparation review training

	of the stakeholders for BAPA formulation ➢ Importance of social preparation	times)	
4) Conduct mini-lectures at DOE	➢ Outline of social survey ➢ PCM method ➢ SWOT analysis ➢ Evaluation method	➢ BAPA formulation ➢ Social preparation ➢ Measure of monitoring ➢ Social preparation for PV project	➢ Electric Tariff setting ➢ Check points for monitoring ➢
5) Development of a guidebook for social preparation, BAPA formation and management	➢ Guide on social aspect for rural electrification ➢ Field manual for social survey	➢ Draft guidebook on social preparation and BAPA formation and management	➢ Finalize guidebook on social preparation and BAPA formation and management ➢ Development of educational video of social preparation

4) Policy and Procedure of RE based rural electrification

As mentioned above, the Team identified the issues on project formulation method and monitoring for RE-based rural electrification projects.
The formulation and implementation of rural electrification projects has been initiated by central government. This is so called as "Supply-side-Approach". So, self-help efforts of beneficiaries was not required to get an approval of project, and this is the reason why it is difficult to build cense of self-support in RE-based electrification projects.

Meanwhile, DOE-REMD had carried out a series of project implementation and management such as Rapid Rural Appraisal (RRA), Social Preparation, Project Supervision, and monitoring after implementation. However, it was practically difficult for REMD to adequately conduct monitoring activities only by itself. Though LGUs were expected also to monitor such RE projects, they seldom do monitoring. Therefore, there is limited monitoring data to figure out and evaluate current situation of existing RE systems, and this is a one of barriers on sustainability improvement of such systems.

The issues and the corresponding activities related to policy and procedures of RE projects are shown as follows:

Items	Issues	Actions
Project Implementation Framework	➢ Even if there is no self-efforts of beneficially, a project is implemented. So, cense of self-support cannot be built by themselves. ➢ LGUs have little cense of proponents so that they are not aware of their responsibilities. ➢ It is difficult for limited resources of DOE to carry out all activities.	➢ Review implementation framework and procedures of RE-based rural electrification projects, including review of budget, roles of stakeholders; ➢ Prepare standard MOA and implementation guideline for DOE-funded RE project.
Monitoring Framework	➢ Monitoring framework for monitoring of RE systems is not clearly established. ➢ Since there is insufficient monitoring data, technical supports cannot be provided. ➢ Without monitoring data, project implementation cannot be improved.	➢ Review monitoring framework and develop a monitoring database for RE based rural electrification project.

During the first and second year of the Project, main focus was put on transfer of basic technology to the counterparts, and activities for improvement of policy and programs on RE-based electrification was carried out from the third year.
The Team discussed and examined with DOE、DILG、LGUs、ANECs on implementation framework of RE projects. As a result of the examination, it was found that it is not practical to newly establish a framework and that it is better to clarify responsibilities of stakeholders, and then to strengthen the current relationship among the stakeholders.

Through implementation of the pilot and rehabilitation projects, the Team carried out the followings for the implementation framework:

- Make self-efforts of beneficiaries compulsory for project approval;
- Make LGUs' responsibilities clear by reviewing Memorandum of Agreement (MOA) for project implementation;
- Clarify roles of stakeholders by reviewing project implementation framework;
- Review project implementation manual for RE-based projects.

As for monitoring framework, the Team selected the activities as follows:

- Clarify responsibilities of stakeholders by reviewing monitoring framework;
- Develop a monitoring database;
- Preparation of Monitoring guideline;
- Inform of monitoring framework and consult with stakeholders.

(4) Other Attention for Project Implementation

1) Aim to Improve Household Level Electrification Rate.

An important policy issue of the Philippines is the elimination of unenergized barangays. The Government of the Philippines has made considerable efforts in this subject and this target seems to be achievable. The next subject is to improve household level electrification rate and the Government of the Philippines has already implemented efforts toward the solution of this subject. Actually, even if barangays are declared as electrified, there are many people who cannot still access to electricity because of limited number of connections and defect of electrification systems. Therefore, this Project aims to contribute to subsequently increase of household level electrification rate by improving sustainability of RE systems and further utilization of the technology.

2) Emphasis on Self-dependence in RE-based Village Electrification

a) Emphasis on Technology Transfer and Capacity Building by Collaboration

This Project does not aim to directly accelerate implementation of RE-based village electrification projects, but aims capacity building of DOE and ANECs. So that DOE will play roles to improve and maintain sustainable RE development in village electrification even after termination of this Project.

The basic strategy is that the DOEs' capacity building is cultivated through working directly with specialists assigned in this project at the same office. DOE has own projects such as BEP Projects.Also, DOE has received support from World Bank and UNDP in the renewable energy field. This project is expected to build DOE's capacity to promote its own projects and to respond as counterpart in World Bank and UNDP's projects by the collaboration in this project. This project emphasizes complementary supports on DOE's implementation of measures proposed by World Bank and UNDP through reports and builds the capacity of DOE and ANECs in the process. Manuals would be prepared by DOE staff, not and JICA experts jointly. The central issue of this project is to provide indirect support such as advices for DOE staff to improve their capacity.

b) Emphasis on application of idea of Demand-Side-Approach

The past rural electrification projects had been planned and implemented by the central government unilaterally in the Philippines. However, it is difficult for the central government to understand the scale of electrification needs and supervise each village's power supply smooth operation after the project implementation. The demand-side-(rural area) approach or bottom-up-approach

calls for positive participation from the beginning so that beneficiaries have a sense of ownership and the sustainability is improved. Therefore, this demand-side-approach was supposed to be spread in planning, implementing and operating the electrification project.

However, since the Government of the Philippines has specific target of rural electrification, DOE has responsibility to accelerate rural electrification. Since DOE cannot wait for actions from local stakeholders, it is difficult to completely adopt the demand-side-approach into barangay electrification program. Therefore, it was planned that part of the idea of the demand-side-approach should be applied. So, commitments from local counterparts such as barabgay resolution and counterpart fund should be clearly specified as requirements for project implementation.

3) Capacity Building of the Philippines side and Socialization of Renewable Energy

The effective utilization of renewable energy for improvement of household level electrification rate is an important subject for the Philippines having many islands and secluded places in the mountains. The technical features of micro-hydropower and photovoltaic generation used for village electrification are that the beneficiaries (village people) have to use and maintain relatively advanced techniques which are essential to the success of village electrification utilizing renewable energy. The renewable energy technology will be accepted and utilized by communities in the Philippines, thus, it is necessary to build the capacity of wide-ranging concerned parties including communities and private companies. This project provides training programs to DOE and ANECs to enhance technical capabilities, monitors them afterward and supports new technologies that are granted to the communities.

4) Cooperation with other Entities in Rural Electrification and Renewable Energy Fields

a) Cooperation with IBEKA

Cooperation activities with an Indonesian NGO, IBEKA, has been planned and implemented in this Project for effective technical transfer because IBEKA has attained many successful achievements in rural electrification via micro-hydro power in Indonesia. Its experiences should be helpful and good reference for rural electrification in the Philippines.

b) Assistance for Capacity Enhancement of CeMTRE

JICA has been assisting De La Salle University in establishment of Centre for

Micro-hydropower Technology for Rural Electrification (CeMTRE) since 2003. The capacity enhancement of CeMTRE is regarded as a part of this Projet components. So, CeMTRE should be involved in the activities along the implementation of this Project.

c) Information Exchange with Other Donors

JICA Expert Team works with DOE staff in DOE during the project implementation period and many of works are related to other donor-centered projects of World Bank and UNDP. This Project should form a productive complementary relationship with other donors so it is necessary to hold meetings between donors on-site.

4.3 Reviewed Project Implementation Structure and Components

(1) Change of Experts and Implementation Structure

In the first 2 years, two main experts for micro-hydropower and PV technology and 1 long-term expert for social preparation were individually dispatched, and in order to supplement them, short-term experts for specific technical areas were also dispatched. But after completing 2 years project activities, JICA decided to change the cooperation mode from individual experts dispatch type to the contract-out project type. The purpose of this change was 1) to attain the more effective project management, 2) to pursue outcome-oriented approach, and 3) to set the project leader to manage the each specific activity as an entire "Project" and to lead and attain the project purpose. According to this change of mode, the experts, as a team, in 7 technical areas are dispatched, succeeding individual experts, who shuttle between Japan and the Philippines periodically, and all the expert members had changed

(2) Change of Project Design Matrix (PDM)

Since the beginning of this project, PDM of the project has been revised three times. The previous revision of PDM change is as following table. The latest PDM and the previous PDM from the first version to the third version are shown in Appendix 1;

PDM ver. 1 (March 2004)	PDM ver. 2 (March 2005)	PDM ver. 3 (February 2007)
(Overall Goals) Household level electrification rate is increased	**(Overall Goals)** Household level electrification rate is increased. Scheme to ensure sustainability is established.	**(Overall Goals)** Village Electrification Program under Expanded Rural Electrification Program is successfully implemented.
(Project Purpose) Capability of DOE, ANECs is enhanced to improve sustainability of Renewable Energy Projects in village electrification	**(Project Purpose)** Capacity of DOE, ANECs LGUs and NGOs are enhanced to prepare sustainable Renewable Energy based village electrification projects.	**(Project Purpose)** Capacity of the target group (DOE-REMD, ANECs, LGUs, NGOs and CeMTRE) is enhanced to promote and manage sustainable RE based village electrification projects.
(Outputs) 1. Well organized social preparation is leaded by DOE and ANECs for sustainable RE development 2. DOE's and ANECS' technical services from project identification to monitoring and evaluation are enhanced for sustainable RE development 3. Capabilities in local manufacturing and installation are strengthened through testing application and standardization	**(Outputs)** 1. Failure prevention system are established. 2. Support system for problem -solving are established.	**(Outputs)** 1. BEP and rehabilitation program are improved. 2. Necessary knowledge and skills for RE schemes are transferred. 3. Monitoring system and database for RE projects is established. 4. Accreditation and certification system is established in collaboration with CBRED Project. 5. Practical and technical requirements of micro-hydro equipment are prepared at CeMTRE.
(Activities) 1-1 Monitoring and evaluation of energized of barangays using RE systems 1-2 Preparation of manuals 1-3 Training of stakeholders 1-4 Social preparation(community organization and institutional development and other activities) 2-1 Monitoring and evaluation of energized barangays using RE systems 2-2 Preparation of manuals 2-3 Training of stakeholders 2-4 Supervision and administration of project 3-1 Monitoring and evaluation of energized barangays using RE systems 3-2 Monitoring and evaluation of capabilities of local fabricators and installers 3-3 Formulation of micro-hydro technology standards 3-4 Implementation of RE technology standards 3-5 Evaluation of existing accreditation and certification activities for RE technology	**(Activities)** 1-1 Technical training for installation, operation and maintenance using prepared technical training manuals 1-2 User training for operation and maintenance using prepared user training manuals 1-3 Preparation of guidelines (project evaluation, system designing, installation, operation and maintenance, etc.) 1-4 Preparation of standard technical specifications for bidding 1-5 Preparation of failure preventive monitoring method 1-6 Monitoring and evaluation of energized barangays using RE systems 1-7 Evaluation of components and preparation of quality certificate system 1-8 Training on RE components manufacturing 2-1 Preparation of mechanism for problem-solving system (Brgy → LGU → DOE)2-2 Preparation of guidelines for proactive problem-solving system 2-3 Preparation of manuals for establishment and operation of BAPA 2-4 Social awareness in renewable energy system 2-5 Social preparation (community organization and institutional development and other activities) 2-6 Technical assistance to CeMTRE	**(Activities)** 1 Review of the existing program (Procedure, structure, budget etc.) 2 Implementation of pilot projects 2-1 micro-hydropower rehabilitation projects 2-2 micro-hydropower projects 2-3 PV projects under BEP 3 Training program on social preparation, institution development and RE development 3-1 OJTs at pilot project sites 3-2 Lectures 3-3 Technical Trainings 3-4 Workshops 4 Renewal of Monitoring system 4-1 Review of current monitoring system 4-2 Renewal of database for RE project 5 Preparation of Guidelines and manuals 5-1 Preparation of necessary guidelines and manuals 5-2 Preparation of standard technical specifications for bidding 6 Establishment of Solar PV accreditation and certification system

The first version of PDM was formulated in March 2004 when the project documents were prepared, just before the project had started. After 10 months activities in the project, based on the feedback from the results of field survey, the Japanese experts and DOE staff decided to revise the PDM, because the original PDM was structured by specific technical area-base, but they thought that the problems in rural electrification projects are interrelated closely, and to put more focus on "sustainability", the task-base PDM with two outputs, "problem prevention" and "problem solving", would be more appropriate to express their concept.

However, 2nd version PDM was, as a management tool of the project, not clear to show the way how to reach the project purpose through the outputs. So in February 2007, the PDM was modified again as above through discussion with Japanese experts and DOE counterparts.

Even though the PDM was revised three times as the result of elaboration of Japanese experts and Philippine counterparts, some still remained to be improved, such as logic of narrative summary or indicators. During the project midterm evaluation in November 2007, JICA's evaluation team recommended further revision of the PDM to reflect the actual activities and targets properly in the PDM. Finally, the PDM was again revised in March 2008 to share the same understanding of the Project and keep our eyes on the same goal in the rest of the Project period.

5 Inputs

5.1 Inputs from Japanese Side

(1) Experts

During the first 2 years (June 2004- June 2006), 2 specialists as main experts for micro-hydropower and solar PV technology were dispatched, and complementarily 1 long-term experts and 6 short-term experts were individually dispatched. Since September 2006, JICA contract out the project to the expert team to conduct this project. The records of expert dispatch are shown in Appendix 2 and Appendix 3.

