

**Royal Government of Bhutan  
Bhutan Power Corporation Limited (BPC)**

**Technical Cooperation Project  
for Improvement of Efficiency  
for Rural Power Supply  
(Phase II)**

**Project Completion Report**

**August 2014**

**Japan International Cooperation Agency  
Tokyo Electric Power Company Inc.**

IL
JR
14-098



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Abbreviations

Abbreviations	Words
AAAC	All Aluminum Alloy Conductor
ACB	Austrian Coordination Bureau
ACSR	Aluminum Conductor Steel Reinforced
ADA	Austrian Development Agency
ADB	Asian Development Bank
AMR	Automatic Meter Reading
BPC	Bhutan Power Corporation Limited
CB	Circuit Breaker
CFO	Chief Financial Officer
CP	Counterpart
CT	Current Transformer
CMTD	Central Maintenance and Training Division
CSP	Corporate Strategic Plan
DCSD	Distribution and Customer Services Department
DDCS	Distribution Design Construction Standard
DHI	Druk Holding and Investment
DMS	Distribution Management System
DORE	Department of Renewable Energy
DT	Distribution Transformer
EDCD	Engineering and Design Services Department
EMMD	Energy Management & Customer Care Division
ERP	Enterprise Resource Planning
ESD	Electricity Services Division
FI	Fault Indicator
FYP	Five Year Plan
GIS	Geographical Information System
GM	General Manager
GNH	Gross National Happiness
GO	Gang Operated
GoJ	Government of Japan
HPP	Hydro Power Plant
HQ	Headquarters
HRAD	Human Resource and Administration Department
HV	High Voltage
JCC	Joint Coordinating Committee
JICA	Japan International Cooperation Agency
KPI	Key Performance Index
LBS	Load Break Switch
LV	Low Voltage
MD	Managing Director
MOEA	Ministry of Economic Affairs
MOU	Memorandum of Understanding
MV	Medium Voltage
NCM	Numerical Calculation Method
NLC	National Land Commission
O&M	Operation and Maintenance
ODA	Official Development Assistance
OH	Over Head
OJT	On the Job Training

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PBIS	Performance Based Incentive System
PDCA	Plan, Do, Check, Action
PDM	Project Design Matrix
PI	Priority Issue
PMC	Project Management Cell
QC	Quality Control
RE	Rural Electrification
RECD	Rural Electrification & Construction Division
RED	Rural Electrification Department
RGoB	Royal Government of Bhutan
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SC	Service Center
SCADA	Supervisory Control and Data Acquisition
SMD	Substation Maintenance Divisions
SMS	Short Message Service
SOP	Standard Operating Procedure
T2LUPIN	TEPCO & Togami Low Voltage Underground Distribution Fault Point Investigation Device
TA	Technical Assistance
TEPCO	Tokyo Electric Power Company
TEPCO	Tokyo Electric Power Services Company
TOR	Terms of Reference
TOT	Training of Trainers
TW	Transmission Wing
UED	Urban Electrification Division
UG	Underground
VEEET	Village Electrical Entrepreneur and Electrical Technician



## Chapter 1 Outline of the Project

### 1.1. Outline

#### 1.1.1. Title of the Project

Technical Cooperation Project for Improvement of Efficiency for Rural Power Supply (Phase II)

#### 1.1.2. Project Term

From March 2012 to August 2014

#### 1.1.3. Counterpart

Bhutan Power Corporation (BPC)

The chief ministry is the Ministry of Economic Affairs (MOEA), Department of Renewable Energy (DORE).

The following figure shows the organizational structure of Bhutan Power Corporation. Furthermore, the numbers in this figure indicate the number of employees. In addition, this figure includes the departments to be established in the future. As of July 2014.

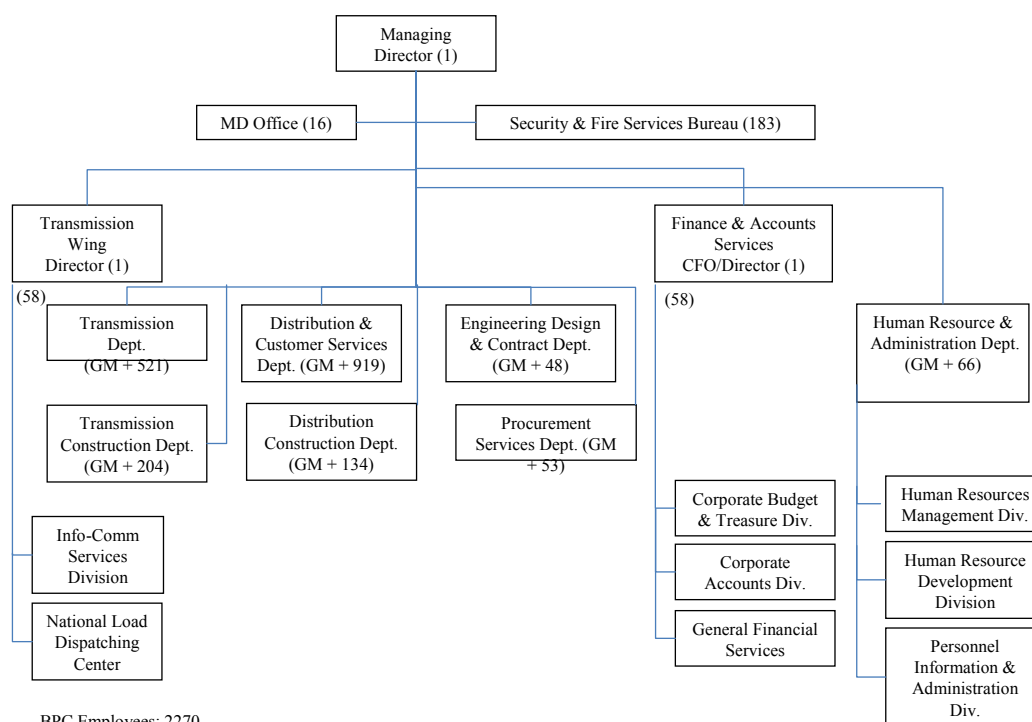


Figure 1-1 Organizational Structure of Bhutan Power Corporation

#### 1.1.4. Target Group

The Distribution & Customer Service Department (DCSD) is the department where the distribution facilities are transferred after the rural electrification. After the distribution facilities are transferred, the DCSD is responsible for operations and maintenance (O&M) of the distribution facilities. Therefore, DCSD is thought to have many problems that need to be solved in the area of the O&M work of the distribution facilities, and is selected as a target group. The following figure shows the organizational structure of DCSD. As of July 2014.

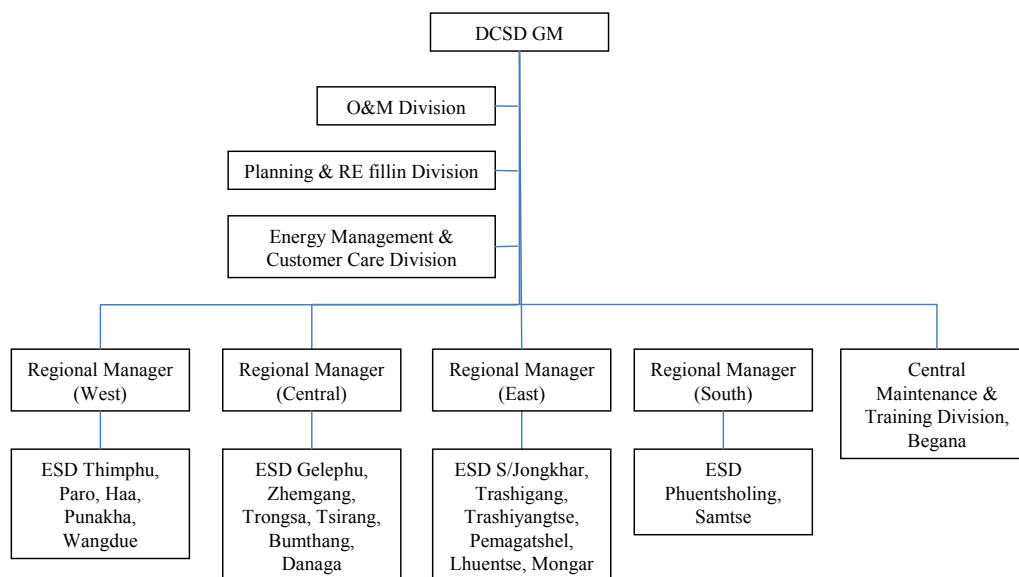


Figure 1-2 Organizational Structure of Distribution & Customer Service Department

#### 1.1.5. Target Area

The target area is the whole area of Bhutan. The following places show the main active places in this project.

- BPC Headquarters (Thimphu)
- Central Maintenance and Training Division (CMTD), Begana
- Project sites such as Trashigang, Wangdue Phodrang, Lhuentse, Tsirang etc

The following figure shows a map and the representative spots of Bhutan.

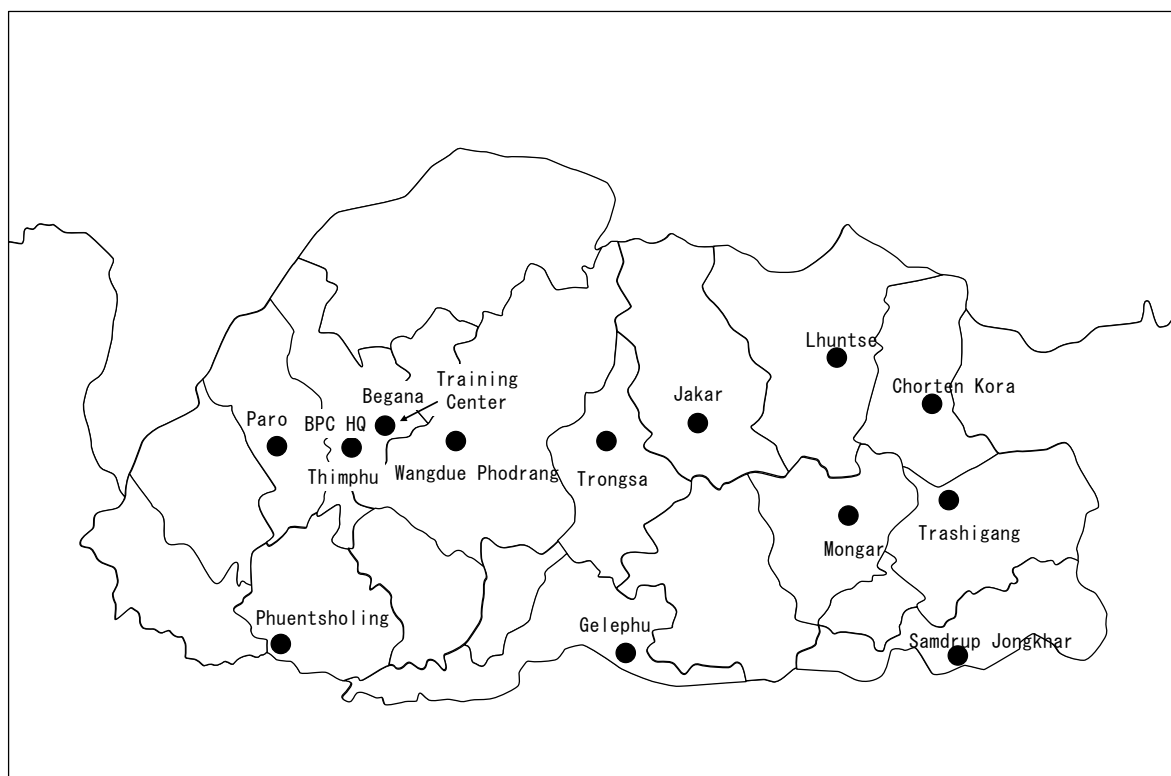


Figure 1-3 Map and Representative Pilot Project Sites of Bhutan

## 1.2. Purpose of Technical Assistance

### 1.2.1. Background

The Royal Government of Bhutan (hereafter “RGoB”) has formulated the Tenth Five Year Plan (2008-2013) and addressed the “Provision of Electricity for all by 2013.” This target is planned to be achieved via the extension of distribution lines and the utilization of renewable energy such as photovoltaic power and micro-hydropower.