(2) Counterpart Training in Japan

The counterpart training in Japan was held five times from 2005 to 2008. The C/P training consisted of lectures and study tours for about two weeks. The subjects of the C/P training were mainly on "Micro Hydro Power and Solar Photovoltaic design and Manufacturing Technology" and "Renewable Energy in Rural Electrification". Totally, 13 REMD staff members had an opportunity to attend the series of the training in Japan. The list of the trainees is shown as follows:

Participants of Counterpart Training in Japan from FY 2004 to 2008

No.	NAME		C/P Training in Japan					Program
			FY2004	FY2005	FY2006	FY2007	FY2008	
1	ROMULO B. CALLANGAN JR.	PV	Mar. 13-28, 2005					CP Training Program 2004
2	EPIFANIO G. GACUSAN JR.	MHP						
3	JIMMY B. PLANAS	PV		Nov. 6-19				CP Training Program 2005
4	JOSEPH E. CALIP	PV						
5	RONALDO T. ANGELES	PV			Mar. 4-17, 2007			CP Training Program 2006
6	ELINOR P. QUINTO	Social						
7	HELDILITA I. VILLANUEVA	Social						
8	NELSON A. FAJARDO	MHP				Sep. 24-Oct. 6		CP Training Program 2007
9	RUSSELLE G. PANDARAOAN	MHP						
10	IDA A. MADRIDEO	Social						
11	ARNULFO M. ZABALA	PV					Sep. 28-Oct. 11	CP Training Program 2008
12	REY V. SALVANIA	MHP						
13	ROMEO M. GALAMGAM	PV						

(3) Equipment

One 4WD vehicle and equipment necessary for this Project as listed in Attachment 4 was purchased during the Project period. Most of the equipment in 2004 – 2006 was purchased as carrying equipment of Japanese experts, and others were procured as donation equipment to the DOE. The total amount of equipment as of the time of evaluation is JPY 13,199 mil (FY2004:JPY1.397mil, FY2005:JPY3.915mil, FY2006:7.132mil, FY2007:JPY0.705mil, FY2008:JPY0.050mil). All equipment purchased under the Project was donated to the DOE to manage RE projects.

(4) Others

JICA has shouldered local activity cost, such as travel expense, Pilot and rehabilitation project costs, seminar/workshop and others. The total amount for local activity cost was JPY 72.0mil (FY2004:JPY2.4mil, FY2005:JPY2.5mil, FY2006:16.5mil, FY2007:JPY17.4mil, FY2008:JPY25.1mil, FY2009:JPY8.1mil) excluding the above mentioned cost for expert dispatch and equipment.
And also, JICA shouldered all expenses for capacity enhancement of CeMTRE, JICA-Net Seminar.

5.2 Inputs from Philippine Side

(1) Counterpart

During the first two years of the Project implementation, all staff members of REMD were assigned as the counterparts of Japanese experts. However, it was not clear who were responsible for each technical field. Since FY 2006, the DOE assigned individual counterparts for each technical field from REMD staff.
The current counterparts for each area are as follows:

Technology Area	Counterpart	Japanese Expert
Policy and system	OIC of REMD /R.N.Sargento/ R.B.Callangn	Mr. Jun Tamakawa
Social Preparation	I.A. Madrideo / H.I.Villanueva	Ms. Nobuki Hayashi
Micro-hydro technology	E.G.Cacusan / R.G.Pandaraoan	Mr. Mitsuru Shimizu
Micro-hydro system	R.V.Salvania	Mr. Keisuke Kumihashi
Micro-hydro control	N.A.Fajardo / R.T.Angeles	Mr. Isihi Yoshikazu
Solar Photovoltaic Technology	J.E.Calip / R.M. Galamgam	Mr. Koichi Iwabu
Solar Photovoltaic Technology	J.B.Planas / A. M. Zabala	Mr. Doi Fumikazu

⑵ Spaces and facilities for project activities

DOE offered the office space for the Japanese experts in REMD. For the training activities or seminars, not only DOE in Manila, but also the field office of DOE in Visayas and Mindanao were offered to conduct the training and seminars. Addition to this, other counterpart agencies, such as ANECs and DLSU also cooperated to offer the spaces and facilities to have a meeting, seminars and also the training courses.

⑶ Counterpart fund by the Philippine side

Based on the R/D, DOE shoulders the travel expenses of the counterpart to accompany site survey since JFY 2007. From 2007 to 2009, the total amount incurred by the Philippine side for the project activities was approximately Php900,000.
It also pays for the utilization costs of electricity and water in the project office and provided office supplies.

6 Project Activities

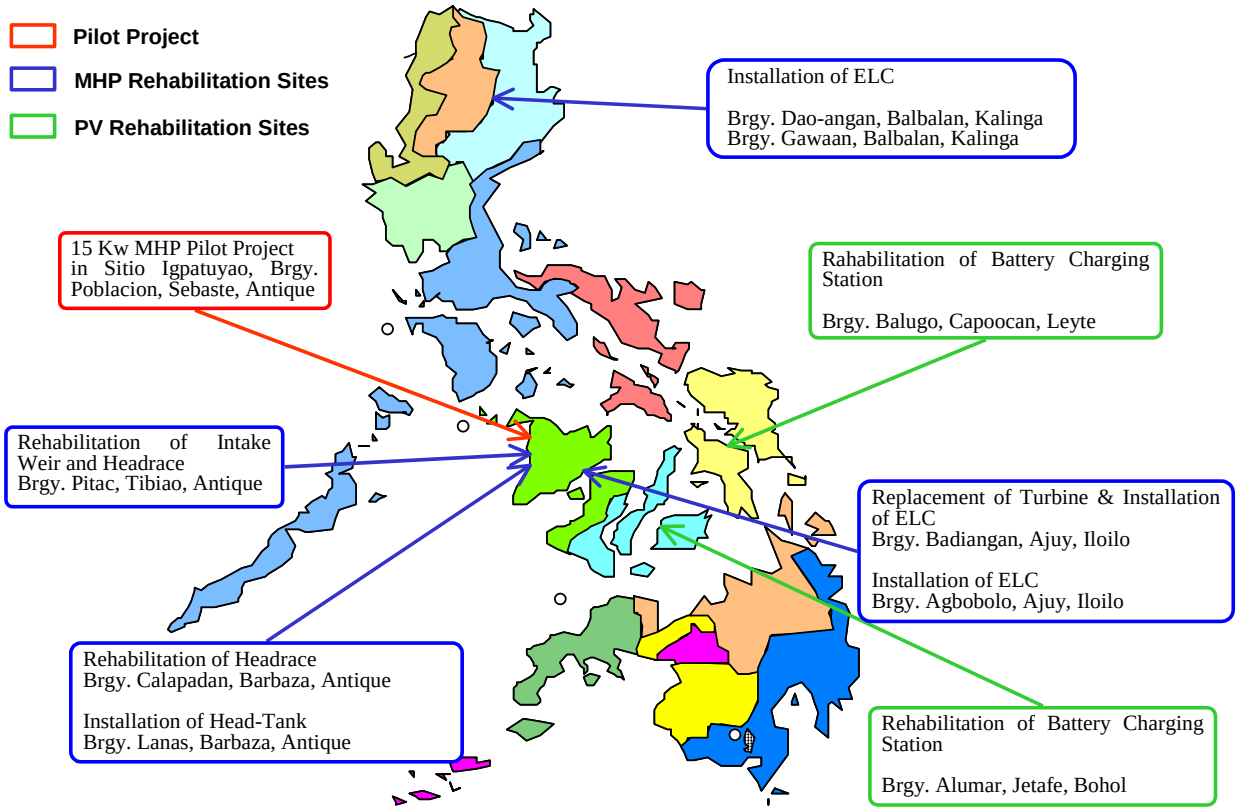
6.1 Outline of Project Activities

The Project Team conducted various activities by trial and error for five years from June 2004 to June 2009. What the Team consistently conducted was to provide technical transfer with practice or exercise. OJT or hands-on training was main strategy of the technical transfer. The pilot project and rehabilitation projects were also means to provide C/Ps with practice fields as well as the best fields for OJT. During the technical training, we employed hands-on for trainee to exercise. Aside from the training, we prepared materials and framework for C/Ps to stand up for themselves in promoting sustainable RE-based electrification projects.
The summary of the activities is mentioned in the table below. Detailed technical transfer activities are shown in Appendix 5 – 10.

Summary of Activities

	MHP Technology	PV Technology	Social Preparation	Management, Monitoring
OJT	36	29	18	-
Pilot Project	1	-	-	-
Rehabilitation Project	7	2	-	-
Technical Training	11	16	3	-
Seminar/workshop	12	-	5	2
Manual/ Guideline	8*	4	1	2
User Guide	-	2	1	-
Video	-	-	1	1
Database	-	-	-	1

** including W/T software and W/T fabrication manual through CeMTRE*



Location Map of Pilot and Rehabilitation Project

6.2 Activities related to Micro-hydropower Technology

(1) Micro-hydropower Pilot Project

1) Purpose and Background

In order to carry out in practice what the C/Ps have learned on MHP technology, the MHP pilot project was planned. This was also expected to provide the C/Ps with opportunities of better OJT through the implementation of a MHP project. Some candidate project sites in the Panay Island, where the ANEC was active, were investigated. As a result of the investigation, the Igupatoyao site in the municipality of Sebaste, Antique province was selected. For the purpose mentioned above, DOE-C/Ps carried out site reconnaissance survey (river flow measurement and topographic survey were included), planning, and design of the main structures, cost estimation, construction supervision and manufacturing/installation of turbine in collaboration with JICA experts.

2) Activities

The Team decided to implement a MHP pilot project in 2007 for practical and effective

transfer of knowledge and skills. In the same year, the seven candidate sites were found through acquisition of data from map study, and then Igpatuyao, Sebaste in Panay Island was finally selected as a pilot project site through site surveys. JICA experts and the C/Ps made site investigation, planning, designing and drawing.

Based on the design and know-how obtained in Indonesia, a T-12 designed water turbine for the project was fabricated through CeMTRE.

Prior to the start of construction of the project, Memorandum of Agreement (MOA) was concluded among DOE, JICA, LGUs and Central Philippines University (CPU), and then the construction work was contracted out to CPU in June 2008.

The construction was started in July 2008, and it was completed in the end of January 2009.

In the course of implementation of the project, the C/Ps together with JICA experts (sometimes alone) have visited the site from time to time to conduct supervision of construction and monitoring.

	Duration	Activities	Remarks
1	2007.6	Setting of the Criteria for site selection	
2	2007.6	Map Study for Candidate sites in the Panay Island	7 sites were selected
3	2007.6	Site Reconnaissance Survey for the Candidate sites	Sebaste site was qualified (Refer to Table S-2)
4	2007.8 - 2008.11	Filed Survey at Sebaste site	Measurement river flow and head Topographic survey Survey for demand area
5	2007.11 - 2008.1	Planning, Design	
6	2008.6	Cost estimation Preparation of Project Profile	
7	2008.7	MOA signing	
8	2008.7 - 2009.1	Construction and inspection	
9	2009.5 – 2009.6	Monitoring	

Based on "Manual for Micro-Hydro Development", all the above-mentioned activities were carried out by the C/Ps under JICA expert's instruction. The outline of activities is shown below.

a) Criteria for Site Selection

The Team and the C/Ps examined and decided the following criteria for site selection:

- Accessible
- Grid has not been extended
- Source has a potential capacity of 15-20 kW
- Demand must be within 1km radius
- LGU must be willing to have a counterpart
- Social condition (acceptance of the project, capacity and willingness to pay)
- Security/Peace and order

b) Map Study

Seven candidate sites were identified on 1/50,000-scaled topographical maps.

c) Site Reconnaissance Survey

The conformity to the criteria of the seven above-mentioned sites was checked at the site. The Igupatoyao site in the municipality of Sebaste, Antique province was finally selected.

d) Field Survey

- Measurement of river flow rate (June and September, 2007)

  River flow rate was measured in near the proposed intake site. As a result of the flow measurement, it was confirmed that amount of water of 0.3m3/s or more will be securable for the micro-hydropower plant.

- Measurement of Head and Topographic Survey

  C/Ps carried out the topographical survey at the proposed site.

- Demand survey

  Using a handy GPS, the C/Ps checked the distribution of the unelectrified houses to decide supply area of the project. The result was reflected in the power distribution plan.

Site Survey (Water flow measurement)

Meeting with LGU on MOU

e) Power Generation Plan and Design

Power generation specifications were determined from the result of the field survey. Main structures were designed according to "Manual for Micro-Hydro Development." This result is shown in the following table.

Feature of the MHP Pilot Plant

Items		Unit	Contents	Remarks
Location		-	Sitio-Igpatoyao, Sebaste, Antique Province	
Name of River		-	Ipayo River	
Cacthment Area		km^2	6.0	
River Flow Rate		m^3/s	0.31 (June 29, 2007) 0.35 (Sep. 7, 2007)	Results of Flow Measurement
Maximum Discharge		m^3/s	0.220	67% of the result of the flow measurement
Elevation of Intake		EL.m	60.000	Independent Elevation
Elevation of Tailrace		〃	38.800	
Gross Head		m	21.20	
L o s s	Intake- H/Tank	m	1.900	
	H/Tank-Powerhouse	m	1.800	
	Powerhouse-Tailrace	m	3.000	
	Others	m	0.500	
	Total Loss	m	7.200	
Effective Head		〃	14.00	
Total Efficiency		%	50	
Maximum Output		kW	15	

f) Cost Estimation and Project Proposal

The conventional method of the cost estimation for micro-hydropower plant in the Philippines has the following issues.

- Relation with the quantity (ex. concrete OOm3) of construction is not clear.
- The required number of laborers is un-reckonable.
- Since construction speed is not clear, it cannot decide an exact construction schedule.

In this pilot project, the construction cost was calculated in accordance with the

method shown in "Manual for Micro-Hydropower Development". The result of the site investigations, plan, design, and cost estimation was reflected in the project proposal.

g) Construction management

CPU-ANEC carried out the construction of this project. JICA experts and the C/Ps in cooperation with VFO carried out construction supervision and inspection periodically.