The Japan International Cooperation Agency (hereafter “JICA”) has supported the above plan via the ODA Loan titled the “Rural Electrification Project” from 2007, and the loan agreement of phase 2 was signed between JICA and the Royal Government of Bhutan in 2011.

JICA has also implemented the Technical Cooperation Project for the Improvement of Efficiency for Rural Power Supply (Phase I) from June 2008 to June 2011 in order to support operations and the maintenance of rural electrification.

Against this background of JICA’s cooperation for rural electrification in Bhutan, Phase II of the above technical cooperation project was requested by the RGoB, and the Government of Japan (hereafter “GoJ”) approved the Technical Cooperation Project for the Improvement of Efficiency for Rural Power Supply (Phase II) (hereafter “the Project”) in 2011.

### **1.2.2. Objective**

Against this background, for BPC, which is the enforcement body of the rural electrification business, in order to enhance the efficiency of rural power supply, support for BPC's capacity building on organizational and technical improvement is carried out. Activities to achieve the following results are carried out.

- Capacity to handle areas identified under Priority Issue Solving Activities (hereafter “PI activities”) is enhanced. (Output 1)
- An Operation and Maintenance Manual (hereafter “O&M manual”) is introduced for rural power supply. (Output 2)
- Training capacity of the Central Maintenance and Training Division (hereafter “CMTD”), Begana, in distribution operations and maintenance is upgraded. (Output 3)

### **1.2.3. Objective**

Overall Goal, Project Purpose and Outputs in the Project Design Matrix (hereafter “PDM”) are follows.

#### **(1) Overall Goal**

Efficiency of rural power supply is enhanced.

#### **(2) Project Purpose**

Capacity for operation and maintenance of rural power supply is developed.

#### **(3) Outputs**

- Capacity to handle areas identified under PI activities is enhanced. (Output 1)
- O&M manual is introduced for rural power supply. (Output 2)
- Training capacity of CMTD, Begana is upgraded. (Output 3)

### 1.3. Technical Assistance Team Members

Table 1.1 shows the TA Team Members.

**Table 1-1 TA Team Members**

Field	Expert
Team Leader/PI Expert	Noboru SEKI (from 2012.3 to 2014.8)
Distribution Planning	Toshiya MINEJIMA (from 2012.3 to 2012.10)
	Masahiro MYOGA (from 2012.10 to 2013.8)
	Satoru KOIZUMI (from 2013.8 to 2014.8)
Distribution O&M	Junichi OHISHI (from 2012.3 to 2013.8)
	Kazuhiro YOSHIMURA (from 2013.8 to 2014.8)
O&M Manual	Eiichi ARAKAWA (from 2012.3 to 2012.10)
	Masaki IWAMA (from 2012.10 to 2014.8)
Training Equipment/Facility	Akihiro HAYASHI (from 2012.3 to 2012.10)
	Sari ISHIZUKA (from 2012.10 to 2014.8)
Training Planning	Keiichi FUJITANI (from 2012.3 to 2014.8)
Fault Location (1)	Masakatsu KOBAYASHI (2013.7)
Fault Location (2)	Keiichi TANII (2013.7)
Fault Location (3)	Yoshiki NAKANO (2013.7)



## Chapter 2 Basic Policy and Flow for Project Implementation

### 2.1. Basic Policy for Project Implementation Flow

The technical cooperation project to improve the efficiency of rural power supply was implemented from 2008 to 2011. JICA had supported the improvement of the capability of operations and maintenance for rural electrification from a technical and managerial perspective. In that project, the priority issue (PI) solving activity was functioning effectively. Based on the project experience, such as training in-house leaders through PI solving activities and having experience with other countries' systems, the TA Team established the following basic policies and implemented project activities based on these basic policies.

Basic policy 1: Enhancement of operations and maintenance capability to sustain reliability and quality of rural power supply based on priority issues

BPC is tackling the electrification of rural farm villages which have not yet undergone electrification. In this situation, BPC has various problems, which became obstacles towards the improvement of effective business and customer service. Even if they notice those problems, they, including management, lack the enthusiasm to tackle those problems at their workplace. In order to improve the operations and maintenance capability of BPC headquarters, the customer service department and the local branch, to sustain reliability and the quality of rural power supply, it is very important to conduct priority issue (PI) solving activities and a PDCA (Plan, Do, Check and Action) maintenance circle, which is the basis of PI solving activities. Therefore, in this project, the TA Team supported such activities as problem analysis, planning, project proposals and monitoring for effectiveness confirmation through pilot projects. In addition, since the distribution and customer services department (hereafter “DCSD”) of BPC plays a main role in the pilot project according to the work and budget allotment of BPC, pilot project costs shall be covered by BPC’s regular budget. Therefore, the TA Team supported DCSD’s proposal for the pilot project in consideration of the proposed evaluation criteria of the BPC board members and conducts activities so that it may be enough for the annual budget approval of BPC.



Presentation of PI solving activity to the board members

Basic policy 2: In-house leadership training to enhance awareness raising and autonomous PI solving activities

The purpose of implementing the PI solving activity according to basic processes in the workplace is to promote, primarily, changes in the way of thinking. If all workers always have a PI solving mind, it is expected that this will result in an automatic rise in efficiency.

In order to promote future PI solving activities continuously, it is necessary to develop trainers equipped with the knowledge that will contribute to their future leadership skills.

The TA Team provided a technology transfer via an OJT system so that independent continuous PI solving activities by BPC may be established after the end of this project through the nurturing of personnel who may grow to be future leaders. Therefore, the TA Team conducted coaching so that the 2<sup>nd</sup> batch of pilot project members could follow the 1<sup>st</sup> batch of pilot project members' instructions.



Support for PI Activities

Basic policy 3: Technology transfer through PI solving activities

PI solving activity is an in-house job improvement activity. Therefore, the counterparts need to have a grasp of their workplace issues and solve them. By grasping and analyzing the organizational and technical problems and situation at each stage, the experts try to solve the problem together each using the knowledge of their field. Therefore, the PI solving activity is extremely effective for the technical transfer and nurture of personnel to the counterparts. During this Technical Assistance, the TA Team worked with BPC to grasp and analyze the present situation in consideration of the organizational and technical aspects at each stage. Since the tasks will be primarily conducted on-site (in Bhutan), the opportunity for technology transfer and overall human resource cultivation is deemed important. The TA Team members provided technical assistance to counterparts for capacity enhancement in each field of specialization. Through one-on-one coaching, knowledge and skills have been imparted to the counterparts and priority issue solving activities were carried out.

Each expert has explained the TA objectives and the ways and methods of evaluating the results. Moreover, the counterparts have been encouraged to execute their tasks through OJT as much as possible.



Basic policy 4: Support the enhancement of operations and maintenance capability

The following two points are mentioned as priority matters for the enhancement activities of operations and maintenance capability in BPC.

(1) Creating of the operation and maintenance manual

The operation and maintenance manual (O&M manual) of the distribution system and the pocket size operation and maintenance manual were created through this project. In order to utilize the O&M manual effectively, it was necessary to meet the on-site user's needs based on the analysis of the on-site problem. Therefore, the TA Team checked the on-site situation, and supported the creation of the manual so that it might become suitable for the actual on-site conditions.

(2) Upgrade of the Central Maintenance and Training Division, Begana in Distribution Operations and Maintenance

Although CMTD, Begana near Thimphu conducts the training of the distribution section in BPC, it is in a situation where efficient training cannot be performed due to the shortage of equipment and an immature curriculum. Although BPC plans to strengthen the CMTD, Begana, they cannot specify the equipment needed and the curriculum. Therefore, the TA Team introduced a personnel training method from a Japanese electric power company and the good practices of a training center in Japan to BPC, and the TA Team supported the activities to create an improvement plan for the CMTD, Begana planned by BPC and gave them technical advice.

Basic policy 5: Establishment of a support system for smooth operations

(1) Establishment of a support system on the Japanese side for smooth project operations

In this project, a long-term expert for coordination and rural electrification was dispatched during the project period. The purpose of dispatching a long-term expert is for smooth and efficient operations of the project via instruction and advice toward the related organization and on-site activities, such as the preparation of on-site activities and pilot project monitoring. Therefore, the TA Team maintained a good relationship with the long-term expert and shared project information.

(2) Establishment of the support system on the Bhutanese side for smooth project operations

In order to establish a support system on the Bhutanese side, the TA Team reconfirmed the following points, and in case the TA Team needs to improve the relationship between the

Bhutanese side and the Japanese side, the TA Team discussed the problem to achieve smooth project operations.

- ◆ Establishment of a Joint Coordinating Committee (hereafter “JCC”) which made the Director of DRE, MOEA the chairperson (held every year)
- ◆ Appointment of General Manager (hereafter “GM”) of DCSD to project director
- ◆ Appointment of suitable staff from DCSD to project manager by the project director
- ◆ Allocation of suitable staff from DCSD and the Rural Electrification Department (hereafter “RED”) to the project member
- ◆ Support for project activities by the Human Resource and Administration Department (hereafter “HRAD”) and the Managing Director's Office (hereafter “MD Office”). (Support for the required budget for the project and allocation of participants for training and workshops, etc.)

### (3) Counterpart training in Japan

Regarding the counterpart training in Japan carried out as part of the technology transfer, the TA Team submitted a counterpart training proposal to JICA for the effective technology transfer of this project with a long-term expert, who has been dispatched separately, and carried out the counterpart training in Japan.

## 2.2. Project Implementation Flow

Along with the extension of the distribution line to the rural areas, the amount of equipment installed in the rural areas increases and the work volume increases too. In consideration of the limitation of materials and manpower, it is indispensable to improve the operations of maintenance management ability in the rural power supply of BPC for the efficient supply of steady electric power. Based on such a viewpoint, a technology transfer has been attempted, aiming for the continuous improvement of operations maintenance management ability even after the Project.

The work was executed at BPC headquarters, the CMTD, Begana, and the pilot project Electricity Services Division (hereafter “ESD”).

The composition of the work content (TOR correlation diagram) and the whole work flow is shown in Figure 2-1. The investigation of the preparation stage and the implementation stage was executed in the first term. Furthermore, the investigation of the monitoring stage was executed in the second term. Support for the PI solving activities and necessary technology transfer was carried out throughout the Project, and a workshop was held.

The Project implementation flow is as shown in Figure 2-2.

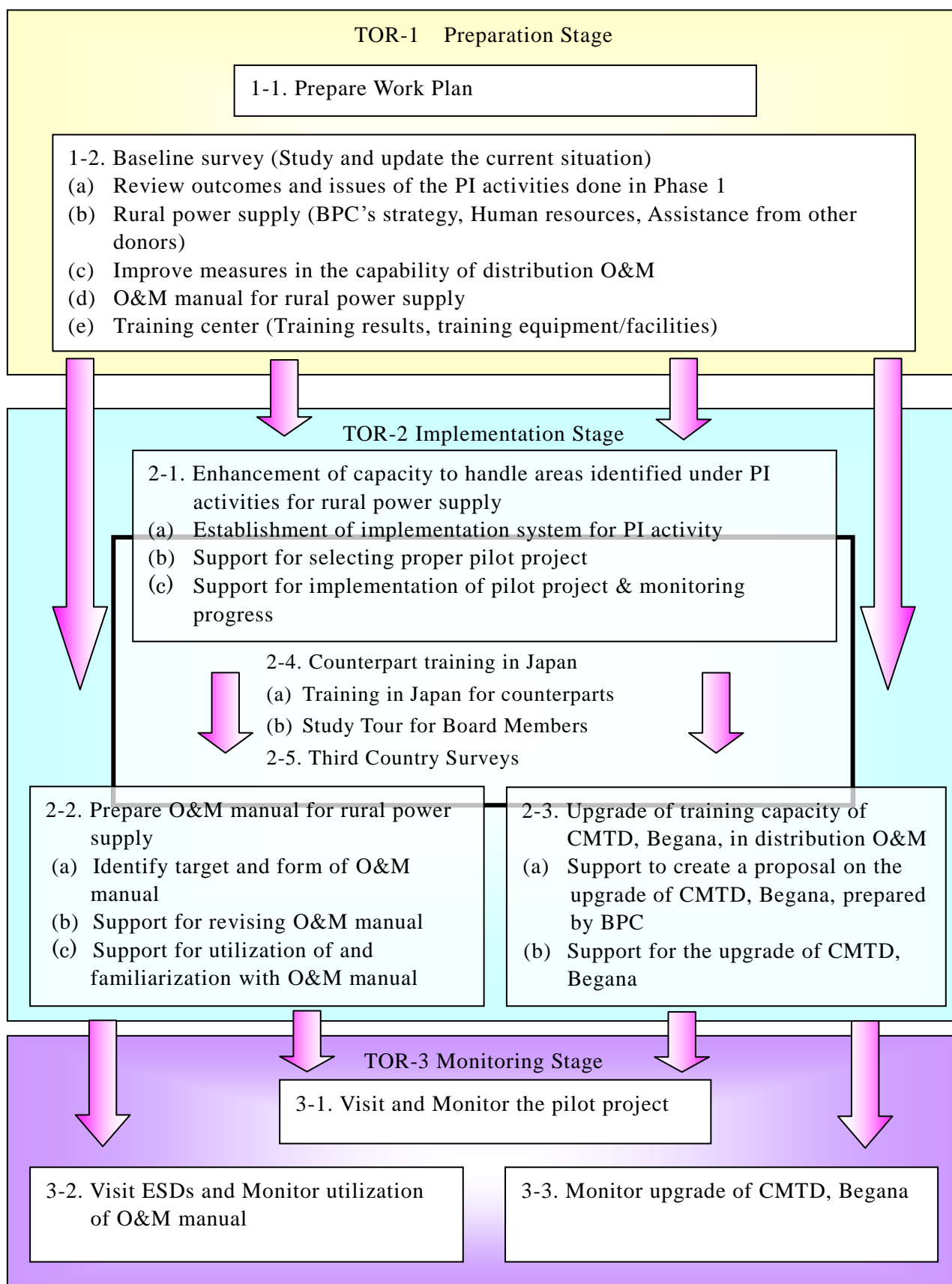


Figure 2-1 Composition of Work Contents (TOR Correlation Diagram)

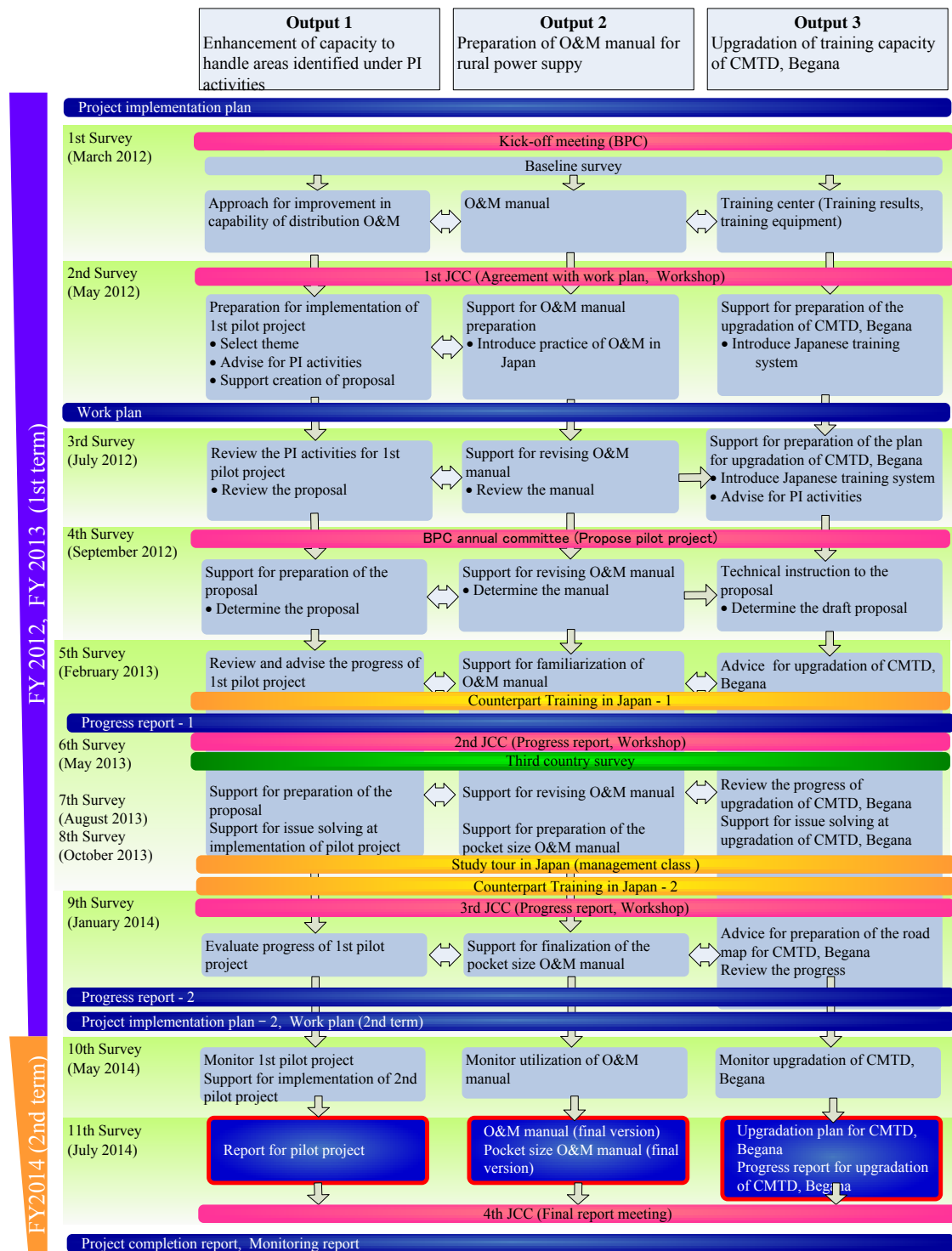


Figure 2-2 Project Implementation Flow

## Chapter 3 Input

### 3.1. Input from Japanese Side

#### 3.1.1. Experts

This project involved the dispatch of expert project teams and team leaders from Japan. The performance and achievements of these expert project leaders are outlined in Appendices 1 and 2. Table 3-1 shows the total dispatch Records of the project.

**Table 3-1 Total dispatch Records of the project**

FY	M/M (Site Survey)	M/M (Domestic Survey)	Total
2011	1.73	0.53	2.26
2012	9.3	4.43	13.73
2013	11.43	4.1	15.53
2014	3.68	2.75	6.43
	26.14	11.81	37.95

#### 3.1.2. Counterpart Training in Japan

Counterpart Training (C/P) in Japan was held three times, including a Study Tour in Japan for management level counterparts, between FY2012 and FY2013. The C/P training consisted of lectures and study tours for about two weeks. The subjects of the C/P training were mainly on the “Construction, Operation and maintenance of Distribution system”, “Distribution Automation”, “Training System and Facility”, “Safety Management” and “Quality control”. In total, 27 BPC and DORE members had the opportunity to attend the series of training in Japan.

The trainees’ lists of C/P training in Japan can be found in Appendices 3 and 4.

#### 3.1.3. Project Cost

The project cost is shown in Appendix 5. The project cost in the first term is the actual cost. The project cost in the second term is the contract amount.

### 3.2. Input from Bhutan Side

#### 3.2.1. Counterparts

Counterpart organizations are as shown in 1.1.3. and 1.1.4.

#### 3.2.2. Spaces and facilities for project activities

BPC offered office space for the long-term expert at BPC, and the utilization costs of electricity and water in the project office.



## Chapter 4 Project Activities

### 4.1. Outline of Project Activities

The project, whose implementation started in March 2012, is intended to provide technical assistance to enhance the capacity of BPC and related organizations. The site surveys were implemented eleven times and the third country surveys were implemented.

- The 1<sup>st</sup> site survey: From March 14, 2012 to March 24, 2012
- The 2<sup>nd</sup> site survey: From May 6, 2012 to May 19, 2012
- The 3<sup>rd</sup> site survey: From July 9, 2012 to July 26, 2012
- The 4<sup>th</sup> site survey: From September 9, 2012 to September 16, 2012
- The 5<sup>th</sup> site survey: From January 27, 2013 to February 8, 2013
- The 6<sup>th</sup> site survey: From May 8, 2013 to May 17, 2013
- The 7<sup>th</sup> site survey (1): From June 10, 2013 to June 19, 2013
- The 7<sup>th</sup> site survey (2): From July 14, 2013 to July 24, 2013
- The 7<sup>th</sup> site survey (3): From August 22, 2013 to September 6, 2013
- The 8<sup>th</sup> site survey: From September 16, 2013 to September 29, 2013
- The 9<sup>th</sup> site survey: From January 13, 2014 to January 29, 2014
- The 10<sup>th</sup> site survey: From May 12, 2014 to May 23, 2014
- The 11<sup>th</sup> site survey: From July 9, 2014 to July 19, 2014
- The third country survey (Theme 6a): From July 6, 2013 to July 13, 2013
- The third country survey (Theme 6b): From July 7, 2013 to July 12, 2013
- The third country survey (Theme 7): From June 23, 2013 to June 28, 2013
- The third country survey (Theme 8): From July 1, 2013 to July 6, 2013
- The third country survey (Theme 9): From June 24, 2013 to June 29, 2013
- The third country survey (Theme 10): From July 14, 2013 to July 20, 2013
- The third country survey (Theme 11): From June 23, 2013 to June 29, 2013

The correspondence of the plans and the results of the project are shown in Table 4-1. The details are shown in Appendix 6 and Chapter 4.2 “Activities”.