Design Discussion at the site

Explanation of Design to Residents

3) Accomplishments of the Pilot Project

42 households (direct power distribution: 36 households, battery charge: 6 household) have been received the electric power from the MHP plant. The C/Ps were able to learn the concrete technology on MHP development from site selection to O&M through the pilot project implementation.

It is expected that such transferred technology will be reflected not only in new development but also in monitoring of the existing plant and rehabilitation activities.

4) Efforts and Lessons Learned

In order to make future maintenance easy, the pilot project was carried out on the assumption of the local-base development that all of materials and manpower should be obtained locally.

The following matters were verified through the pilot project.

- Local base development is possible and effective.
- Local residents are able to perform construction work as long as they can get the assistance of DOE or ANEC.
- The construction cost of the pilot project was 5,240,000pesos, and the unit construction cost was about 350,000 pesos/kW that is much expensive than the one of ordinary MHP projects for rural electrification in the past. In the

construction cost, labor cost and management costs of CPU-ANEC were included. If such expenses are deducted, the unit construction cost becomes to about 250,000 pesos/kW. On the other hand, the DOE's budget for the MHP projects is uniformly about 3,000, 000pesos /site. If we construct MHP within the DOE's budget, the capacity of MHP is 12kW or less. Other financial assistances are required for more than 12kW capacity of MHP development.

Intake Weir

Settling Basin

Headrace

Turbine and Generator

Powerhouse

Inauguration (Swearing-in)

Inauguration (Guests)

ANNEX A

Summary of the Assessment of the Candidate Sites for JICA's Micro-hydro Pilot Project

	Target Barangay/ Sitio	Municipality	Province	Source	Coordinates	Drainage Area (km^2)	Gross Head [Net Head] (m)	Measured Flow [DesignFlow] (m^3/s)	Accesibility	Target Unenergized HH	Potential Capacity (kW)	Distance (Demand to potential MHP Plant) (km)	LGU Counterpart	Social Condition	Security	Remarks
1	Brgy Victoria	Tubungan	Iloilo	Tarao River	-	-	no H measurement was conducted	no Q measurement was conducted	Accessible by four-wheel vehicle Cabatuan A/P to Tubungan - approx30km (1hr)	none	no Q & H measurement was conducted	-	Tubungan LGU is willing to have a counterpart	LGU through the Municipal Mayor wassupportive to the purpose of the project.	guaranteed by LGU (NPA destryed Globe Tower 2 weeks ago)	DISQUALIFIED no available unenergized area
2	Sitio Botong, Brgy Laserna	Nabas *	Aklan	Gibon River	N 11°50.669' E 122°01.814'	9.50	no H measurement was conducted	0.23	Accessible by four-wheel vehicle Caticlan A/P to Nabas - approx 12km (25min) Highway to Bgry Proper - 3km	60	-	2	Nabas LGU is willing to have a counterpart	The Mayor, LGU municipal engineers down to Personal Secretary were cooperative and supportive through the assistance they extended in going to the area/site.	guaranteed by LGU	DISQUALIFIED Demand is 2 km away from potential Micro-hydropower site but EC grig is only 1 km from Sitio
3	Brgy Pawa			Pawa Falls	N 11°52.63' E 121°59.90'	12.50	no H measurement was conducted	no Q measurement was conducted	Accessible by four-wheel vehicle Caticlan A/P to Nabas - approx12km (25min) Highway to Brgy Proper - 5km	120	no Q & H measurement was conducted	3.5				DISQUALIFIED Demand is 5 km away from potential Micro-hydropower site
4	Brgy Tag-osip	Buruanga *	Aklan	Buruanga River	N 11°50.50' E 121°56.50'	11.00	no H measurement was conducted	no Q measurement was conducted	Accessible by four-wheel vehicle Caticlan A/P to Buruanga - approx15km (30min) Poblacion (bayan) to Tag-osip - 4km (accessible by single motor	60	no Q & H measurement was conducted	3	Buruanga LGU is willing to have a counterpart	The out-going and in-coming mayors are willing to support the proposed project but the town will be 100% energized through the AKELCO and MIRANT Project which will be extended to all the town sitios.	guaranteed by LGU	DISQUALIFIED On-going extension of grid by AKELCO through MIRANT Funding
5	Sitio Tapul, Brgy El Progreso				N 11°50.00' E 121°55.30'	11.00	no H measurement was conducted	no Q measurement was conducted	Accessible by four-wheel vehicle Caticlan A/P to Buruanga - approx15km (30min) Poblacion (bayan) to El Progreso - 2km	50	no Q & H measurement was conducted	0.5				DISQUALIFIED Grid extension by AKELCO at Brgy Tag-osip will be passing by Sitio Tapul, through MIRANT Funding
6	Sitio San Juan	Libertad	Antique	San Roque River	N 11°46.764' E 121°59.676'	20.00	10.3 [6] with 600m of headrace	0.36 [0.25]	Accessible by four-wheel vehicle Caticlan A/P to Libertad - 30 km Highway/EC line to Bgry Proper - 3km	60	9	0.1	Libertad LGU is willing to have a counterpart	LGU and the community within the sitio are very cooperative and willing to give support to the project through the assistance they showed during the site assessments and social survey.	guaranteed by LGU	DISQUALIFIED low potential capacity Has a grid extension plan by AKELCO, just waiting the funding from NEA
7	Sitio Igpatuyao	Sebaste	Antique	Ipayo River	N 11°36.144' E 122°06.703'	6.00	21.9 [16] with 500m of headrece	0.32 [0.20]	Accessible by all type of vehicles Caticlan A/P to Sebaste - approx55km Kalibo A/P to Sebaste - approx70km (1.5hrs) Highway to Sitio Proper - 2.1km From Sitio Proper to Low voltage EC line - 0.9 km to High voltage EC line - 1.5 km	59	18	0.3	Sebaste LGU is willing to have a counterpart	LGU staff and the target community are very cooperative and willing to have the project by assuring their interest and counterpart support if they are luckily chosen as the demo site.	guaranteed by LGU	POSSIBLE SITE ANTECO confirmed that they have no grid- extension program for Sitio San Juan

* Water source being used to supply water to Boracay Island

Criteria	
1	Accessible
2	Grid has not been extended (at least 50 unenergized Household (HH))
3	Source has a potential capacity of 15-20 kW
4	Demand must be within 1 km radius
5	LGU must be willing to have a counterpart
6	Social Condition (acceptance of the potential project; capacity and willingness to pay)
7	Security/Peace and Order

⑵ Micro-hydropower Rehabilitation Projects

1) Purpose

The C/Ps could acquire a wide range of knowledge from the basic theory to the development planning related to micro-hydropower projects through OJTs, seminars, and short lectures which had been conducted in the Project. The rehabilitation projects for existing micro-hydropower plants were implemented in order for the C/Ps to settle their improved knowledge deeply by carrying out in practice. The C/Ps experienced the actual activities of investigation, analysis, and evaluation under the instruction of the Experts.

2) Activities

Outline of the seven projects, which were implemented from the third year to the fifth year, is shown in the following table.

	Period	Site	Location	Implementer	Nos. of Beneficiaries	Rehabilitation Items
1	Dec.2006. – Mar. 2007	Calapadan MHP	Barbaza, Antique	CPU-ANEC	22	・Rehabilitation of headrace
2	Dec. 2006 – Mar. 2007	Pitac MHP	Tibiao, Antique	CPU-ANEC	99	・Rehabilitation of intake weir and headrace
3	Dec. 2007 – Mar. 2008	Lanas MHP	Barbaza, Antique	CPU-ANEC	21	・Installation of head tank
4	Dec. 2007 – Mar. 2008	Badiangan MHP	Ajuy, Iloilo	CPU-ANEC	58	・Replacement of turbine ・Installation of dummy load governor
5	Dec. 2007 – Mar. 2008	Agbobolo MHP	Ajuy, Iloilo	CPU-ANEC	37	・Installation of dummy load governor
6	Nov. 2008 – Jan 2009	Dao-angan MHP	Balbalan, Kalinga	KASC-ANEC	98	・Installation of dummy load governor
7	Nov. 2008 – Jan 2009	Gawa-an MHP	Balbalan, Kalinga	KASC-ANEC	82	・Installation of dummy load governor

The project sites were selected according to the following criteria set in advance:

- Grid has not been extended,
- Under BEP (Include ANEC Regular Budget from DOE),
- Social Condition (Activities of BAPA, Support of LGU, Efforts of Beneficiaries) based on CPU-ANEC Recommendation,

- Technical Aspects (There are sufficient data/information for trouble shooting. Appropriate Planning),
- Cost Performance (Low Initial Project Cost which is less than 100,000 pesos/kW, will be excepted),
- Effectiveness for rehabilitation/Improvement (Over 5kW),
- Security/Peace and order.

The outline of each rehabilitation project is shown as follows:

a) Calapadan MHP

Barangay Calapadan is located in the Municipality of Barbaza, Antique Province in the western Panay Island. Calapadan MHP plant has been supplying electricity to 22 households since 2005.

Name of MHP	Calapadan
Head	20.0 m
Discharge	0.040 m^3/s
Output	5 kW

Source：CPU-ANEC

The rehabilitation project was started with the investigation in December 2006, and completed in March 2007. The flow of the rehabilitation project is shown below.

＜Flow of the Project＞

	Year	Date	Contents of the Activities
Calapadan	2006	Dec4-8, 2006	Site reconnaissance
	2007	Jan.16-15	Planning of the rehabilitation
			Signing of MOA
			Contract for the rehabilitation
		March, 2007	Completion

＜Contents of Rehabilitation＞

Problem	Contents of Rehabilitation	Remark
Base of Headrace was destroyed	➢ Reinforce the base by Gabions ➢ Installation of spillway at small creaks	

Gabion Installation

Commissioning

b) Pitac MHP

Barangay Pitac is located in the Municipality of Tibiao, Antique Province in the western Panay Island. Pitac MHP plant had been supplying electricity to 90 households since 2003. However, in 2005, the intake weir and the headrace were damaged by a strong typhoon.

Name of MHP	Pitac
Head	9.0 m
Discharge	0.200 m^3/s
Output	15 kW

Source：CPU-ANEC

The rehabilitation project was started with the investigation in December 2006, and reconstruction of a new intake weir was completed in March 2007.The flow of the rehabilitation project is shown below.

Aside from the intake weir, rehabilitation of headrace was expected done by LGU under the financial assistance from Provincial Government. However, it has not been completed because of constraint of bidding process. So, the power plant has unfortunately not been operated until now.

The rehabilitation project was started with the investigation in December 2006, and completed in March 2007. The flow of the rehabilitation project is shown below.

Completed Intake Weir

Commissioning

＜Flow of the Project＞

	Year	Date	Contents of the Activities
Pitac	2006	Dec4-8, 2006	Site reconnaissance
	2007	Jan.16-15	Planning of the rehabilitation
			Signing of MOA
			Contract for the rehabilitation
		March, 2007	Completion of the Intake Weir

＜Contents of Rehabilitation＞

Problem	Contents of Rehabilitation	Remark
Intake weir	Construction of new intake	Cause: Lack of the Depth of the cut-off and Cheap Length
Headrace	Construction of the protection wall	LGU expense burden

c) Lanas MHP

Barangay Lanas is located in the Municipality of Barbaza, Antique Province in the western Panay Island. Lanas MHP plant has been supplying lectricity to 21 households since 2005. Since the catchment-area was small, the small space in front of the intake weir was performing as a regulating pondage during the dry season. In order to maintain the pondage, much manpower was required to remove the sediments.

So, a regulating tank was newly constructed.

Name of MHP	Lanas
Head	60.0 m
Discharge	0.05 m^3/s
Output	6 kW

Source：CPU-ANEC

The rehabilitation project was started with the investigation in November 2007, and completed in March 2008. The flow of the rehabilitation project is shown below.

＜Flow of the Project＞

	Year	Date	Contents of the Activities
Lanas	2007	Nov.12-16	Site reconnaissance
		Dec	Planning of the rehabilitation
			Signing of MOA
			Contract for the rehabilitation
	2008	Jan, 2007	Completion of the Intake Weir

＜Contents of Rehabilitation＞

Problem	Contents of Rehabilitation	Remark
Burial of the front of the intake weir	Construction of the water tank	Inappropriate Planning

Regulating Tank

Commissioning

d) Badiangan Site and Agbobolo Site

Barangays of Badiangan and Agbobolo are located in Iloilo Province in the eastern area of Panay Island. Both of the MHP plants have been supplying electricity to the Barangays since 2002. Design specifications reported by CPU-ANEC are shown in the following table.

Items	Badiangan	Agbobolo
Head	13.5 m	42 m
Discharge	0.090 m^3/s	0.030 m^3/s
Outpur	6 kW	6 kW

The rehabilitation projects were completed on February 22, 2008, eight months after commencement of the preliminary survey on June 2007. Subsequently, the Team conducted monitoring surveys as following-up activities in May and August 2008. Overall work schedule is shown in the following table.

<Implementation schedule>

	Year	Period	Items
Project	2007	Jun. 25 – Jun. 30	Site selection survey
			Drafting and proposing of the project plan
			Signing of MOA
			Conclusion of construction contract
		Aug.22 – Sep. 5	ELC fabrication training
	2008	Feb.7 – Feb.11	Implementation of performance tests for new turbine
		Feb. 17 – Feb. 20	Construction work
		Feb. 21 – Feb. 22	Completion inspection
Monitoring	2008	May 27 – May 30	Monitoring survey
		Aug. 6 – Aug. 8	Monitoring survey

In the site selection survey, it was confirmed in both sites of Badiangan and Agbobolo that no controller was installed and consequently the frequency/voltage fluctuated significantly in response to change in the power consumption of the community. Newly installation of dummy load governor was selected as one of rehabilitation items to improve the quality of generated power. In addition, overload operation that power consumption exceeded power generation in the peak hours was observed in Badiangan site. Considering reported site conditions such as head and discharge, increase in the generator output could be expected by improving the turbine efficiency. Replacement of the crossflow turbine was therefore selected to resolve shortage of supplies power.