**Table 4-1 Plans and Results of the Project**

Stage	Project Plan		Project Result		
	Contents	Detailed Contents	Survey	C/P Training	Third Country Survey
			from 1st to 11th		
TOR-1 Preparation	1-1. Prepare Work Plan		○		
	1-2. Baseline survey	(a) Review outcomes and issues of the PI activities done in Phase 1	○		
		(b) Rural power supply (BPC's strategy, Human resources, Assistance from other donors)	○		
		(c) Improvement measures in the capability of distribution O&M	○		
		(d) O&M manual for rural power supply	○		
	(e) Training center (Training results, training equipment/facilities)	○			
TOR-2 Implementation	2-1. Enhancement of capacity to handle areas identified under PI activities for rural power supply	(a) Establishment of implementation system for PI activity	○		
		(b) Support for selecting proper pilot project	○		
		(c) Support for implementation of pilot project & monitoring progress	○		
	2-2. Prepare O&M manual for rural power supply	(a) Identify target and form of O&M manual	○		
		(b) Support for revising O&M manual	○		
		(c) Support for utilization and familiarization of O&M manual	○		
	2-3. Upgrade of training capacity of CMTD, Begana, in distribution O&M	(a) Support to create the proposal on the upgrade of CMTD, Begana, prepared by BPC	○		
		(b) Support for upgrade of CMTD, Begana	○		
	2-4. Counterpart Training	(a) Implementation of counterpart training in Japan		○	
2-5. Third Country Survey	(a) Implementation of third country survey			○	
TOR-3 Monitoring	3-1. Visit and Monitor the pilot project		○		
	3-2. Visit ESDs and Monitor utilization of O&M manual		○		
	3-3. Monitor upgrade of CMTD, Begana		○		

The targets of the each contents and achievements are shown in Table 4-2.

**Table 4-2 Project Targets and achievements**

Project Main Contents	Target	Outputs	Achivement
2-1. Enhancement of capacity to handle areas identified under PI activities for rural power supply	All PI teams propose pilot projects and all targeted pilot projects carry out the proposed plan.	PI Activities Final Presentation	PI Theme#1-5 proposed pilot projects to the BPC management on 11th September 2012 and PI Theme#6-11 proposed on 25th September 2013.
2-2. Prepare O&M manual for rural power supply	Prepare and confirm the contents of the O&M manual and the pocket size O&M manual, and all EDS use it.	O&M manual Pocket size O&M manual	O&M manual and the pocket size O&M manual was published and distributed to all ESDs.
2-3. Upgrade of training capacity of CMTD, Begana, in distribution O&M	The up-gradation plan including roadmap of CMTD is prepared and up-gradation activities are carried out	Upgradation of CMTD	The implementation plan including roadmap was prepared and presented at the third JCC.



## 4.2. Activities

### 4.2.1. Outcome of Study

- Preparation of reports
    - Implementation Plan
    - Work Plan (1st Term)
    - Project Progress Report (FY2012)
    - Third Country survey Report
    - Project Progress Report (FY2013)
    - Implementation Plan (2nd)
    - Work Plan (2nd Term)
    - Project Completion Report (This report)
  - Study and preparation of Technical Assistance
    - O&M manual (draft)
    - Training Policy & Guidelines (draft)
    - Pocket size O&M manual (draft)
    - Upgradation of CMTD (draft)
    - Priority Issues Solving Activity (Theme #1-5)
    - Priority Issues Solving Activity (Theme #6-11)
    - Third Country Survey Reports
    - O&M manual
    - Pocket size O&M manual
    - Upgradation of CMTD
- |  |
|--|
| Reported by Project Progress Report (FY2012) |
|--|

Reported by Project Progress Report (FY2013)
--

Reported at the beginning of 2 <sup>nd</sup> Term
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Reported by Project Progress Report (FY2012)
--

Reported by Project Progress Report (FY2013)
--

Reported by Project Completion Report and Deliverables
--

### 4.2.2. Site Survey Implementation

- Accomplished tasks during the first site survey  
(From March 14, 2012 to March 24, 2012)
  - Implementation Plan explanation to the counterparts (held kick-off meeting)
  - Data collection and information review
  - Review PI activities carried out at Phase 1
  - Present status on rural power supply
  - Select the Project theme (1st PI project)
- Accomplished tasks during the second site survey  
(From May 6, 2012 to May 19, 2012)
  - Conducted the first Joint Coordination Committee meeting
  - Discuss and agree on the Work Plan
  - Carry out a workshop specifically for sharing best practices in Japan.
  - Approach to improve O&M capability
  - Review the present status of the O&M manual

- Review the present status of the Training system in Begana
- Advise on PI activities for the pilot project
- Site survey for the pilot project
  - ◇ The first group
    - Visited the Trashigang ESD, and understood the actual protection relay situation concerning the PI theme 1 “Protection coordination”
    - Visited the Lhuentse ESD, and conducted a survey on the actual situation of the data collection method and the loss origin to contribute to the loss calculation concerning the PI theme 4 “To Identify real technical loss”
  - ◇ The second group
    - Visited the Wangdue ESD and the Dagana ESD, and conducted a survey on the actual situation of the correspondence method at the time of the accident outbreak concerning the PI theme 2 “Standard Installation of Fault Location” and PI theme 3 “Calculation on the methodology for correct reliability indexes from a customer viewpoint”
    - Visited the Trirang ESD, and conducted a survey on the actual situation of the electric bill payment in rural areas
- Accomplished tasks during the third site survey  
(From July 9, 2012 to July 26, 2012)
  - Carry out a workshop
  - Review the PI activities
  - Support for the creation of a pilot project proposal
  - Support for the revision of the O&M manual
  - Support for the preparation of the proposal for CMTD, Begana
  - Support for the preparation of the training policy
  - Site survey for the pilot project
    - ◇ The first group
      - Visited the Lhuentse ESD, and conducted an additional survey on the data collection method to contribute to loss calculation, and conducted a survey on the actual situation of the pilot feeder chosen by the Review Team
    - ◇ The second group
      - Visited the Wangdue ESD, and conducted a survey on the actual situation of the pilot feeder chosen by the review team
- Accomplished tasks during the fourth site survey  
(From September 9, 2012 to September 16, 2012)
  - Carry out the final presentation for PI solving activities
  - Carry out the workshop
  - Advice on the proposal for the pilot project

- Support to increase familiarization with the O&M manual
- Technical advice to the proposal prepared by BPC
  
- Accomplished tasks during the fifth site survey  
(From January 27, 2013 to February 8, 2013)
  - Carry out the workshop
  - Review and advise on the progress of the 1st pilot project
  - Select the Project theme (2<sup>nd</sup> PI project)
  - Site survey for the candidate areas for the transformer maintenance center
  - Site survey for the pilot project
    - ◇ The first group
      - Visited the Wangdue ESD, and conducted a survey on the installed situation of the ARCB and the FI. Visited the Gelephu ESD, and conducted a survey on the proposed site for training center improvements
    - ◇ The second group
      - Visited the Thimphu ESD, and conducted a survey on the fault searching method and current situation of the service center operation
  
- Tasks accomplished during the sixth site survey  
(From May 8, 2013 to May 17, 2013)
  - Conducted the second Joint Coordination Committee meeting (May 14, 2013)
  - Carried out the presentation for progress reports of 1<sup>st</sup> PI solving activities (May 13, 2013)
  - Carried out the presentation for progress reports of 2<sup>nd</sup> PI solving activities (May 13, 2013)
  - Technical advice on the proposal for the upgrade of CMTD, Begana prepared by BPC (May 9, 2013)
  - Carried out the workshops (May 14, 2013)
    - ◇ Distribution System Planning (Distribution System Planning in TEPCO)
    - ◇ Smart Grid (Overview of Smart Grid in TEPCO)
  - Site survey for the pilot project (From May 10, 2013 to May 11, 2013)
    - ◇ The first group
      - Visited the Haa and the Paro ESD, and conducted a survey on the actual situation of the metering, billing and collection in rural areas concerning the PI theme 7 “Study on metering, billing, collection procedures, process and technologies and preparation of a road map for implementation including cost benefit analysis”, and conducted a survey on the actual situation of using the GIS system concerning the PI theme 9 “Effective utilization of GIS in DCSD”
    - ◇ The second group

- Visited the Trongsa ESD, and conducted a survey on the actual situation of the operation and maintenance of Mini/Micro hydro power plant concerning the PI theme 10 “Study on sustainability and effective usage of existing Mini/Micro Hydels of BPC”
  
- Tasks accomplished during the seventh site survey  
(From June 10, 2013 to June 19, 2013, July 14, 2013 to July 24, 2013 and August 22, 2013 to September 6, 2013)
  - Advice on the proposal for the 2<sup>nd</sup> pilot project
  - Carried out the presentation for progress reports of 2<sup>nd</sup> PI solving activities (July 19 and 22, 2013)
  - Advice on the proposal for the third country surveys (From June 10, 2013 to June 14, 2013)
    - ◇ Purpose, Target setting, Schedule
  - Reviewed the present status of the new O&M manual (July 19 and 22, 2013)
  - Technical advice on the proposal for the upgrade of CMTD, Begana prepared by BPC (August 26, 2013)
  - Carried out the fault locating (From July 15, 2013 to July 18, 2013)
    - ◇ Carried out the fault locating for accident in underground cable
    - ◇ Carried out the fault locating demonstration
  - Carried out the workshops (July 18, 2013)
    - ◇ Smart Grid System
    - ◇ Issue Solving Activity
    - ◇ Result of the fault locating activities
  
- Tasks accomplished during the eighth site survey  
(From September 16, 2013 to September 29, 2013)
  - Advice on the proposal for the 2<sup>nd</sup> pilot project
  - Carried out the final presentation for 2<sup>nd</sup> PI solving activities (September 25, 2013)
  - Support for the creation of the pocket size O&M manual (September 24, 2013)
  - Support for the preparation of the proposal for the upgrade of CMTD, Begana (September 24, 2013)
  - Site survey for the pilot project (From September 19, 2013 to September 21, 2013)
    - ◇ The first group
      - Visited the Tsirang ESD, and conducted a survey on the actual situation of the Service Center, Multitask staff, Metering, Billing, Collection, and conducted a survey on the situation of the O&M manual and GIS data system concerning the 2<sup>nd</sup> PI theme
      - Visited the Wangdue ESD, and conducted a survey on the installation situation of the ARCB and Fault Indicator (FI) concerning the 1<sup>st</sup> PI theme

- Tasks accomplished during the ninth site survey  
(From January 13, 2014 to January 29, 2014)
  - Conducted the third Joint Coordination Committee meeting (January 22, 2014)
  - Carried out the presentation for progress reports of 1<sup>st</sup> PI solving activities (January 22, 2014)
  - Carried out the presentation for progress reports of 2<sup>nd</sup> PI solving activities (January 22, 2014)
  - Advice on the pocket size O&M manual (January 24, 2014)
  - Support for the preparation of the proposal for the upgrade of CMTD, Begana (January 21, 2014)
  - Site survey for the pilot project (From January 15, 2014 to January 20, 2014)
    - ◇ The first group
      - Visited the Trongsa, Zhemgang, Dagana, Punakha ESD, and conducted a survey on the actual situation of the Service Center, Multitask staff, Metering, Billing, Collection, and conducted a survey on the situation of the O&M manual, GIS data system, Relay coordination and Mini/Micro hydro power plant concerning the 1<sup>st</sup> and 2<sup>nd</sup> PI theme
    - ◇ The second group
      - Visited the Mongar, Lhuentse ESD, and conducted a survey on the actual situation of the Service Center, Multitask staff, Metering, Billing, Collection, and conducted a survey on the situation of the O&M manual, GIS data system, DT meter installation concerning the 1<sup>st</sup> and 2<sup>nd</sup> PI theme
  