MOA signing with LGU

Replaced Turbine

ELC Panel

Commissioning

e) Dao-angan Site and Gawa-an Site

Barangays of Dao-angan and Gawa-an are located in Kalinga Province in the northern area of Luson Island. The two MHP plants have been supplying electricity to the Barangays since 2002 and 2000 respectively. Design specifications reported by KASC-ANEC are shown in the following table.

Items	Dao-angan	Gawa-an
Head	17 m	27 m
Discharge	0.230 m^3/s	0.074 m^3/s
Output	20 kW	10 kW

The rehabilitation projects were completed on January 24, 2009, seven months after commencement of the preliminary survey in June 2008. Subsequently, the Team conducted monitoring survey as a following-up activity in May of 2009. Overall work schedule flow is shown in the following table.

<Implementation schedule>

	Year	Period	Items
Project	2008	Jun. 3 – Jun. 7	Site selection survey
			Drafting and proposing of the project plan
			Signing of MOA
			Conclusion of construction contract
		Jul. 28 – Aug.5	ELC fabrication training
	2009	Dec. – Jan.	Construction work
		Jan. 21 – Jan. 24	Completion inspection
Monitoring	2009	May 13 – May 16	Monitoring survey

In the site selection survey, it was confirmed in both sites of Dao-angan and Gawa-an that the controller that had been designed and fabricated by KASC-ANEC malfunctioned and consequently the frequency/voltage fluctuated significantly in response to change in the power consumption of the community. Replacement of the controller of dummy load governor was selected as a rehabilitation item to improve the quality of generated power.

Existing Turbine

ELC Panel

3) Result of Activity

a) Results of the rehabilitation for Calapadan MHP, Pitac MHP and Lanas MHP

MHP	Structure	Problem	Cause	Counter measures
Calapadan	Headrace	Damage of the base	Disposal of the running water from small creak is not appropriate.	Reinforce the base by Gabions Installation of spillway at small creaks
Pitac	Intake Weir	Damage by flood	Lack of the Depth of the cut-off and Cheap Length	Newly construction of Floating type of Intake Weir
Lanas		Shortage of the water during dry season	Inappropriate Planning	Newly construction of the small water tank

b) Results for Badiangan Site and Agbobolo Site

The results of the rehabilitation work implemented in Badiangan and Agbobolo MHP are summarized in the following table as well as failures and problems which were observed in the monitoring surveys.

Site	Items	Problems	Causes	Measures
Badiangan	Turbine	Output lower than expected	Turbine design (narrow inlet width)	・No measure was taken in accordance with the result of comparative study, including possibility of turbine and penstock replacement.
		Damage of bearing (Spherical roller bearing)	Improper alignment between turbine and generator	・Replacement of bearing
	Dummy load governor	Interruption of power supply	Action of protective function for under voltage due to over load operation	・Implementation of enlightenment activities on proper demand management ・Adjustment of setting value of protective function
		Malfunction	Breaking of PCB circuit and damage of IC due to lightning surge	・Repair of PCB ・Installation of varistor (Proposal)
		Burnout of magnetic contactor	Frequent action due to over load operation	・Implementation of enlightenment activities on proper demand management ・Adjustment of setting value of protective function ・Replacement of magnetic contactor (Proposal)
Agbobolo	Dummy load governor	Malfunction	Breaking of PCB circuit	・Repair of PCB
		Malfunction	Change in characteristics of generator	・Replacement of generator
		High frequency setting (results in high generator voltage)	Voltage drop due to long-distance transmission line	・Adoption of High-voltage transmission system (Proposal) ※Installation of transformers for step-up and step-down

Although plenty of failures and problems occurred after implementing the project as shown above, the C/Ps are steadily taking countermeasures against each issue one by one without being left unsolved. The C/Ps were able to learn a lot about how to indentify causes of the failures and to draw up the appropriate measures. Especially, some solutions were figured out as minimum measures necessary to continue the operation taking into account the budgetary limitation. These experiences will surely contribute to the sustainability improvement of existing and future rural electrification projects.

c) Results for Dao-angan Site and Gawa-an Site

It is confirmed in the completion inspection that the installed dummy load governor functioned properly. Short-circuit failure occurred at the dummy load heaters after commencement of the operation, however the damaged heaters were replaced by KASC-ANEC and abnormal conditions were not observed in the subsequent monitoring survey.

Over load operation was observed in Gawa-an MHP as well as Badiangan MHP and therefore the dummy load governor could not keep the frequency stable during the peak hours. It was evaluated that this phenomenon is cause not only by increase of power consumption in the community but also by reduction of the generator output due to increase in the penstock losses. The C/Ps learned a manner to regulate the setting value by the adjustable resistors in the ELC panel box as so to avoid frequent power supply interruption arising from the action of the protective function of under voltage or frequency. KASC-ANEC is considering taking measures to mitigate this problem in the future.

d) Technical Transfer to Engineers Concerned

The C/Ps of REMD, CeMTRE, and ANEC could enhance their learning level of techniques concerning rehabilitation of micro-hydropower facilities by experiencing the following various actual works in the projects. It is expected in the future that the knowledge and skills acquired through hands-on experiences will extensively benefit not only to future rehabilitation projects but also to other works such as monitoring for existing systems and planning/evaluation for new projects.

REMD	・Candidate site survey, survey result analysis, and target sites finalization ・Drawing up a rehabilitation plan, including system design ・Preparation of a project proposal and contract documents ・Construction supervision and completion inspection ・Monitoring and project evaluation

CeMTRE	・Turbine design and preparation of fabrication drawings ・Management of manufacturing schedule and quality ・Unit performance test ・On-site installation work and comprehensive performance test
ANEC	・Candidate site survey ・Specification review and procurement for materials ・Installation and supervision ・O & M and monitoring

4) Efforts and Lessons Learned

a) Importance of the activity in the beginning stage of the development

The causes of faults of civil structures are integrated as follows.

- The designer does not understand the predetermined function required of the civil structures.
- The designer does not understand the basic technology of the design for civil structures.
- Site surveys, such as the head and the river flow rate, are not sufficient.
- Insufficient budget for the development

Many expenses are needed for rehabilitation for the civil structures. In case of inappropriate planning, it is difficult to rehabilitate effectively. In order to operate MHP plant for long time certainly/cheaply, activities of the initial stage such as Investigation, Planning, and Designing of project should be adequately carried out.

b) Utilization of Outputs from the Training

"Turbine manufacturing training" and "ELC fabrication training" was implemented once a year in conjunction with IBEKA of Indonesia in the Project. Contents of the rehabilitation projects were therefore selected so as to utilize the outputs from these equipment-manufacturing trainings. In particular, ELC panel boxes fabricated by the trainees were utilized for the installation of dummy load governor. Trainees from ANEC modified the panel boxes in accordance with the site conditions and installed the boxes and heaters to the sites on their own. Furthermore, A trainee from CeMTRE designed the new Crossflow turbine that was applied to Badiangan MHP. Based on the fabrication drawings he had prepared, a workshop in Manila procured the required materials and assembled the turbine.

The trainees could experience the overall process related to the rehabilitation projects, including system design necessary to apply the equipment to the actual sites and on-site installation and testing. Through planning and implementation of the projects, the C/Ps could acquire more practical knowledge and skills.

c) Need for Correct Information on Site Conditions

Some of failures observed in Badiangan and Agbobolo MHP could be avoided by collecting accurate information in the preliminary survey. It is preferable to collect information of head, discharge, voltage drop of transmission lines, and supply-demand balance by actual measurement as far as possible. Reliable values are necessary for said information because it considerably affects the planning of rehabilitation project and equipment designing.

(3) Micro-hydropower Planning Training/Workshop

1) Purpose and Background

The existing micro-hydropower plants are holding many issues by inappropriate investigation, planning, designing and construction, as mentioned above. Especially, the faults in the initial stage of MHP development will be very difficult to be recovered after construction. Therefore, it is very important to spread the appropriate knowledge and skills for investigation, planning, and design.

From this viewpoint, various trainings and workshops for aiming at the spread of the appropriate technology on micro-hydropower development were carried out.

2) Activities

a) Technical Training for MHP

Basic training for MHP technology on site reconnaissance, project planning, monitoring and hands-on was conducted ten times in this Project. Target participants were mainly staff of REMD, VFO and MFO of the DOE, and ANECs.

At the end of the series of MHP technical training, MHP technology, review training was held in November 2008 for REMD staff, other DOE officials and PNOC to fully absorb the knowledge and skills necessary for micro-hydropower development. In the review training, the C/Ps of REMD for MHP technology performed as main trainers. During the training, proficiency tests were taken at the beginning and the end of the training. As results of the proficiency test, the score of all the participants were improved after the review training. This is proving that the contents of training are appropriate.

Technical Training Record

Year	Period	Venue	No. of Participants	Contents
2004	NoV.8	VFO	22	Hydro development cycle Reconnaissance Study of MHP MHP Development for Rural
2005	Apr.18	CPU (Iloilo)	13	Training on Monitoring
2005	Jul.26	MFO		Training on Monitoring Basic hydropower Technology
2005	Oct.18-20	MFO	7	Basic hydropower Technology Field Training on Monitoring
2005	Nov.8-11	VFO	7	Basic hydropower Technology Field Training on Monitoring
2005	Nov.14-17	DOE	15	MHP Generating System Technology Basic Hydrology Potential Site Survey
2006	Jun.5	VFO		Hands-on Training on Instrument Use for Site Survey and Monitoring
2006	Jun.8	MFO		Training on Site Reconnaissance F/S of MHP Potential Projects
2006	Jun.17	MFO		Hands-on Training on Instrument Use for Site Survey and Monitoring
2008	Nov.10-14	DOE-AVR	15	Refer to the following Table

Curriculum of Training for Micro-Hydropower Development

Course	Contents		
Basic Course	1	Map Study	Outline of Hydropower
			Catchment Area
			Potential Site
			Duration Curve
	2	Planning	Function of Main Structure
			Layout of Main Structure
			Selection of Main Structures Location
Advance Course	1	Site Reconnaissance	Outline of Site Reconnaissance
			Measurement River Flow
			Measurement of Head
	2	Designing for Civil	Intake Weir
			Intake and Settling Basin
			Headrace
			Head tank
			Penstock and Spillway
			Power House
			Calculation of Head Loss
	3	Designing for Mechanical Equipment	Turbine
			Driving system

b) Workshop and Short Lecture for MHP

Seminars and workshops on several subjects related to MHP technology were held totally 12 times to establish common and proper understanding of stakeholders on MHP development. Those seminar/workshops were held not only in Manila but also outside Manila so that necessary information for sustainable development of RE systems would widely spread to engineers of ANECs and LGUs in the country.

In order to frankly and continuously provide knowledge and skills to REMD's C/Ps, short lectures were conducted in the DOE. However, since REMD staff was quite busy, it was difficult to arrange the lectures in advance. So, the number of short lectures is limited to 8 times.

	Purpose	Target Group	Trainer	Means	Venue	Date
①	Technical Transfer to C/P	DOE-PEMD-C/P DOE-Field-Offices ANEC	JICA Expert	Workshop	Manila, Cebu, Davao	July, 2005 – Jan.2006
				Short Lecture	DOE-REMD	Oct.2006 – Aug.2008
②	Technical Transfer to Implementers	MLGU Operators	JICA Expert ＆REMD-C/P	Workshop On site Training	Karinga, Ifugao	Jan.2007 – Jan.2008

c) Manuals and guidelines on MHP

Following manual and guideline were prepared in this Project, and it was utilized for the above-mentioned training.

- Project Evaluation Guideline for Micro Hydropower Development,
- Guideline for Selection of Potential Sites and Rehabilitation Sites of Micro-Hydropower,
- Manual/guideline for Design, Implementation and Management for Micro-hydropower (Revised "Manual for Hydro Power Development"),
- Micro-hydropower Training Manual,
- Site Completion Test Manual for Micro-hydropower Project,
- Operator Training Manual for Micro-hydropower.

3) Result of Activities

a) Positive transformation of the stakeholders' view on the development of micro hydropower

Conventionally, MHP development was regarded as an easy power supply, and it had been planned and developed easily. Many MHP plants cannot be operated as the result. However, MHP is a system, which transforms unstable natural power sources into electric energy stably although the scale is small. The technology required for MHP development is almost the same as bigger hydropower development.

Through the training, the C/Ps have recognized that MHP cannot be developed without careful consideration, and that it is important to properly carry out required procedures in accordance with the development stages.

b) Training of the trainer for the appropriate technology spread in future

The C/Ps played the leading roles in the training. It is expected that the C/Ps will carry out the activities to disseminate appropriate technology to as trainers, utilizing the various manuals/guidelines, which were prepared in the Project.

4) Efforts and Lessons Learned

In the training, the Team prepared training program focusing on the subjects, which are easily misunderstood by stakeholders, based on problems happened at the existing MHP plants. And also, the Team took into consideration how to conduct site survey, planning and designing even special tools and equipment. As a result, even participants who had limited experience were able to acquire necessary technology for MHP development.

(4) Water Turbine Manufacturing Training/Workshop

1) Purpose and Background

Water turbines which had been used for rural electrification in the Philippines were fabricated by local machine shops just copying without design technology. Therefore, most of them were low efficiency and low quality.

In order to improve the situation, the Team planned seminars/workshops on appropriate design and manufacturing technology as enlightenment activities

As for the water turbine manufacturing technology, the Team examined what kind of training is appropriate in the Philippines. Since the scale of Micro-hydropower market is small, it is not necessary to transfer the technology to wide range of manufacturers. So,

the Team conducted a series of water turbine manufacturing training for small number of engineers to firmly acquire necessary knowledge and skills so that they can manufacture reliable water turbine.