- Tasks accomplished during the tenth site survey  
(From May 12, 2014 to May 23, 2014)
  - Carried out the presentation for progress reports of 1<sup>st</sup> PI solving activities (May 20, 2014)
  - Carried out the presentation for progress reports of 2<sup>nd</sup> PI solving activities (May 20, 2014)
  - Carried out the workshops (May 20, 2014)
    - ◇ Earthing/Grounding in Japan
  - Advice on the pocket size O&M manual (May 19, 2014)
  - Support for the preparation of the proposal for the upgrade of CMTD, Begana (May 19,21, 2014)
  - Site survey for the pilot project (From May 14, 2014 to May 17, 2014)
    - ◇ The first group
      - Visited the Bumthang, Mongar, Wangdue Phodrang ESD, and conducted a survey on the actual situation of the Service Center, Multitask staff and conducted a survey on the situation of the O&M manual, GIS data system,

ARCB, ABC cable and Mini/Micro hydro power plant concerning the 1<sup>st</sup> and 2<sup>nd</sup> PI theme

- ◇ The second group
  - Visited the Phuentsholing, Haa ESD, and conducted a survey on the actual situation of the Service Center, Multitask staff, Metering, Billing, Collection, and conducted a survey on the situation of the O&M manual, GIS data system, DT meter installation and Earthing system concerning the 1<sup>st</sup> and 2<sup>nd</sup> PI theme
  
- Tasks accomplished during the eleventh site survey  
(From July 9, 2014 to July 19, 2014)
  - Conducted the fourth Joint Coordination Committee meeting (July 16, 2014)
  - Carried out the presentation for progress reports of 1<sup>st</sup> PI solving activities (July 14, 2014)
  - Carried out the presentation for progress reports of 2<sup>nd</sup> PI solving activities (July 14, 2014)
  - Carried out the workshops (July 15, 2014)
    - ◇ Outline of Priority Issue Solving Activity
    - ◇ QC Tools
    - ◇ Exercise: QC Tools - Basic of Statistics
    - ◇ Basic of Economic Analysis
    - ◇ Data Management
    - ◇ Exercise: How to use Excel effectively?
  - Site survey for the pilot project (From July 11, 2014 to July 13, 2014)
    - Visited the Phuentsholing ESD and Tshimalakaha ESSD, and conducted a survey on the actual situation of the Service Center, Multitask staff, Metering, Billing, Collection, and conducted a survey on the situation of the O&M manual and AMR installation concerning the 1<sup>st</sup> and 2<sup>nd</sup> PI theme

#### 4.2.3. Cooperation on a Variety of Reports and Conferences

The TA Team explained the plan for the project and held a discussion with BPC and related organizations on how to proceed with the survey. The JCC and workshop title, date and target are shown in Table 3-2. The minutes of meeting for JCC are attached in Appendix 7.

**Table 4-3 JCC and Workshop**

Title	Date	Target	Remarks
The first JCC	May 15, 2012	Agreement of Work Plan	
The first Workshop	May 15, 2012	Introduction of Japanese electric power example	
The second Workshop	July 16, 2012	Introduction of TEPCO and BPC examples	
The third Workshop	February 6, 2013	Protection Relay and Protection coordination	
The second JCC	May 14, 2013	Reporting and agreement of pilot project progress and future plan	
The fourth Workshop	May 14, 2013	Distribution System Planning and Smart Grid	
The fifth Workshop	July 18, 2013	Smart Grid System and Priority Issue Solving	
The third JCC	January 22, 2014	Reporting and agreement of pilot project progress and future plan	
The sixth Workshop	May 20, 2014	Earthing/Grounding in Japan	
The seventh Workshop	July 15, 2014	Priority Issue Solving Activity and Useful Tools	
The fourth JCC	July 16, 2014	Reporting of project achievements and discussing future plan	

- The first Joint Coordination Committee meeting
  - The TA Team introduced the project's plan, discussed how to proceed with the survey, and obtained an agreement on the joint adjustment meeting members and work plan.
  
- The first workshop
  - Subject : Introduction of Japanese electric power example
  - Venue : Hotel Migmar conference room
  - Presenters : JICA short-term experts
  - Participants : BPC staff (mainly distribution division members) about 30 persons
  - Program :
    - Introduction of TEPCO's Power Distribution Network System (Mr. Toshiya Minejima)
    - Fault location (Mr. Eiichi Arakawa)

- Countermeasures for Safety (Mr. Junichi Ohishi)
- Meter, Billing and Collection system (Mr. Akihiro Hayashi)
- Introduction of In-house Training for Distribution Technical Employees of Tokyo Electric Power Company (Mr. Keiichi Fujitani)

Each of the five programs was received favorably by the participants. In particular, with regard to the Fault Location and Safety Countermeasures, the participants provided much positive feedback concerning the usefulness of the programs to the work they are doing. In addition, other than the programs mentioned above, there were requests for workshops on meter rings such as smart meters, too.

■ The second workshop

- Subject : Introduction of TEPCO and BPC examples
- Venue : BPC headquarters conference room
- Presenters : JICA short-term experts and BPC staff
- Participants : BPC staff (mainly distribution division members) - about 30 persons
- Program :
  - The Smart meter (Mr. Akihiro Hayashi)
  - Introduction of In-house Training for Technical Employees of TEPCO (Mr. Keiichi Fujitani)
  - Rural electrification of Bhutan, Fault locating method of BPC (BPC)

There were some questions concerning smart meters, such as whether or not the meter is capable of recording inverse load flow, such as photovoltaic power generation and which installation locations would yield the most benefits.

In addition, concerning the theme of personnel training, there were some questions on the construction of the upbringing policy, adoption businesses such as the educational background of new employees, and incentives from companies for self-study.

■ The third workshop

- Subject : Protection Relay and Protection coordination
- Venue : BPC headquarters conference room
- Presenter : JICA short-term expert
- Participants : BPC staff (about 50 persons)
- Program :
  - Protection Relay and Relay Coordination (Mr. Keiichi Fujitani)

For this Workshop, staff across sections such as the substation division and the load dispatching division participated as well as the distribution division staff, and although it was a workshop which handled only one theme, the number of participants was double that of previous workshops.



- The second Joint Coordination Committee meeting
  - The TA Team and PI team member reported the pilot project progress, discussed how to proceed with the survey, and obtained an agreement on the joint adjustment meeting members.
  
- The fourth workshop
  - Subject : Distribution System Planning and Smart Grid
  - Venue : Hotel Phuntso Pelri conference room
  - Presenters : JICA short-term experts
  - Participants : BPC staff (mainly distribution division members) - about 30 persons
  - Program :
    - Distribution System Planning (Distribution System Planning in TEPCO) (Mr. Masaki Iwama)
    - Smart Grid (Overview of Smart Grid in TEPCO) (Mr. Masahiro Myoga)

Each of the programs was received favorably by the participants. In particular, concerning the Smart Grid, the participants provided much positive feedback concerning the usefulness of the programs to the work they are doing. In addition, there were requests for further workshops on Smart Grid.
  
- The fifth workshop
  - Subject : Smart Grid System and Priority Issue Solving
  - Venue : Namgay Heritage Hotel conference room
  - Presenters : JICA short-term experts
  - Participants : BPC staff (mainly distribution division members) - about 20 persons
  - Program :
    - Smart Grid System (Mr. Masaki Iwama)
    - Priority Issue Solving (Mr. Noboru Seki)

Each of the programs was received favorably by the participants. In particular, concerning the Smart Grid, the participants provided much positive feedback concerning the usefulness of the programs to the work they are doing. And there were many questions about the Smart Grid System.
  
- The third Joint Coordination Committee meeting
  - The TA Team and PI team members reported the pilot project progress, and discussed how to proceed with the survey, and obtained an agreement on the joint adjustment meeting members.
  
- The sixth workshop
  - Subject : Earthing/Grounding in Japan
  - Venue : Taj Tashi Hotel conference room

- Presenters : JICA short-term experts
- Participants : BPC staff (management and PI activities leaders) - about 20 persons
- Program :
  - Earthing/Grounding in Japan (Mr. Kazuhiro Yoshimura)

The participants received this program favorably. And there were many questions about the earthing system.

■ The seventh workshop

- Subject : Priority Issue Solving Activity and Useful Tools
- Venue : Hotel Phuntso Pelri conference room
- Presenters : JICA short-term experts
- Participants : BPC staff (mainly distribution division members) - about 15 persons
- Program :
  - Outline of Priority Issue Solving Activity (Noboru Seki)
  - QC Tools (Kazuhiro Yoshimura)
  - Exercise: QC Tools - Basic of Statistics (Keiichi Fujitani)
  - Basic of Economic Analysis (Keiichi Fujitani)
  - Data Management (Noboru Seki)
  - Exercise: How to use Excel effectively? (Masaki Iwama)

Each of the programs was received favorably by the participants. In particular, concerning the Outline of Priority Issue Solving Activity, the participants provided much positive feedback concerning the usefulness of the programs to the work they are doing and there were many questions about this program.

■ The third Joint Coordination Committee meeting

- The TA Team and BPC reported the pilot project progress, achievements and future plan, and discussed how to continue the PI activities by BPC, and obtained an agreement on the joint adjustment meeting members.

#### 4.2.4. Counterpart Training in Japan

Counterpart Training sessions in Japan were held in FY2012 and FY2013. The C/P training consisted of lectures, and distribution facility and distribution equipment manufacturing process study tours for about two weeks. The subjects of the C/P training were mainly “Management method”, “Distribution engineering”, “Data management” and “Quality control”. Twenty-four BPC staff members had the opportunity to attend the training series in Japan. The TA Team submitted both reports to JICA on March 31, 2013 and December 5, 2013.

The trainees’ lists of counterpart training in Japan can be found in the Appendix.

Moreover, a Study Tour in Japan for board members was held in FY2013. The Study Tour consisted of distribution facility and distribution equipment manufacturing process study tours

for about one week. The subjects of the Study Tour were mainly “Japanese technology”, “Data management” and “Quality control”. Two BPC board members and one DORE high officer had the opportunity to attend the tour series in Japan. The TA Team submitted the report to JICA on November 6, 2013.