For the training, the Team declined to employ Japanese technology because it is too difficult to transfer and it would not be disseminated because of the high cost. Therefore, the Team focused on technology of T-12 turbine, which is widely used in Indonesia. The Team decided to conduct the training in cooperation with Indonesian NGO, IBEKA, which has abundant experiences in designing and manufacturing water turbines in Indonesia.

2) Activities

a) Water Turbine Workshop

To spread the turbine manufacturing technology not only in REMD also to whole Philippines, the first workshop was held in Manila. And another workshop to improve the turbine manufacturing technology in Mindanao was held in Davao on 27 Aug. 2007. By this workshop, the participants from DOE(MFO) and ANECs in Mindanao, which is far from Manila, could share the information and technology.
In addition to the work shop, below action were also conducted.

- Developmental action by using JICA Net
- Reinformcement of CeMTRE's facility
- Developmental action to ANECs by CeMTRE

b) Water Turbine Manufacturing Training

Turbine manufacturing trainings for T-12 Turbine designed by SKAT Switzerland were held in Bandon Indonesia on the physical year of 2007 and 2008, as follows.

- First training 22 Jan. 2007 to 28 Feb. 2007
- Second training 5 Nov. 2007 to 13 Dec. 2007

As a continuation of the 1st and 2nd training on water turbine manufacturing, which was held in Bandung Indonesia in 2007 with the technical support by IBEKA, the 3rd training was held for 38 days from 20 August to 26 September 2008 at the machine shop in Balenzuela city in Manila. The training is a real hands-on training where the trainees fabricated a Skat T-12 designed turbine. The 3rd training was conducted in Manila in cooperation with trainers who were the former trainees of the 1st training in Indonesia.

The design of the turbine fabricated in this training was modified and simplified from the original Skat design, taking the experiences during the 1st training into account. It was determined by IBEKA's engineers that the modification did not affect the function and performance of the turbine.

The training in Manila was conducted effectively and smoothly. The results of the training turned out better than expected.
Throughout the 3rd water turbine manufacturing training, detailed photographs for each step of the turbine manufacturing process were taken and put together for the purpose of making a turbine manufacturing guide that will assist in the manufacturing of T-12 turbines hereafter.

As a result of these three trainings, a total of 12 Philippine engineers have been trained in the technology of T-12 turbine manufacturing. Therefore, we expect that turbine manufacturing technology in the Philippines will improve.
The following table is a breakdown of the trainees:

Training for T-12 turbine participants

Section	Number of Training			Total
	First	Second	Third	
DOE/REMD	1			1
DOE/MFO		1		1
CeMTRE	1	1		2
CPU/ANEC	1			1
KASC/ANEC	1	1		2
BSU/ANEC		1		1
CMU/ANEC			1	1
CLSU/ANEC			1	1
SU/ANEC			1	1
MSU/ANEC			1	1

Training (Side plate processing)

Training on welding

Side plate processing

Assembling

3) Result of Activities

As mentioned above, totally 12 participants were able to lean water turbine manufacturing technology through the three time training. Two persons among them have skilled up to teach others as trainers. Some of them have already fabricated a water turbine utilizing knowledge and skills leaned during the training. Therefore, the turbine manufacturing technology was successfully transferred to the Philippines.

Furthermore, such technology was accumulated in CeMTRE, and then CeMTRE developed water turbine design software and manufacturing manual. CeMTRE became a main technical center for water turbine technology.

4) Efforts and Lessons Learned

During the workshop and the training, we were able to acquire the cooperation from IBEKA of Indonesia. Since the trainers from Indonesia where is similar to the Philippines, the lectures and training was acceptable for the participants so that the activities were effectively conducted.

As for the water turbine manufacturing training, trainees of the first training participated in the third training as trainers. In order for them to perform as trainers, they tried to make the training more efficient. Because of their efforts, they were able to learn the technology much more than before. Teaching someone is a good opportunity to learn deeply. As results, the technology was firmly settled in the Philippines.

⑸ Electronic Load Controller (ELC) Fabrication Training

1) Purpose and Background

Dummy load governor controlled by Electronic Load Controller (ELC) has a function to improve the quality of the generated electricity by keeping the frequency constant, and therefore is frequently applied to micro-hydropower projects due to the relatively modest

cost. Some cases of installation using foreign products and devices of own making can be found in the Philippines. However, established technology on designing, fabricating, and maintaining ELC had not been shared widely among engineers involved in MHP projects for rural electrification projects.

Based on this background, the ELC fabrication training was initiated in the third year to enhance the technical capabilities of the domestic engineers in cooperation with IBEKA that is a NGO of Indonesia and has abundant experiences on designing and manufacturing of ELC.

2) Activities

Records of ELC fabrication training in the Project are shown in the following table.

	Contents	Period	Location	Nos. of Trainee
1st	Fabrication of printed circuit board (PCB)	Dec. 11 - 15, 2006	De La Salle University	12
2nd	Fabrication of ELC panel box applicable for 10kW single-phase synchronous generators	Aug. 22 - Sep. 5, 2007	De La Salle University	12
3rd	Fabrication of ELC panel box applicable for 30kW single-phase synchronous generators	Jul. 28 - Aug. 8, 2008	De La Salle University	6
	On-site installation of ELC panel box	Aug. 6 – Aug. 8, 2008	Badiangan MHP Agbobolo MHP	6

a) Participants

The trainings were attended by representatives from ANECs, NGOs and suppliers/fabricators of hydropower equipment as well as DOE and CeMTRE. As for the second and third training, the trainees were selected among the participants in the past training so that they could make their acquired skills and knowledge more established. Six trainees in the third training consequently joined all the trainings. Affiliation of the trainees is shown in the table in the next page.

b) Contents of the Training

In the 1st training in 2006, a control board that constitutes a core component of the ELC was fabricated and tested by the trainees in order to learn the circuit construction and the operating principle. In the 2nd training in 2007, the training includes printed circuit board (PCB) manufacturing, assembling and wiring of ELC panel box, and performance test using a testing turbine-generator. Trainees were encouraged to acquire more practical skills in designing and fabricating ELC. In the 3rd training in 2008, the ELC panel boxes were designed and fabricated in the same procedure as the 2nd training aiming the repetitive effect. More versatile ELC applicable to 30kW single-phase synchronous generators was selected as

the subject of the training. In addition, field trainings in the existing micro-hydropower plants were incorporated into the curriculum as an opportunity to acquire techniques on installation, adjustment, and O&M of ELC on site.

Affiliation		1st	2nd	3rd
DOE	DOE-REMD	1	1	1
	DOE-MFO	1	1	
	DOE-VFO		1	
ANEC	CPU	1	1	1
	KASC	1	1	1
	BSU		1	
	USEP	1	1	
NGO	SIBAT	1	1	1
	YAMOG	1	1	1
	REDCREST	1	1	1
Supplier/ Manufacturer	San Roque Power Co.	1		
	PAMATEC	1		
	PETCO	1	1	
	CeMTRE	1	1	

3) Result of Activities

a) ELC Panel Box

Six single-phase ELC panel boxes with the capacity of 10kW and three single-phase ELC panel boxes with the capacity of 30kW were fabricated as the outputs of the second and third training. Some ELC panel boxes were utilized as a control part for dummy load governing system in the rehabilitation and the pilot projects. A few trainees took the ELC panel boxes to apply to their projects or utilize as a sample in fabricating new one. Application of fabricated nine ELC panel boxes is shown in the following table.

Type	User	Purpose of use
10kW Single-phase	CPU-ANEC	Application to rehabilitation project
	CPU-ANEC	Application to rehabilitation project
	SIBAT	Application to their project
	KASC-ANEC	Application to their project under consideration
	KASC-ANEC	Sample for new ELC panel box
	CeMTRE	Sample for new ELC panel box
30kW Single-phase	CPU-ANEC	Application to pilot project
	KASC-ANEC	Application to rehabilitation project
	KASC-ANEC	Application to rehabilitation project

b) Technical Transfer to Engineers Concerned

The trainees could experience the actual fabrication and installation of ELC panel box and acquire the following knowledge and skills through the three times training. These experiences were expected to benefit fabrication of new ELC and O&M of existing ELC in the future.

- Circuit constitution and operating principle of ELC
- Designing of PCB
- Fabricating of control board
- Performance test using oscilloscope
- Assembling of ELC panel box including installation of equipment and wiring
- On-site installation and adjustment of ELC panel box
- Built-in protective functions of ELC panel box
- Identification procedures and repair method of faulty parts

Lecture on ELC Design

Fabrication of ELC Plate

Completed ELC Box

Installation Training

4) Efforts and Lessons Learned

a) Selection of Contents Considering the Actual Conditions

Some subjects, such as Induction Generator Controller (IGC), Automatic Voltage Controller (AVR), and three-phase ELC, were listed as options by the trainer and trainees. Reviewing the MHP projects for rural electrification in the Philippines, single-phase synchronous generators with capacity of more than 10kW and independent systems have been adopted in plenty of projects. Meanwhile, ELC panel boxes fabricated in the second training can be applied only to generators with the capacity of less than 10kW.

Considering the above present status, "Fabrication of ELC panel boxes applicable to single-phase synchronous generators with a capacity of 30kW" was selected as the training subject in the third training. In this way, the subject that was expected to be the most effective for application to micro-hydropower projects in the Philippines was selected.

b) Local Procurement of Tools and Materials

Components and tools for the trainings were intended to prepare in the Philippines so that the trainees could fabricate ELCs on their own even after the training. As a result, most of the components, including panel boxes, meters and switchgears, could be purchased at the shops in Quiapo City. Polyethylene capacitors, heat sinks, and thyristors were unable to be found in the city, but it was confirmed that these components could be purchased on the online shopping site. A components list in which the shops and price were summarized was distributed to the trainees so as to help them fabricate new ELC panel boxes

c) Implementation of On-site Installation Training

Although trainings focusing on only manufacturing of ELC panel box were initially planned, an installation training was incorporated into the training contents in the third training in 2008 considering suggestions from the trainer from IBEKA and some trainees. The installation training was conducted in Badigangan and Agbobolo MHP in which the fabricated ELC panel boxes had been installed in the rehabilitation projects of 2008. The trainees could deepen their understanding of on-site adjustment method for control gains and setting values and troubleshooting by experiencing both equipment manufacturing and on-site installation.

(6) OJT by Monitoring at Micro-hydropower Plants

1) Purpose and Background

Monitoring surveys were conducted in order to early identify the abnormal conditions by periodical and continuous observation and adopt appropriate measures. This activities were vital for sustainable operation of generating facilities. Repetitive OJT on monitoring survey was implemented in the Project taking advantage of opportunities of site selection surveys, completion inspections, and follow-up surveys related to the pilot and rehabilitation projects, which aimed to enhance C/P's ability to find and solve problems.

2) Activities

Records of OJT on micro-hydropower site monitoring are summarized in the following table.

	Period	Site	Location	Purpose
1	Jan. 15-19, 2007	Calapadan MHP	Barbaza, Antique	Site selection survey for rehabilitation project in the 3rd year
		Lanas MHP		
		Pitac MHP	Tibiao, Antique	
2	Jun. 25-30, 2007	Pitac MHP	Tibiao, Antique	Site selection survey for rehabilitation projects in the 4th year
		Badiangan MHP	Pandan, Antique	
		Badiangan MHP	Ajuy, Iloilo	
		Agbobolo MHP		
3	Feb. 17-22, 2008	Badiangan MHP	Ajuy, Iloilo	Completion inspection for rehabilitation projects in the 4th year
		Agbobolo MHP		
4	May 27-30, 2008	Badiangan MHP	Ajuy, Iloilo	Monitoring survey for rehabilitation projects in the 4th year
		Agbobolo MHP		
5	Aug. 6-8, 2008	Badiangan MHP	Ajuy, Iloilo	Monitoring survey for rehabilitation projects in the 4th year
		Agbobolo MHP		
6	Jun. 3-7, 2008	Dao-angan MHP	Balbalan, Kalinga	Site selection survey for rehabilitation projects in the 5th year
		Gawa-an MHP		
		Balbalasang MHP		
7	Jan. 21-24, 2009	Dao-angan MHP	Balbalan, Kalinga	Completion inspection for rehabilitation projects in the 5th year
		Gawa-an MHP		
8	May 13-16, 2009	Dao-angan MHP	Balbalan, Kalinga	Monitoring survey for rehabilitation projects in the 5th year
		Gawa-an MHP		
9	Jan. 26-30, 2009	Igpatuyao MHP	Sebaste, Antique	Completion inspection for pilot project
10	May 19-21, 2009	Igpatuyao MHP	Sebaste, Antique	Monitoring survey for pilot project

a) Site Selection Survey

In the site selection surveys for the rehabilitation projects, visual inspection and performance tests using instruments were conducted in order to collect information on the site conditions, such as head and flow rate, necessary for drawing up a rehabilitation plan as well as to accurately grasp the current situations of the existing facilities. Problems for each site were listed based on analysis results of the collected data, and conclusively the appropriate measure were finalized through the comparative study of the alternatives.

b) Completion Inspection

After the installation work, visual inspection to check the installation conditions and comprehensive performance tests were carried out in order to verify that the installed equipment functioned properly in the overall system. Minor failures were fixed or adjusted on site immediately after they were found in the inspection. As for major failures that require arrangement of tools and materials, appropriate measures were discussed among people concerned and ANEC was asked to take the measures as soon as possible. The results of the measures were confirmed in the subsequent monitoring surveys.

c) Monitoring Survey

After the completion inspection, visual inspection and performance tests were carried out in order to verify that the installed equipment continued the normal operation and that proper measures were taken if some failures had occurred. At the same time, it was confirmed that the additional measures ANEC had been asked for were implemented adequately. If improper O&M was observed in the survey, the operators were instructed in the points to be considered in their works.