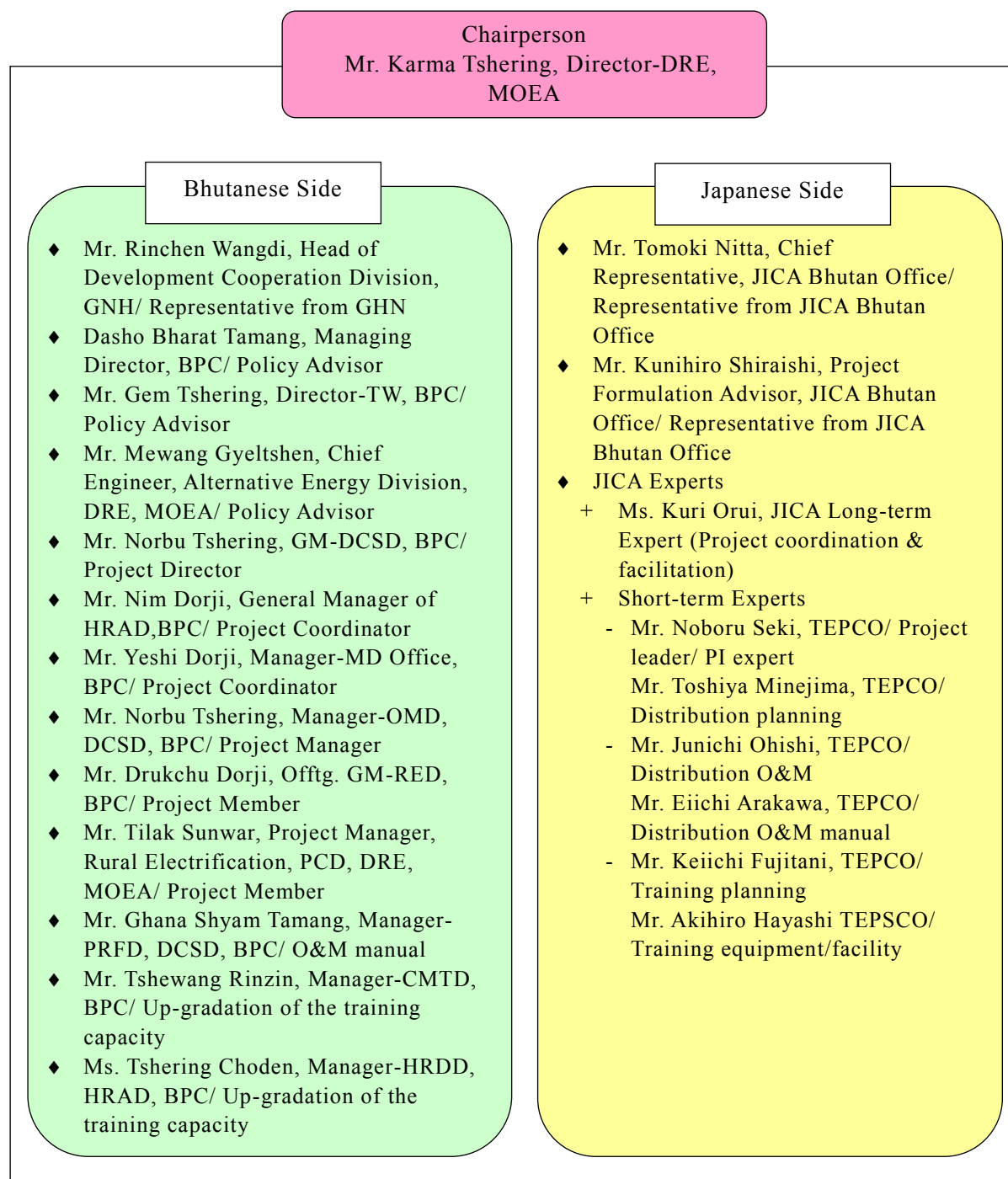
The participant lists for the study tour in Japan can be found in the Appendix.

#### **4.2.5. Third Country Survey**

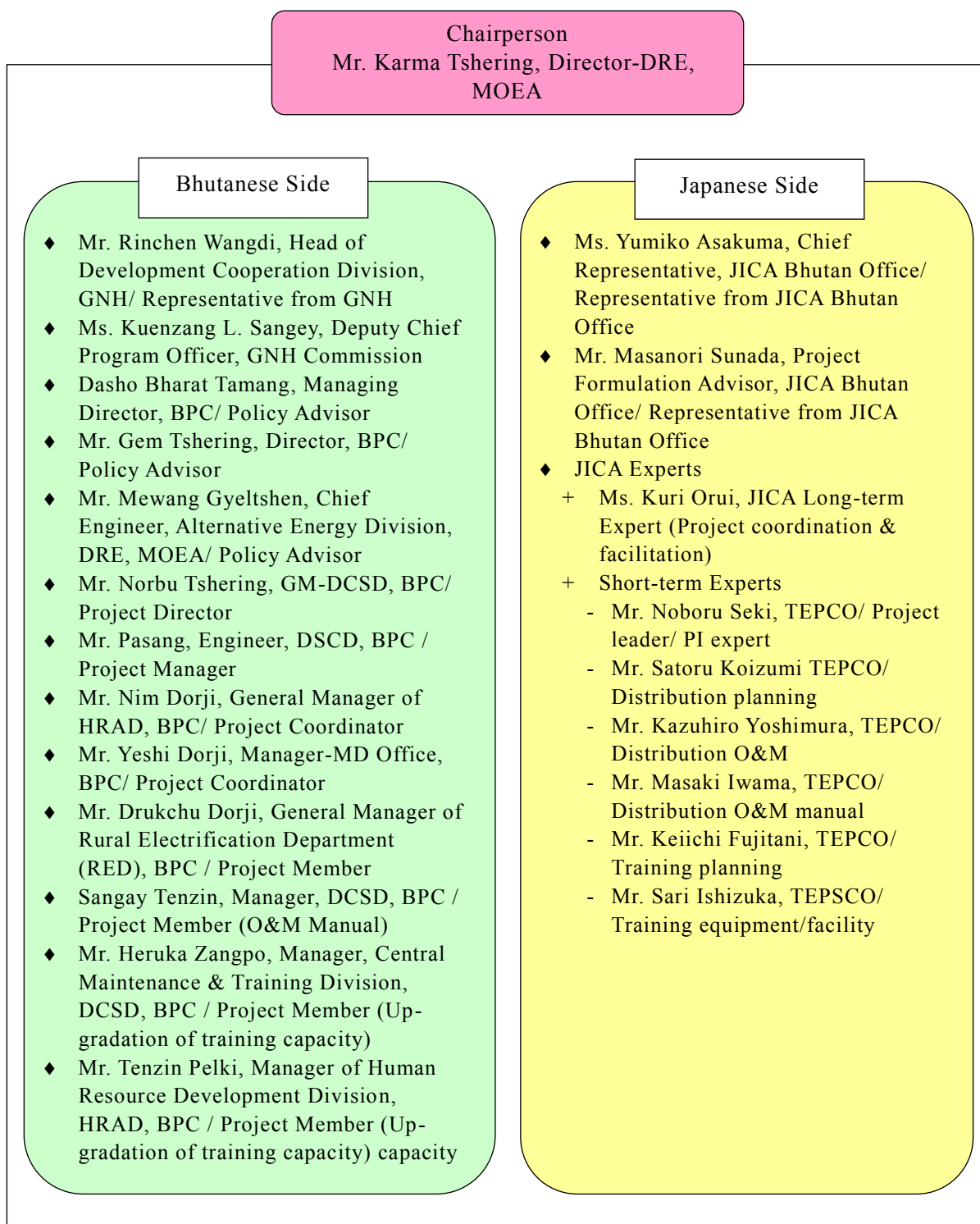
The third country survey was held in FY2013 for the purpose of obtaining ideas on each group’s theme solution as part of the PI activity. In the third country survey, they discussed with the electric power company, a manufacturing company and another company, and collected the information necessary for the PI activity. The schedule of the third country survey is shown in Chapter 3.1 and the details are shown in the Third Country Survey Reports.

### 4.3. Joint Coordinating Committee

In the first field survey (March 2012), the JCC was organized. The original members are shown in Figure 4-1. The members as of January 2014 are shown in Figure 4-2.



**Figure 4-1 Organizational Chart of Original Joint Coordinating Committee (JCC)**



**Figure 4-2 Organizational Chart of Joint Coordinating Committee (JCC) as of January 2014**

## **4.4. Enhancement of capacity to handle areas identified under PI activities**

### **4.4.1. Support for selecting proper pilot project**

The TA Team carried out the following activities in order to execute the pilot project for the solution of priority issues in the operations and maintenance of rural electrification via discussion with BPC counterparts.

- ◆ Selection of the Study Theme
- ◆ Selection of target ESDs
- ◆ Selection of participants for PI solving activities
- ◆ Confirmation of future activities

In setting the theme, the process of picking up the cause of the issue multilaterally and analyzing it in depth is very important. Therefore, a thorough discussion via the conducting of a brainstorming session where a BPC management also participated was carried out before the deciding on the theme.

The presentation session and workshop for the theme setting were held, and the following themes were decided.

#### **(1) Theme and Background for PI activities for 1st Pilot Project**

The meeting to set the theme of PI activity on March 19, 2012 was carried out, and the following five PI themes were selected. Each theme and background is described as follows.

##### **(a) Theme #1 “Protection coordination”**

- ◆ Team leader: Mr. Cheten Tshering, Engineer, SMD Kanglung
- ◆ Support staff (JICA): Keiichi Fujitani
- ◆ Target ESD: Trashigang ESD
- ◆ Background:

The basic idea of “Protection Coordination” is minimizing the outage area when a fault occurs. When a fault occurs in the distribution line, the nearest circuit breaker, which is installed on the generation side, opens in order to protect a healthy line and to minimize the fault influencing area, and the fault section is separated. However, in the system of Trashigang, a wide range outage occurred, because the circuit breaker which was installed in the upper stream opened instead of the nearest circuit. Although the cause of this problem assumes the “Protection Coordination” of this system cannot be set under appropriate conditions, this team will analyze the phenomenon in detail and pinpoint the cause from various viewpoints minus any prejudgments.

##### **(b) Theme #2 “Standard Installation of Fault Location”**

- ◆ Team leader: Mr. Nagawang Norbu, Sr. Engineer, EDCD
- ◆ Support staff (JICA): Eiichi Arakawa

- ◆ Target ESD: Wandhi Dhodang ESD

- ◆ Background:

In the case of a fault occurrence in the distribution line, quick faulty point detection allows for early restoration, leading to shortened interruption time. As it stands now, a patrol team conducts a visual inspection to detect the faulty point in a faulty section, which is identified through the operations of the CB in the substation and the isolators installed in the distribution line. If the length of a section is shortened by an additional installation of isolators, the faulty point detection time within a faulty section is expected to be shortened, while the identification and isolation of a faulty section may need more time. The PI team tries to optimize the installation criteria for isolators taking into consideration the expected total restoration time and cost. Being capable of isolation, ARCB (Auto Re-closing Circuit Breaker), which enables automatic switching operations, is also studied as an alternative, though it is expensive.

(c) Theme #3 “Calculation on the methodology for correct reliability indexes from a customer perspective”

- ◆ Team leader: Mr. Vesraj Bhujel, Manager, RECD-Samtse

- ◆ Support staff (JICA): Toshiya Minejima

- ◆ Target ESD: All ESDs

- ◆ Background:

SAIDI (System Average Interruption Duration Index) and SAIFI (System Average Interruption Frequency Index) are well known indices, by which BPC is improving their system reliability.

According to general procedures, the number of all interrupted customers is to be counted and recorded as well as the duration time of the outage period. The team conducted the baseline survey and it found that BPC's way of creating data is quite different from the general one. It means that BPC is regarding the first successful reclosing of the tripped circuit breaker of the outaged distribution network as the end of the interruption. This will lead to the overestimation of system reliability because in many cases the outages are still continuing; even if the circuit breaker is reclosed successfully, the backward section where the fault occurs is isolated from the network by the disconnecting switch. At the same time, the efforts of BPC's linemen to shorten the time for re-energizing the outaged network are never reflected to the betterment of the indices. From the point of view of this situation, the reliability index was removed from the evaluation indices for PBIS (Performance Based Incentive System) of ESDs for 2011. Immediate improvement was needed for the method of evaluation using the SAIFI/SAIDI and it was decided to have a conclusion drawn up by the end of May.