Measurement of Output

Recording in Monitoring Sheets

Commissioning Test

Commissioning Test

3) Result of Activities

a) Technical Transfer to Engineers Concerned

The C/Ps of REMD and ANEC could enhance their learning level of techniques concerning analysis of the present conditions and selection of the rehabilitation items for micro-hydropower facilities by experiencing the following various actual works in the monitoring surveys. It is expected in the future that the knowledge and skills acquired through hands-on experiences will be put in practical use for the problem prevention.

REMD Engineers	・Measurement of site conditions and operational data using instruments ・Study on scope of rehabilitation works, considering collected data and cost-effectiveness ・Prioritization of candidate sites, considering the various conditions ・Selection of performance test items according to rehabilitation items ・Analysis of collected data in performance tests ・Evaluation for results of rehabilitation ・Instruction on points to be considered in O&M works
ANEC Engineers	・Measurement of site conditions and operational data using instruments ・Instruction on points to be considered in O&M works

4) Efforts and lessons learned

a) Preparation of Survey Plan

Survey plan was established for each monitoring activity and discussed among the experts and counterturns in advance, in which purpose of survey, itinerary, test items, and used instruments were summarized. This preparatory work

enabled the C/Ps to fully understand necessity and procedures of each test items. Since the required tools and materials were also clarified in the plan, situations that all the scheduled tests were not conducted could be avoided as much as possible.

b) Consideration of Safety

Survey work inside the powerhouse may put the workers at risk of physical damage due to electrical shock and contact with rotating parts. The C/Ps were recommended to put on a helmet inside the powerhouse and to keep eye on the motion each other to prevent from contacting with rotating parts. Furthermore, exposed live parts were covered with insulation tapes to avoid electrical shock hazard in operation. As the result, fatal accidents were not caused in the ten times monitoring surveys.

6.3 Activities related to PV technology

(1) Training for PV engineers

1) Purpose and Background

Not only DOE engineers who are project manager, but also AREC and LGU engineers who support the project at the site and the private company engineers who supply and install PV system, are involved in the rural electrification project using PV technology, and it is required that all engineers involved have proper knowledge and skills. Therefore the Team provides the PV training for engineers who are involved in PV project to improve their capability, and also develops the PV training program available to conduct continuously.

2) Activities

As for the training for PV engineers, three (3) different types of training had been conducted as shown in below.

a) Preliminary training

The two-day preliminary training of solar PV technology was conducted at DOE from Jan. 25 to Jan. 26, in 2006, and the number of training participant was forty-one. This training provided basic knowledge on PV technology with lecture and practicum, and the confirmation test of understanding was conducted on the last day.

b) Solar PV trainers' training

The solar PV trainers' training had been conducted 6 times from 2005 to 2007, and a total of one hundred seven (107) engineers participated. The target participants were mainly DOE engineers, but also engineers who belonged to AREC, LGU and private company were involved.

No.	Year	Period	Venue	Participant
1	2005	Sep. 26 – Oct. 6	Cebu, Palawan	18
2	2006	Feb. 12 – Feb. 21	Cebu	21
3	2006	Dec. 4 – Dec. 9	Cebu	16
4	2007	Feb. 4 – Feb. 9	Cebu	16
5	2007	Jun. 18 – Jun. 22	Baguio	18
6	2007	Oct. 15 – Oct. 20	Davao	18

Lecture

Monitoring

The training consisted of lecture, practicum and qualification examination. The first and second training took long time to conduct the practical training at the PV site, and whole training took around ten (10) days. From the third training, the Team unified the training program and set the training period for six (6) days. Also, the preparation of training was conducted in cooperation with C/Ps and the qualified PV trainers participated in the training as trainers since the second training. The qualification examination was conducted in the last day, and then the qualified person was determined by judging the exam scores and the scores which were given based on personal attitude through the training against the predetermined criteria.

c) Solar PV engineers' training

The solar PV engineers' training had been conducted three (3) times in 2008. The target participants were local engineers such as AREC and LGU engineers. These trainings were conducted in three (3) region, Luzon, Visayas and Mindanao, to encourage all AREC to participate, and a total of forty six (46) engineers were participated.

The training consisted of lecture, practicum and confirmation examination. The training contents were reviewed and unified for local engineers, and the Team set the training period for six (6) days.

The training plan and management were implemented by mainly C/Ps. The Team also attempted to provide the inexperienced trainers with opportunities to serve as a trainer and to assign them lecture and hands-on in combination with experienced trainers.

In addition, the Team held "confirmation examinations" on the first and the fourth day in order to confirm their understanding, and the trainer provided individual

guidance by pinpointing their weak points. These new attempts contributed to the effective and efficient training.

No.	Year	Period	Venue	Participant
1	2008	Jun. 8 – Jun. 13	Tagaytay, Luzon	13
2	2008	Oct. 20 – Oct. 25	Talibon, Bohol	20
3	2008	Nov. 17 – Nov. 22	Davao, Mindanao	13

Performance check of charge

Performance check of PV module

3) Result of Activities

a) Improvement of PV engineer's ability

A total of one hundred seven (107) persons were participated in the solar PV trainers' training. Twenty five (25) of them were certified as PV trainers and five (5) of them were certified as PV engineers. As for the PV trainers, eighteen (18) were from DOE, five (5) from AREC and two (2) from LGU. On the other hand, a total of forty six (46) engineers, mainly from AREC and LGU, participated in the solar PV engineers' training. Adding 41 persons who participated in preliminary training to them, this project had provided a total of one hundred ninety four (194) persons with opportunities to participate in the PV training and contributed to improve PV engineer's capability.

Unlike other training spending much in the lecture on the theory of PV cell, these trainings consisted of lecture and practicum focused on contents directly linked to daily work of PV engineers and were getting a favorable reputation by participants. Also the participants were provided plenty of opportunities to participate more actively, such as small group activities and exercises. Moreover, the overall

participant's capability was improved by the individual guidance given by trainers in accordance with their understanding. This achievement could be confirmed by the results of two times confirmation examination in the PV training.

Solar PV Trainers' Training

Organization		DOE						ANEC	LGU	Private Co.	Total
		REMD	VFO	MFO	SPOT	Other	Total				
1st	Participant	7	2	3	3	1	16		2		18
	Qualified person	2	1	1	1		5		1		6
2nd	Participant	5			2		7		6	8	21
	Qualified person	2					2			3	5
3rd	Participant	3	1	1	2		7		3	6	16
	Qualified person				1		1		1		2
4th	Participant	(3)					(3)	7		9	16
	Qualified person	3					3	2		1	6
5th	Participant					2	2	11		5	18
	Qualified person					1	1	1			2
6th	Participant	3		4			7	7	1	3	18
	Qualified person	3		3			6	2		1	9
Total	Participant	18	3	8	7	3	39	25	12	31	107
	Qualified person	10	1	4	2	1	18	5	2	5	30

( ) only examination

Solar PV Engineers' Training

Organization		DOE						ANEC	LGU	Private Co.	Total
		REMD	VFO	MFO	SPOT	Other	Total				
1st	Luzon Region							10	3		13
2nd	Visayas Region		2				2	8	10		20
3rd	Mindanao Region							9	4		13
Total		0	2	0	0	0	2	27	17	0	46

b) Development of PV trainer

Although the certification of engineer should be normally implemented complying with the existing certification system, it was in the difficult situation to set in the existing certification system in the beginning of this project due to small PV market. On the other hand, for the continuous development of PV engineers, there was a need to develop PV trainers in the country. Therefore the Team set its own criteria in this project and started the certification of PV trainer. Six (6) persons were certified as PV trainers in the first training, and the number of

qualified PV trainers had finally reached to twenty five (25). The qualified PV trainers participated in the subsequent training as trainers, and they tried to improve their own capability and also contributed to improve trainee's capability. Also the PV engineers, mainly REMD staffs, were trying to be certified as PV trainer with voluntary efforts. In addition, opportunities that the qualified PV trainers are invited to lectures and other trainings on PV technology as a trainer has increased.

c) Self-confidence as expert

By participating in the PV training and acquiring proper knowledge of PV technology, C/Ps are able to work on his daily duties, such as pre-survey, project planning, procurement of equipment, completion inspection, monitoring and technical instructions to persons involved, with confidence. Also C/Ps are able to respond properly to the inquiry about PV technology from different bodies, and the scene where C/P explains about PV technology to visitor using training materials become common.

d) Implementation of voluntary PV training

Qualified trainers of Mindanao Field Office (MFO) and Bicol University (BU) have conducted PV trainings by themselves using the training materials developed in this project. Also in other AREC, PV training for the untrained staffs is being conducted by the trained staff using the training materials used in PV training.

e) Development of PV training module

On the basis of the solar PV engineers' trainings that had been implemented in this project, the solar PV training module was developed and distributed to the field offices of DOE and all ARECs. Although this training module can be used to the above mentioned voluntary PV training, it is recommended to be used to the systematically training for local engineers and users. In the AREC workshop, the Team explained about how to use training module and how to conduct PV training to AREC staff in cooperation with C/Ps.

4) Efforts and Lessons Learned

a) Training planning adjusted to level of participant's capability

At the beginning of solar PV trainers' training, most of participants were the engineers who were directly involved in PV project, such as DOE engineers and private company engineers. By expanding range of the training target, to adjust level of training to whole participants became difficult due to mixing the less experienced engineers and expanding difference in the level of participants.

Therefore, in the solar PV engineers' training, the questionnaire was distributed to check the background of participant before the training, and then participants were selected on the conditions that the person who had experience on PV project or electrical engineer. As the result, the contents of training could be set at the same level and effective training was provided.

⑵ OJT by PV site monitoring

1) Purpose and Background

In the previous BEP, the monitoring had not been conducted and there were many neglected PV systems with problems. The monitoring leads to early detection and improvement of the problems, and it also leads to preventive maintenance by reflecting the monitoring result to other project and users. Through the existing site monitoring, the Team strengthens capabilities of C/Ps and related persons regarding "Problem solution" and "Problem prevention".

2) Activities

The OJT by PV site monitoring totaled twenty eight (28) times from August 2004 to June 2009 after starting project and a total of one ninety nine (99) persons participated in these trainings.

a) 2004/6～2006/6

The Team conducted PV site monitoring actively in order to improve basic knowledge and skills of REMD staff and to identify the problems occurring at the existing PV site. During this period, all REMD staff were provided opportunities to participate in the monitoring and the monitoring was conducted in small groups. Also the Team selected not only BCS and SHS but also centralized PV system as the monitoring site, and trained them on the monitoring method depending on type of PV system.

Check of PV array output

Measurement of specific gravity of battery

The OJT was provided according to a series of workflows starting from the use of measuring instrument, and then inspection of PV system, arrangement of collecting data, analysis of problems and study of the measure against problems in that order. Also the Team created the common monitoring sheets for the PV site monitoring.

b) 2006/8～2008/9

Several PV site monitoring were conducted in order to identify the present situation of PV site and to provide the OJT on monitoring and user training method for local engineers The Team visited to PV sites with the trained C/Ps and conducted the technical trainings to BAPA technicians and users.

In addition, the repetitive OJT on the monitoring method were provided to the engineers of VFO, VSU-AREC and USC-AREC through the rehabilitation projects. The Team created the monitoring sheets for periodic monitoring that would be conducted by local engineers and used it in these monitoring.

Monitoring of BCS

User training

3) Result of Activity

a) Capability improvement of REMD staff

In the first two years, thirteen (13) REMD staff participated in the PV site monitoring and were provided the OJT. Nine (9) of them were registered as qualified PV trainers, and nontechnical staff were also provided opportunities to experience the PV technology. The overall capability of REMD staff was improved by these activities.

In addition, the C/Ps were able to enhance their knowledge and skills on the monitoring of PV system by experiencing the following actual activities repetitively

and also by training local engineers through the subsequent monitoring:

- Interview to related persons
- Monitoring of PV systems (Visual and measurement inspection)
- Analysis and evaluation of system condition, identification of problems
- Examination and implementation of measures against problem

b) Establishment of monitoring method

The Team unified the monitoring sheets in cooperation with C/Ps. By repeating OJT using these monitoring sheets, the monitoring method was established. Also C/Ps could lead to better understanding of the usage of measuring instruments and the parts with possible problems by acquiring experiences. Also it contributed to decrease monitoring time. In addition, C/Ps could compile the report including not only arranged measurement data but also issues and the measures against them as the monitoring result.

c) Reflection to actual work of C/P

C/Ps began to conduct monitoring for the neglected PV system with problems, and to consider necessary measures. C/Ps proposed the rehabilitation plan such as the replacement of battery and the change of position of PV modules as the monitoring result for the PV system in Pangan-an Island, and implemented a part of the rehabilitation plan. In addition, C/Ps have several requests for the monitoring to the existing PV system from other government agencies and LGUs, and C/Ps became to perform it with confidence.

d) Improvement of capability on technical guidance of C/P

Through the OJT by PV site monitoring, C/Ps could deepen their understanding for not only the monitoring method but also the possible problems and the measures,. By these experiences, C/Ps could conduct proper technical instruction regarding to not only periodic monitoring method but also troubleshooting and countermeasures to possible problems to AREC engineers and BAPA technicians.

4) Efforts and Lessons Learned

a) Standardization of monitoring sheet

In the unifying the monitoring sheets, the Team developed them with choices of code number for monitoring results. It contributes to make them available to send the results by text message using mobile phone. Also it contributes immediate report after monitoring and update of database.

b) Necessity of monitoring instruments

AREC engineers and local technicians frequently requested to provide monitoring instruments during conducting monitoring OJT. Although it is necessary to use reliable measuring instruments for proper monitoring, local engineers and technicians excluding DOE staff does not have those instruments. In addition they don't have enough budgets to purchase them at present. Therefore it is recommendable to provide them and also to consider including necessary measuring instruments for BAPA technicians in case of implementing new project.