(d) Theme #4 “To Identify real technical losses”

- ◆ Team leader: Mr. Ghana Shyam Tamang, Sr. Engineer, DCSD
- ◆ Support staff (JICA): Junichi Ohishi
- ◆ Target ESD: Lhuentse ESD
- ◆ Background:

Distribution losses are mainly classified as either technical losses or commercial losses. At present, it is possible to calculate the total distribution losses as the difference between input and output. However, it is difficult to break down the outbreak sources of the losses. Furthermore, it is hard to come up with countermeasures to reduce distribution losses. Therefore, for the purpose of breaking down the causes behind the losses, this team proposes a calculation methodology to determine how much the technical loss of each facility (medium voltage line, distribution transformer and low voltage line) is. This methodology is supposed to be a theoretical method. However, for the purpose of confirming the proof of the proposed methodology, it is necessary to measure actual distribution losses. In addition, there are some cases which have negative losses and big changes in loss ratio every year. Therefore, this team will attempt to find out these causes as well.

(e) Theme #5 “Improvement of the billing and collection system in rural area”

- ◆ Team leader: Mr. Nawaraj Chhetri, Sr. Engineer, DCSD
- ◆ Support staff (JICA): Akihiro Hayashi
- ◆ Target ESD: Tsirang ESD
- ◆ Background:

Regardless of whether rural or urban area, the BPC reads meters and collects bills every month. In the rural areas, since the office to pay electric bills at is very far away, monthly payments are very inconvenient. From the viewpoint of improving customer satisfaction, improvements are required. In ESD in rural areas, BPC tries to gain customer satisfaction by the cashier visiting remote villages. On the other hand, on the BPC side, electric bill collection in rural areas is more expensive than in urban areas regarding the cost per kWh, so improvements in the electric bill collection system are required. It has considered a wide variety of measures to improve the electric bill collection system, but each measure has its advantages and disadvantages. By comparing these proposed measures, BPC proposes methods of electric bill collection that benefit both the customer and BPC.



**(2) Theme and Background for PI activities for 2<sup>nd</sup> Pilot Project**

The meeting to set the theme of PI activity on February 5, 2012 was carried out, and the following six PI themes were selected. Each theme and background is described as follows.

(a) Theme #6 “Study on existing manpower and management of existing facilities under DCSD”

a) Study on existing manpower and facilities of ESDs

b) Effectiveness of existing Service Centers

- ◆ Team leader a): Sangay Tenzin, Manager, O&MD, DCSD
- ◆ Team leader b): Dechen Dema, Manager, UED, DCSD
- ◆ Support staff (JICA): Noboru SEKI
- ◆ Background:

The Distribution and Customer Service Department (DCSD) of BPC is taking charge of the power sale business. BPC sets up Electricity Services Divisions (ESD) in 19 Dzongkhag except the Gasa Dzongkhag. Each ESD carries out operations and maintenance in distribution lines of 33kV or less, meter-reading, billing, collecting, and the management of customer complaints and so on. Though BPC distributes their own assets (people and things) to each ESD, some ESDs have voiced concerns regarding the lack of assets, and are of the opinion that there is unfairness between the ESDs. The team verifies the validity of the asset allocation based on such a situation, and proposes a proper method of asset allocation.

Moreover, BPC operates a small-scale Service Center aiming to satisfy customer needs in the depopulated area, and to carry out various services concerning electric power supply. However, the activities at this center cannot be seen from the headquarters, and whether it is actually functioning is uncertain. The team will evaluate the effects and the necessity, and propose the direction the Service Center should aim for in the future.

(b) Theme #7 “Study on the metering, billing, collection procedures, process and technologies and preparation of a road map for implementation including a cost benefit analysis”

- ◆ Team leader: Sandeep Rai, Manager, EMMD, DCSD
- ◆ Support staff (JICA): Sari ISHIZUKA
- ◆ Background:

The theme, “Improvement of billing and collection system in Rural Areas”, which is carried out via the PI activities for the first pilot project, is studied in detail, and a more concrete proposal is formed. In particular, the comparison and evaluation of many measures to improve electric bill collection systems proposed by PI activity for the first pilot project is performed first. Next, the study for the implementation of the pilot project applying the new method is performed. Finally, the road map towards the application of the new method is proposed.

(c) Theme #8 “Fault Locating and Rectification of Arial Bundle Conductor (ABC) and Under Ground (UG) cables”

- ◆ Team leader: Nidup, Engineer, EDCD
- ◆ Support staff (JICA): Junichi OHISHI
- ◆ Background:

In urban areas, such as Thimphu and Phuntsholing, the distribution system is composed of underground facilities, and underground cables are utilized in the system. Furthermore, instead of a bare conductor, an Arial Bundle Conductor (ABC) comes to be used in the low voltage overhead system. In the case that there is a fault in the cable facilities, it is very important to grasp the fault point location exactly. However, BPC is facing problems where they cannot easily find out the cable fault point. Therefore, there are many fault cables which have not been repaired and left as they are. In view of reliability and effective utilization of facilities, it is desirable that fault cables be repaired and used promptly. In this theme, the BPC tackles the fault point investigation method and aims to introduce a method and device suitable for the BPC system.

(d) Theme #9 “Effective utilization of GIS in DCSD”

- ◆ Team leader: Dorji Tshewang, Sr. Engineer, DCSD
- ◆ Support staff (JICA): Masaki IWAMA
- ◆ Background:

At the BPC, they input the information of the electric power facilities as positional information on the GIS (Geographical information system) database with the expansion of rural electrification. It is very important to utilize the information of these electric facilities and map information of the GIS in addition to managing various duties effectively. However, EDC recognized that the update of the electronic facilities information in the GIS database wasn't carried out well as today's problem. It is expected that with an effective tool at the time of electric equipment maintenance planning, the accident section identification and accident point investigation at the time of the electric equipment accident will be conducted. It is also expected that this will contribute to labor saving and the shortening in the length of the electric power outage, if BPC constructs the structure updating this electric equipment information at all times, and in a manner where a member of the associated section can easily access it in time of need. This activity will make a proposal about the GIS database information and the adjustment method of the true facilities' situation, adjustment method of the GIS database information and the actual facilities' situation, the structure construction of the GIS database information update method, the training system of the GIS database software operation method and the effective duties administration that utilized GIS data information.

(e) Theme #10 “Study on sustainability and effective usage of existing Mini/Micro Hydels of BPC”

- ◆ Team leader: Sonam Phuntsho, Engineer, CMTD
- ◆ Support staff (JICA): Keiichi FUJITANI
- ◆ Background:

BPC presently operates and maintains the mini/micro hydroelectric power generation facilities. Moreover, BPC plans to connect the off-grid system mini/micro hydroelectric power generation facilities to the on-grid system. However, there are many problems accompanied by a trip, and it serves as a burden in terms of operations maintenance. Moreover, the technical standard for connecting the on-grid system is not prepared and the capability for the on-grid connection is insufficient, so BPC faced a problem with the operations and maintenance of the mini/micro hydroelectric power generation facilities. Therefore, in this theme, BPC tackles the main problem finding, course analysis and evaluation of countermeasures, and proposes the best countermeasure and schedule for implementation.

(f) Theme #11 “Study of the Distribution Transformer (DT) metering in BPC”

- ◆ Team leader: Passang, Engineer, DCSD
- ◆ Support staff (JICA): Masahiro MYOGA
- ◆ Background:

For the appropriate evaluation of power line losses and electric supply reliability, BPC is considering setting up the evaluation methods. Currently, power line losses are calculated based on the difference between the sending power of the power line at a distribution substation and the sum of the consumed power at all customers on the power line. As a result, power line losses are not calculated with enough accuracy. On the other hand, the reliability of the power supply is grasped by the records of the faults at a distribution substation, but there is no good method to grasp a power outage which is caused between a distribution substation and each customer. In this case, BPC grasps the power outage via calls from complaining customers. As a result, the reliability of the power supply is also not calculated with enough accuracy. By the installation of an advanced meter at a distribution transformer, the power demand of each transformer and the power outage at the transformer is able to be grasped. From this information, power line losses and the reliability of the power supply could also be grasped and the next step should be the loss reduction of a power line and the improvement of power supply reliability. In this theme, the installation of the advanced meter at a distribution transformer for the loss reduction of a power line and the improvement of power supply reliability are considered, as well as the specifications and the place to install the meters. Additionally, the plans from the step for the testing installation of meters to the step for full-scale installation will be proposed.

### **(3) Theme and Background for PI activities for 3<sup>rd</sup> Pilot Project**

#### **(a) Theme #12 “Setting of Earthing Standard and Proper Method for Distribution System Earthing”**

- ◆ Team leader: Passang, Engineer, DCSD and Sangay Tenzin, Manager, O&MD, DCSD
- ◆ Background:

There is a problem that the earthing resistance is high and is out of standard level. There are also troubles that the transformers are broken cause by high earthing resistance. Then, the PI team is tackling the PI activity that is set a suitable earthing resistance standard and method of decreasing earthing resistance.

#### **(b) Theme #13 “Fault Locating method for Arial Bundle Conductor (ABC) cable”**

- ◆ Team leader: Passang, Engineer, DCSD and Sangay Tenzin, Manager, O&MD, DCSD
- ◆ Background:

There are many ABC cable accidents in Phobjikha area and PI team is tackling the PI activity to check the cause of accidents for urgently. The PI team is formed and site survey is scheduled for October.

#### **4.4.2. Support for implementation of pilot project**

The TA Team supported the pilot ESDs and DCSD to obtain the approval and budget from the BPC management. Furthermore, all proposals were approved by the BPC management. The contents of the proposal and comments are described as follows.

##### **(1) Support for creating a proposal of the 1st pilot project**

The final presentation for proposing the pilot project was carried out on September 11, 2012. Each team proposed the pilot project to BPC board members, including the MD, and all teams basically got approval for the implementation of pilot projects.

#### **(a) Theme #1 “Protection coordination”**

- ◆ The contents of the proposal

In the system of Trashigang, a wide range outage occurred, because the circuit breaker that was installed in the upper stream opened instead of the nearest circuit. In order to find the cause of the problem, all the protection relays in the Trashigang system area were checked. As a result, it became clear that it was a problem to omit a re-setup after the initial installation of protection relays. Since it became clear that the problem was solved when the setting of the relay was exact, the team decided to perform the re-setting of the relays as a short-term measure. The MD approved this short-term measure at the final presentation session. Moreover, the team decided to introduce the software and to analyze the whole system in consideration of the complication of a future system, as a long-term measure and proposed a software purchase. Furthermore, the team

suggested the necessity of training for the engineers and the technician who can do protection coordination, and the protection coordination committee meeting between the distribution section and the transmission section. Concerning the purchase of software, the MD suggested a detailed study such as a cost benefit analysis and approved its purchase if deemed necessary.

The target is to set up a protection coordination team by the end of 2013.

(b) Theme #2 “Standard installation of the fault location”

◆ The contents of the proposal

Under present conditions, when a fault occurs in the distribution line, the BPC distribution division staff operates the hand-operated load break switch (LBS) of the distribution line and the circuit breaker (CB) on the substation several times and isolates the accident section. However, it requires a long travel time to LBS or Re-blackouts with the failure of the trial closing of CB. In addition, there were no installation standards of LBS uniformed in BPC, and it is thought that this situation produces a difference in the reliability level of each EDC.

In this study, we chose a 33kV distribution line of the Wangdue ESD to the pilot feeder, modified SAIFI and SAIDI, and calculated the equipment installation costs which were assumed after having carried out an improvement plan (some cases) concerning the real accident (1 case), and compared it to the improvement plan.