(3) Solar PV rehabilitation project

1) Purpose and Background

In the PV site monitoring that had been ever conducted, the Team confirmed that a decrease in user and a disuse of PV system were caused by the life of battery, failure of facility and disappearance of BAPA. DOE was aiming to improve the electrification rate at the level of Sitio and Household after the Barangay electrification rate would reach to 100%, therefore REMD staff planned to implement rehabilitation for the problematic PV systems as part of the activity and started to request the budget for rehabilitation project from 2007. In accordance with this action, the Team decided to implement PV rehabilitation projects to provide C/Ps and other related persons the OJT on a series of works such as pre survey, planning, procurement, installation, inspection and monitoring.

2) Activities

PV rehabilitation projects were implemented in two sites, Barangay Balugo in Leyte and Barangay Alumar in Bohol. Both project sites were selected by complying with the criteria for selection of rehabilitation site developed in cooperation with C/Ps.

a) Barangay Balugo

Barangay Balugo is located on the upland area in the northwest of Leyte. The center of Barangay is 6.5 km away from the nearby distribution lines, and this Barangay is one of two Balangays that are not yet extended distribution lines in Capoocan district. The BCS was installed under BEP in 2002 and this Barangay was registered as an electrified village.

The rehabilitation project was started from November 2007 with preliminary survey and completed on February 24, 2008, 4 months after starting. Then the Team conducted three times monitoring by May 2009 as follow-up. The project flow is shown in the following table.

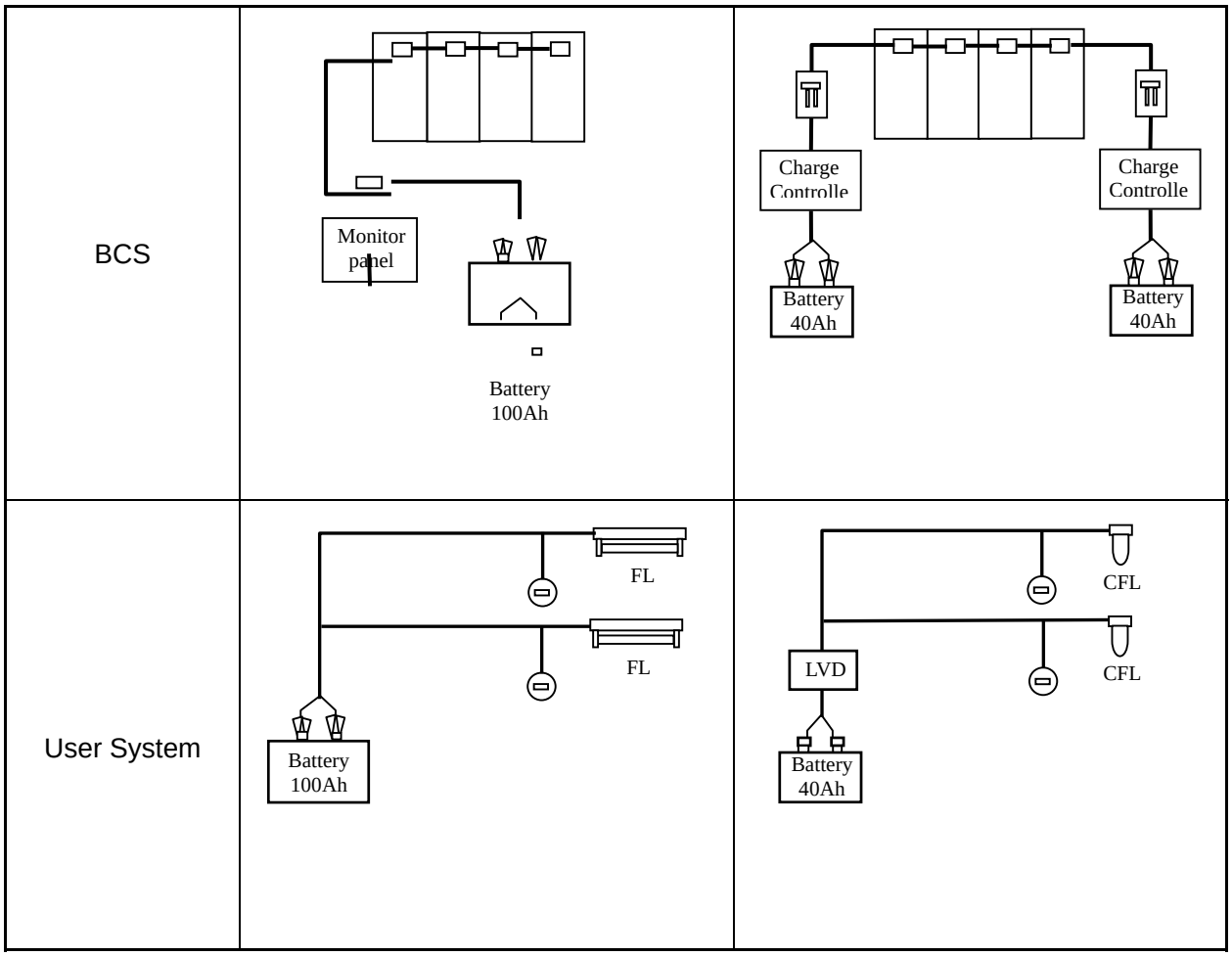
< Flow of implementation>

	Year	Term	Content of activity
Project	2007	Nov. 5 – Nov. 9	Survey for project site selection
		Nov. 12 – Dec. 17	Project planning and proposal
	2008	Dec. 20 – Jan. 18	Signing of MOA
		Jan. 21	Contract of installation work
		Jan. 22 – Jan. 24	Check of specification and BAPA technician training
		Jan. 25 – Feb. 18	Order and procurement of materials
		Feb. 12 – Feb. 23	Installation work
		Feb. 20 – Feb.21	Pre completion inspection
		Feb. 24	Completion inspection
Monitoring	2008	May 27 – May 30	First monitoring
	2009	Jan. 28 – Jan. 30	Second monitoring
		May 12 – May 14	Third monitoring

The problems of the former PV system in Balugo were the premature failure of battery caused by overcharging and over discharging and the transportation of big capacity (100Ah) of battery. The Team discussed measures against these problems with C/Ps and created the rehabilitation plan on the basis of adding equipment to protect overcharge and over discharge of battery and adopting small size battery of 40Ah. In accordance with this plan, the Team commissioned the procurement and installation of PV system to VSU-AREC and conducted the overall project management and completion inspection in cooperation with C/Ps. Also the BAPA technician and user manual for BCS were developed during this project and used effectively in the training. The trainings for BAPA technicians and users were conducted two times before and after installation work, and the OJT to BAPA technicians was also provided through the installation work.

<Comparison of former and rehabilitated PV system>

Item		Former system	Rehabilitation system
BCS	Capacity	900Wp (300 Wp/ch * 3 ch)	900Wp (150 Wp/ch * 6 ch)
	Location	Only one site	3 sites
	MP, C/C	Monitor panel	Charge controller
User System	Battery	12VDC – 100Ah	12VDC-40Ah for solar
	LVD	No	1
	Load	2 - 10W FL with SW	2 – 11W CFL with SW
No. of user		30 (10 users / ch)	30 (5 users / ch)



User training

Rehabilitated BCS and BAPA technician training

In addition, the Team visited to the project site for monitoring three times after completing the project in cooperation with C/P, VSU-AREC and LGU-Capoocan staff. The finding of problem, the response to the problem and the retraining of BAPA technician were conducted during the site monitoring. Also the Team

analyzed these monitoring results with C/Ps, and complied as a project evaluation report and a recommendation to the future rehabilitation project.

b) Barangay Alumar

Barangay Alumar is a small island located on the north in Bohol and belongs to Getafe municipality. The BCS was installed in 2001 under BEP and this Balangay was registered as an electrified village.

The rehabilitation project started from June 2008 with preliminary survey, and it completed on October 29, 2008, 5 months after starting. The Team conducted the site monitoring two times by June 2009 as follow-up. The overall project flow is shown in the following table.

<Flow of project implementation>

	Year	Term	Contents of activity
Project	2008	Jun. 6 – Jun. 7	Survey for project site selection
		Jun. 23 – Jun. 27	Pre survey for project
		Jun. 30 – Aug. 22	Planning and proposal of project
		Aug. 26	Contract of installation work
		Aug. 27 – Oct. 8	Signing of MOA
		Aug. 27 – Aug. 30	Check specification and BAPA technician training
		Aug. 27 – Oct. 14	Order and procurement of materials
		Oct. 16 – Oct. 28	Installation work
		Oct. 18 – Oct. 19	Pre completion inspection
		Oct. 27 – Oct. 29	Completion inspection
Monitoring	2009	Jan. 26 – Jan. 28	First monitoring
		Jun. 18 – Jun. 20	Second monitoring

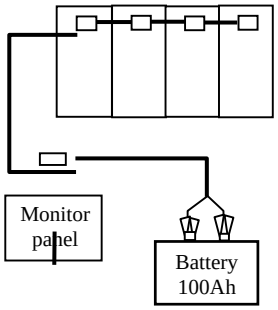
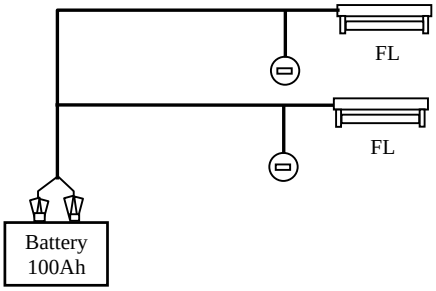
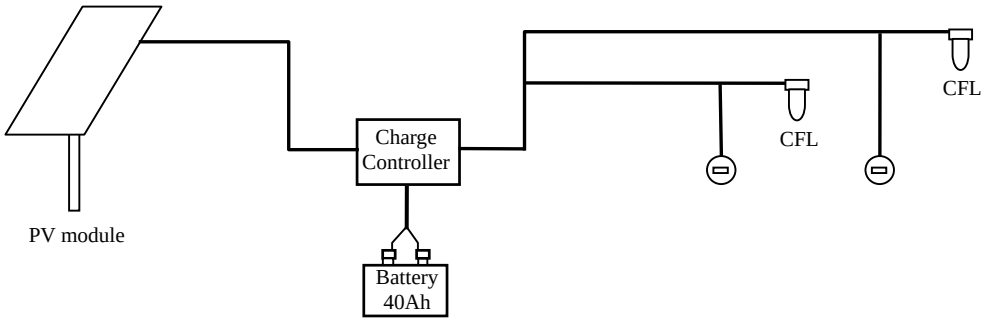
The problems of the former PV system in Alumar were the premature failure of battery caused by overcharging and over discharging and the failure of components such as five (5) PV modules and all monitor panels. The Team discussed measures against these problems with C/Ps and created the rehabilitation plan on the basis of conversion of BCS into SHS because of easy management of charge and discharge of battery and easy BAPA operation.

In accordance with this plan, the Team commissioned the procurement and installation of PV system to USC-AREC and conducted the overall project management and completion inspection in cooperation with C/Ps. Also the BAPA technician and user manual for SHS were developed during this project and used in the effective training. The training for BAPA technicians and users were

conducted two times before and after installation work, and the OJT to BAPA technicians was also provided through the installation work.

In addition, the Team visited to the project site for monitoring two times after completing the project in cooperation with C/P, VSU-AREC and LGU-Capoocan staff. The finding of problem, the response to the problem and the retraining of BAPA technician were conducted during the site monitoring. Also the Team analyzed these monitoring results with C/Ps and complied as a project evaluation report and a recommendation to the future rehabilitation project.

<Comparison of former and rehabilitated PV system>

Item	Former system	Rehabilitation system
Type	Battery charging Station (BCS)	Solar Home System (SHS)
PV system	[BCS] * Capacity: 900Wp (1500Wp/ch * 5 ch) * Monitor Panel [User system] * Battery: 12VDC - 100Ah * LVD: No * Load: 2- 10W FL	[PV module] * 55 Wp: 35 pcs * 75Wp: 15 pcs [Each user] * Battery: 12VDC – 40Ah * Charge controller: 12VDC – 10A * Load: 2 – 11W CFL
No. of User	50 (10 users / ch)	50
BCS		
SHS		

Training for BAPA technicians

Installation work with BAPA

3) Result of Activities

a) Technology transfer to related person

The C/Ps and AREC staff had experiences with the following actual activities through the rehabilitation projects and were able to enhance their knowledge and skills on the rehabilitation of PV system:

Although the technical training had been provided to AREC engineers, LGU engineers and BAPA technicians by C/Ps at the beginning of the project, AREC engineers were able to provide training and instruction of system usage to BAPA technicians and users.

C/P	* Candidate site survey for rehabilitation, analysis of survey result and selection of rehabilitation site * Creation of rehabilitation plan (System design, Schedule, operational system, user training) * Making up project proposal and contract of installation work * Management and completion inspection * Training for BAPA technicians and users * Monitoring of PV system and project evaluation
AREC engineer	* Candidate site survey for rehabilitation * Making up project proposal and contract of installation work * Installation work and management * Training for BAPA technicians and users * Monitoring of PV system
LGU engineer	* Candidate site survey for rehabilitation * Training for BAPA technicians and users * Monitoring of PV system

b) Development of user manual

Under the BEP, LGU, AREC or installer must provide the training for BAPA technicians and users. However there is no common training manual and most training are conducted by using operation manual of PV system prepared by supplier. In view point of this situation the Team discussed with C/Ps and decided to develop manuals for BAPA technicians and users taking consideration into using in the future BEP. The manual for BCS and SHS were developed in both rehabilitation projects and used in the training effectively with translation into local dialect. These manuals were used in the PV engineers' training, and also distributed to all ARECs as a part of the training module.

c) Identification of issues and effects of rehabilitation project

The Team analyzed the results of the site monitoring which had been conducted as the follow-up activities in cooperation with C/Ps, and conducted the project evaluation from technical side. The results are shown in the following table.

Balugo	Improved point	* The user's burden on battery transportation could be reduced by replacing battery 100Ah to 40 Ah and by dispersing BCS into 3 sites. * Overcharge and over discharge of battery was protected by installation of a charge controller and a LVD, and number of battery trouble was reduced.
	Point to be improved	* The charge controller could not manage charging status of battery properly because the voltage drop was increased by rust of battery clips. * It took long time to charge battery fully because the setting voltage of overcharge protection is 13.7V and PWM control starts from low voltage.
Alumar	Improved point	* Both BAPA technician's and user's burden on the transportation and charging management of battery could be reduced by conversion of BCS into SHS. * The risk on battery trouble could be reduced.
	Point to be improved	* Need to verify the system compatibility and to confirm quality control of manufacture because of high rate of CFL failure * Although the Team conducted user trainings again and again, users tended to connect their load with battery directly

Although both systems have great technical improvements by the rehabilitation, some issues are still remaining. The Team discussed the rehabilitation project including these issues with C/Ps and summarized the recommendation to the future rehabilitation project.

BCS	* The voltage drop between battery and charge controller should be minimized. * The monthly monitoring of BCS and user system should be conducted by BAPA technician and the monitoring item should be unified. * This rehabilitation system should adopt as standard system. * When user spread in a wide area, it is recommended to change BCS to SHS.
SHS	* In case that there are available PV modules, the system conversion of BCS into SHS must be considered. * System compatibility must be verified before the project * Confirmation of quality control of products and selection of reliable brand * System design which considers users' usability of previous appliances * Introduction of Battery box with key or strict observation by BAPA technicians in order to prevent direct connection of load with battery

4) Efforts and Lessons Learned

a) Proposal of the rehabilitation plan reflecting on the site situation

The rehabilitation plans of both project sites were created with consideration of not only rehabilitation of the existing PV system but also reduction of the user's burden on system operation. The rehabilitation system in Balugo reduced the user's burden on battery transportation by dividing of BCS and downsizing of battery. On the other hand, the rehabilitation system in Alumar reduced the burden on the management of battery charging by the conversion of BCS into SHS. These rehabilitation plans are applicable in the future rehabilitation project and the electrification project of the Sitio level.

(4) Additional trainings for qualified trainers

1) Purpose and Background

In the solar PV trainers' training, eighteen (18) PV trainers from DOE were certified, and ten (10) of them were REMD staff. The Team provides them the additional trainings and activities to improve capability of qualified trainer and to induce aggressive participation in the dissemination activity of PV technology.

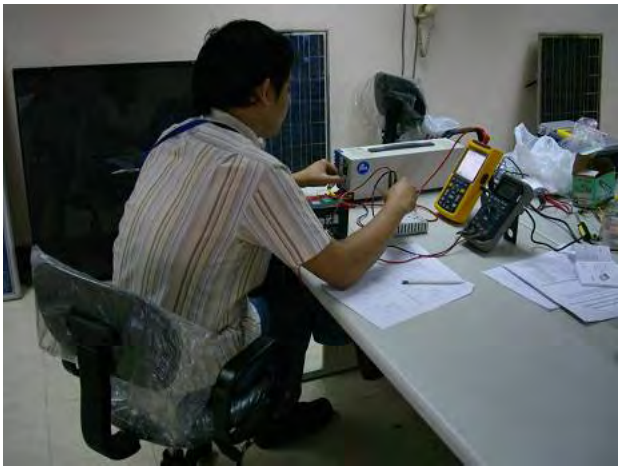
2) Activities

a) Training on performance test of PV equipments

The REMD staff are in charge of the system design, the procurement and the inspection in the government PV project as implementer and manager. Also they are dispatched to the technical working group on the product certification and the certification of PV technicians studying by other organizations. At the moment, although the product certification system for PV equipments has not to be established yet in the Philippines, the REMD staff are in a position to manage the PV equipments used in the government project and are required to gain knowledge on the performance test of PV equipments. Therefore, in order to increase the number of engineers who can check the performance of PV equipments such as PV modules, charge controllers and inverters properly, the Team provided them the training on the PV performance test method with lectures and practicum.

PV equipment	Training Contents
PV module	* How to product PV cell and PV module and role of main component * Introduction of international standard IEC 61215 * Hands-on training on performance test of PV module
Charge Controller	* How to use DC power supply * Introduction of charge controller test method developed by the World Bank * Hands-on training on performance test of charge controller
Inverter	* Introduction of PV inverter test method developed by the World Bank * Hands-on training on performance test of inverter

The training was conducted at the laboratory on the second floor of REMD office from August 2008 to February 2009 arranging the training schedule with trainees. The training was provided mainly the practical training, and each training was conducted in small groups comprising 3-5 members.



Performance test of charge controller

Performance test of inverter

b) Practical training through rehabilitation of PV systems at DOE

There are many demonstration PV systems at DOE. However, those systems have not been operational because of battery deterioration and other troubles. Although qualified trainers in REMD have sufficient basic knowledge for a PV system installation, some of them do not have enough experience in rehabilitation. Therefore, the Team decided to let them create a rehabilitation plan of the PV systems and implement the rehabilitation in order to overcome this weakness through actual implementation.

In this activity, qualified trainers were divided into four groups. Three groups were assigned for the rehabilitation of small PV systems such as SHS. And one group was assigned for the rehabilitation of large PV system installed in the south side of the DOE building.

Group	A	B	C	D
System	Small	Large	Small	Small
Existing PV system	Demonstration system of BCS	Power supply system to office machine	SHS at the Lobby Guard (AC)	Demonstration system of SHS
	300Wp	2.65kWp, 3.64kWp	450Wp	25Wp
Rehabilitation Plan	Street light system in front of REMD office	Grid connection system	SHS at the Lobby Guard (DC)	Cell phone charging system
	150Wp	6.29kWp	375Wp	25Wp

As for the large PV system, Group B conducted to the creation of rehabilitation plan. On the other hand, as for the small PV system, the groups conducted actual rehabilitation in the following order, inspection of existing PV system, creation of rehabilitation plan, system design, procurement, installation and completion inspection. This activity was started from June 2009 and all the groups ended their activities by February 2009.

Installation of street light PV system (Group A)

Inspection of guard house PV system (Group C)

c) Plan and preparation of solar PV engineers' training

Although the solar PV trainers' training had been conducted until 2007 in this project, it turned out that the training would be difficult to take over by DOE after this project. Therefore, the Team discussed the continuable PV training program centered on DOE with C/Ps, and then it was expressed to put most of their efforts into the training for local engineers such as AREC and LGU engineers. Therefore, the Team discussed future PV training program with ten qualified PV trainers in REMD and agreed on developing the training module for the local engineers in 2008.

The training module was developed by revision and addition of the contents of the PV trainer's training, and also the Team shared the preparation work among qualified trainers in order to encourage their active participation.

The developed training module was used in the PV engineers' training three times with revise, and finally, it was completed as the solar PV training module in February 2009.

Group	Items
1	* Prepare questionnaire * Create confirmation test and evaluation sheet
2	* Review main text of PV trainer's training * Create training text on troubleshooting
3	* Review user training material for BCS and SHS * Review monitoring sheet for BCS and SHS

3) Result of Activities

a) Improvement of capability to confirm PV equipment performance

A total of eleven (11) persons participated in the training on performance test of PV equipments, and ten (10) persons completed all courses of training.

As for the PV module, almost all participants had experience in checking the performance through OJT and the previous training, and were able to carry out the performance test appropriately. On the other hand, as for the charge controller and inverter, they were initially unfamiliar with the test equipment such as a DC power supply because the equipment was not used to conduct monitoring activities at the site. However the participants became accustomed to using the test equipment through repetitive practice and eventually developed the capability to execute the performance test appropriately. In order to execute proper performance test, they must experience more and more. Therefore it is expected to continue the training.

b) Reconfirmation of PV technology by conducting PV rehabilitation at DOE

The qualified trainers who participated in this activity had an experience with the following actual activities through a series of activity from survey of PV system at DOE to completion inspection and were able to reconfirm their knowledge and skills on PV technology:

- Inspection of the targeted PV rehabilitation system
- Creation of rehabilitation plan
- Installation and completion inspection

The qualified trainers who are not in charge of PV technology at the daily work forgot some parts such as system design, and these activities were progressed providing technical guidance. On the other hand, the qualified trainers who are in charge of PV system at the daily work could progress these activities without any problem.

c) Upgrading and completion of training materials for PV engineer

By giving a role to the qualified trainers in the development of the training module, many opinions for the training were pointed out actively from the qualified trainers. Especially, to confirm the background of participants before the training in order to adjust level of participant and to conduct the confirmation tests before and after training in order to check the understanding of participant were great helpful for the training. Also, by adding the new contents such as troubleshooting and user

training, the training became more closely-related contents with actual work of local engineers.

The developed training module was used in the PV engineers' training actually. After the training, the Team evaluated it with trainers who participated in the training and used the revised training module in next training. The training module had been used in the training three times with revision, and finally solar PV training module was completed in February 2009.

4) Efforts and lessons learned

a) Knowledge and skill improvement through actual work

It was realized that staff who were not involved in PV technology usually weaken their knowledge and skill. It is difficult to keep their understandings by self study. Therefore it is better to provide them with opportunities to accompany with field monitoring or to cooperate training as a trainer even if they are not in charge of PV technology. It is expected to deepen their knowledge and skill.

In addition, the in-house study regarding issues and measures on each technology is also effective for mutual learning

(5) Other activities

1) Purpose and Background

For the continuous establishment and dissemination of PV technology by C/Ps and related persons after completion of this project, the Team creates manuals, guidelines and standard specification in cooperation with C/Ps. Also, the Team advances the investigation for establishment of PV technology certification system by coordinating with other agencies.

2) Activities

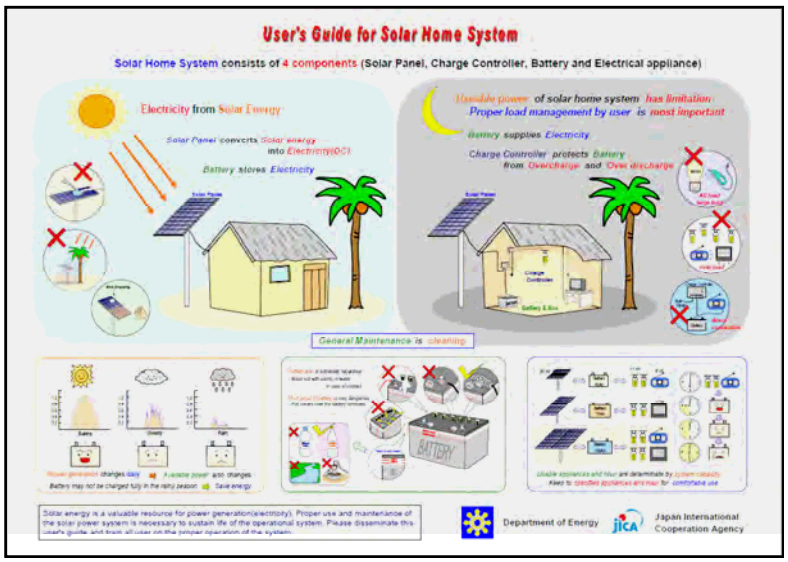
a) Development of manuals / guidelines

Manuals and guidelines were compiled in parallel with activities in this project and completed in June2009 with improvement. The completed manuals and guidelines were shown in the following table.

	Title
1	Manual for solar PV training
2	Manual for user training of solar PV system
3	Guideline for application of photovoltaic power generation system
4	Guideline for PV project evaluation
5	User guide for photovoltaic power generation system

In addition, the Team reviewed the standard specification being used in the previous BEP with C/Ps and used it in the procurement of new project.

Manual & Guideline



User Guide (for SHS)

b) Consideration for establishment of PV technology certification system

In the Philippines, to improve the quality defect of the project based on experiences of the previous project, the consideration on the PV technology certification system had started since 2000. There are two systems being examined in the Philippines. One is "Product qualification and Company certification system" which is being examined by CBRED from 2002. The other is "PV technician certification system" developed by TESDA and AMORE. TESDA is an agency that operates and manages the national competency system. This project has provided the related organizations mainly technical assistance since the beginning of project.

Also the Team discussed the prequalification system of company with related

persons for adopting into the bidding of BEP in 2008. As the results, all relations agreed to include the criteria for prequalification into the TOR and the criteria were used in the actual bidding.

3) Result of Activities

a) Keeping of technology level

During implementation of the rural electrification project by C/Ps, the implementation manual had been developed, but the explanatory materials on PV technology for users and related persons had not been unified, and also the technical design and user training were left to the individual's capability. Therefore, there was difference in technological level between projects. As for the measures against these issues, the Team developed manuals and guidelines related to the PV technology, and then the technological level of the project could be maintained.

b) Improvement of understanding related to quality of project

C/Ps understood the troubles occurring on the PV project through the OJT by PV site monitoring and the technical training. Also, C/Ps could deepen their understanding regarding the measures to improve the quality of the project through the activities such as establishment of the certification system related on PV technology and revision of the standard specification. As the results, C/Ps were aware of the importance of the quality control under BEP and started to eliminate low quality of productions and installations by improving the criteria for contractor selection and tightening of installation inspection.

4) Efforts and Lessons Learned

a) Utilization of manuals and institutional framework

In order to develop the manuals, it is required to understand completely regarding each content. Also it takes long time if it applies for new staff. It is same for establishment of PV technology certification system in terms of it is necessary to consider all comments from stakeholders.

Although individual capability is developed by technical transfer, standardization and institutional framework are necessary to disseminate the technology. It is expected that new REMB uses developed manuals for new staff and in-house education.