The PI task member weighed the following improvement plans in mind using the ARCB (Automatic Reclosing Circuit Breaker) and FI (Fault Indicator) which reserved possession (no installed site) of BPC.

(Plan A) Replace LBS becoming the long-distance (approximately 20km) in ARCB.

(Plan B) Install FI by adding all existing LBS.

(Plan C) Plan A and install FI by adding part of the existing LBS.

As a result, decided plan C as the last suggestion and got MD approval of BPC.

The target is to install the ARCB at the pilot project site by the end of FY2012 and to start the collection of necessary information from FY2013.

(c) Theme #3 “Calculation on methodology for correct reliability indexes from a customer view point”

◆ The contents of the proposal

SAIDI and SAIFI are used by BPC to improve their system reliability but the data shows that the recording method is problematic. This is because the selection and recording of reliability data are too simple and are not reflecting the actual power outages and, as compared with the electric power companies of India or the countries in Southeast Asia, BPC's index value is too good. From this point of view, modifications to the recording methods were proposed to record and report the number of all customers interrupted,

interruption duration, and recovery processes, which are needed to calculate SAIDI/SAIFI.

After the calculation of the reliability data based on the proposed method, BPC will set the targets of SAIDI and SAIFI.

The target is to start the collection of necessary data using a new format from all ESDs and to connect the Sap/ERP system by January 2014.

(d) Theme #4 “To identify real technical losses”

The contents of the proposal

This team aimed to establish a calculation method for technical losses in order to grasp the amount of the losses of the distribution facilities and to set a proper loss target for each ESD. Therefore, they studied the calculation method of the technical losses by collecting actual facilities’ information of a pilot feeder (Minjey Feeder) at a pilot site (Lhuentse ESD). As a result, they made feeder models, which were suitable for the actual situation of the facilities, and could establish the calculation method for technical losses with certain accuracy. Furthermore, the proposed calculation method was approved by the MD.

The target is to finish the loss calculation for all ESDs by the end of 2013.

(e) Theme #5 “Improvement of billing and collection system in rural area”

◆ The contents of the proposal

Based on the field survey results, it became clear numerically that customers are facing problems in making payments despite the small amount of payment, and the cost of metering, billing and collection by multi task staff in BPC is high. Therefore, the team proposed sending SMS or E-mails for metering & billing, and direct debit from the bank for collection as the best and most feasible option.

◆ Comments and issues in the future

The BPC management commented that the team needs to study the security of sending SMS or E-mails, and the other options (e.g. Advance Payment: Three months prepaid etc.).

The team is studied at the second PI activity continuously.

**(2) Support for creating a proposal of the 2<sup>nd</sup> pilot project**

The final presentation for proposing the pilot project was carried out on September 25, 2013. Each team proposed the pilot project to BPC board members, including the MD, and all teams basically got approval for the implementation of pilot projects.

(a) Theme #6a “Study on existing manpower and management of existing facilities under DCSD”

◆ The contents of the proposal

For the management efficiency of BPC, the team members carried out the improvement of the internal entry sheet, the suitable staff number analysis of the technician level in BPC, the suitable amount of facilities and cost analysis of ESD, and a benchmarking. Moreover, they made proposal about the new internal entry sheet, the method of the suitable amount of facilities and cost analysis, and the suitable number of vehicles.

The target is to reflect the proposal in the HR master plan in 2014.

(b) Theme #6b “Effectiveness of existing Service Centers”

◆ The contents of the proposal

The team members carried out the analysis for the suitable number of service center staff from the viewpoints of the work volume, customer satisfaction and cost. They made proposal about the installation standard of a service center, the multitasking staff's work content and the monitoring procedures of the multitasking staff's work.

The target is to set the standard of a service center by April 2014.

(c) Theme #7 “Study on metering, billing, collection procedures, process and technologies and prepare a road map for implementation including cost benefit analysis”

◆ The contents of the proposal

The team members carried out the improvements in metering, billing and collection of electricity fees. They proposed the use of SMS at Thimphu, installation of AMR for MV and HV customers, and every three months metering for rural area customers.

The target is to finish the preparation of the pilot project at Tsirang ESD by July 2014.

(d) Theme #8 “Fault Locating and Rectification of Arial Bundle Conductor (ABC) and Under Ground (UG) cables”

◆ The contents of the proposal

The team members carried out the study of the fault locating method for an insulated cable and an underground cable because it is difficult to find an accident point. It focused especially on the underground cable. They verified the validity of T2LUPIN based on the actual fault locating at Thimphu, compared T2LUPIN and Megger's equipment, and finally proposed the adoption of T2LUPIN.

The target is to purchase the necessary equipment for underground cable fault locating by March 2014.

(e) Theme #9 “Effective utilization of GIS in DCSD”

◆ The contents of the proposal

Although BPC has already had the GIS software, they cannot do facility management using GIS appropriately. The team members carried out a fact-finding study about the current disadvantages and advantages of GIS, and proposed the effective use method of GIS and the road map for installing the GIS.

The target is to finish the preparation of the GIS database system by May 2015.

(f) Theme #10 “Study on sustainability and effective usage of existing Mini/Micro Hydels of BPC”

◆ The contents of the proposal

The team members analyzed operation cost, maintenance cost, and the benefit of power plants. While analyzing the net cost and benefit of all power plants, they also carried out a cost benefit analysis for each plant (Mini Hydels:10, Micro Hydels:8). In conclusion, for Mini-hydro power plants except those under maintenance, they showed that there was merit in continuing operation because the revenue has exceeded expenses. Moreover, for Micro-hydro power plants, they showed that there was merit in connecting to the power grid and proposed the grid connection.

The target is that some Micro-hydro will connect to the system grid by December 2014.

(g) Theme #11 “Study of the Distribution Transformer (DT) metering in BPC”

◆ The contents of the proposal

There is concern regarding whether the numerical value of the loss and reliability indexes, which has been announced by BPC, differs from the actual condition, and exact data collection is needed on DT level. The team members plan to carry out a pilot project to grasp the cost and effect correctly, and prepare the road map to install DT meters in the whole system in Bhutan.

#### 4.4.3. Support for implementation of monitoring progress

The TA Team monitored the progress of the implementation of the pilot projects carried out by ESDs with the DCSD (HQ), and carried out the necessary technical assistance. The contents of monitoring for each pilot project are shown in the follows.

#### (1) Progress of implementation of the 1<sup>st</sup> pilot project

(a) Theme #1 “Protection coordination”

◆ Progress of the pilot project implementation

The project team for protection coordination was established under the O&M Division. The total number of members in the project team is 12; one is a project leader in DCSD, two members cover the east area, four members cover the west area, two members cover the south area and two members cover the center area. The protection & control system training was conducted 4 times. The protection coordination is under enforcement in each ESD.

The main target was almost achieved.





**Figure 4-3 Image of Theme #1 Pilot Project**

(b) Theme #2 “Standard installation of fault location”

◆ Progress of the pilot project implementation

Four ARCBs and three FIs were installed in the 33 kV line of Wangdue ESD. ARCBs tripped 26 times and FI operated one time. The data collection will be continued. BPC plans to prepare a guideline and a standard and shall be included Distribution Design and Construction Standard in the end of 2014.

The main target was almost achieved; the next target is to prepare a guideline and a standard and be include DDCS.



**Figure 4-4 Image of Theme #2 Pilot Project**

(c) Theme #3 “Calculation on methodology for correct reliability indexes from customer view point”

◆ Progress of the pilot project implementation

The project team compared the old calculation method with new calculation method in Samtse ESD and Dagana ESD. The cooperation of the collected data based on a new calculation method and Sap/ERP has been started by all ESDs from January 2014. They are setting the SAIFI and SAIDI targets based on the new calculation method and they plan to set the benchmark after collecting all ESDs’ data by the end of FY2014.

The main target was almost achieved; the next target is to set the benchmark.

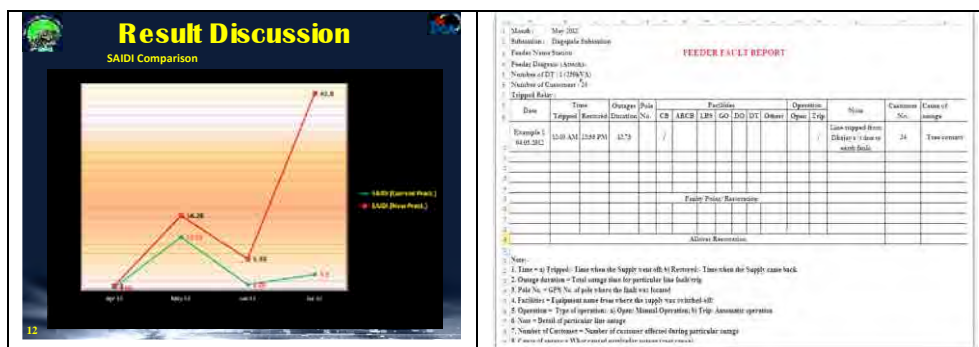


Figure 4-5 Image of Theme #3 Pilot Project

(d) Theme #4 “To identify real technical loss”

◆ Progress of the pilot project implementation

The project team calculated the technical loss of all ESDs except Thimphu ESD using the proposed technical loss calculation method (Numerical Calculation Method (NCM)). They have checked the accuracy of the NCM and confirmed the NCM effectiveness. Based on the calculation result in 2013, the loss target in the 2014 fiscal year was set. The target of each year is set based on the NCM, MiPower and PSS adapt. The main target was almost achieved except for the Thimphu ESD technical loss calculation.

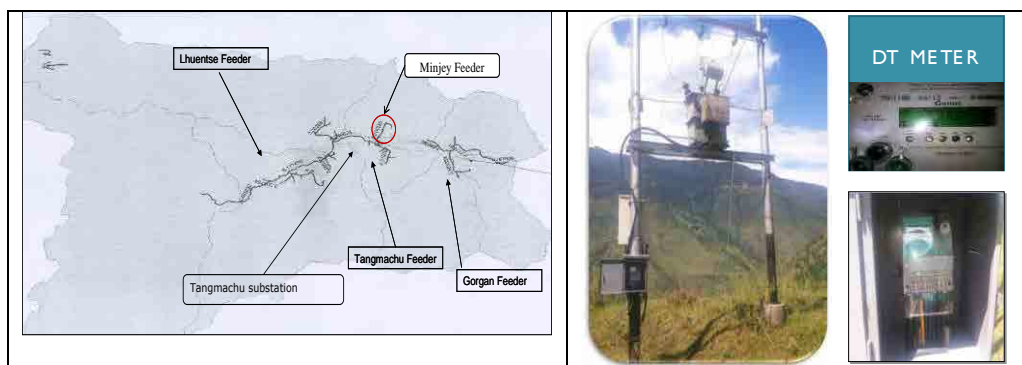


Figure 4-6 Image of Theme #4 Pilot Project

(e) Theme #5 “Improvement of billing and collection system in rural area”

◆ Progress of the pilot project implementation

The project team has obtained approval from the executives about SMS meter reading & billing system and Direct Debit payment, and is setting up the system for the pilot project in Thimphu ESD, which is to start in October (SMS meter reading) and in September (Direct Debit payment )2014.

The main target was almost achieved; the next target is the lateral spread to the whole of Bhutan after analyzing the effect of this pilot project.

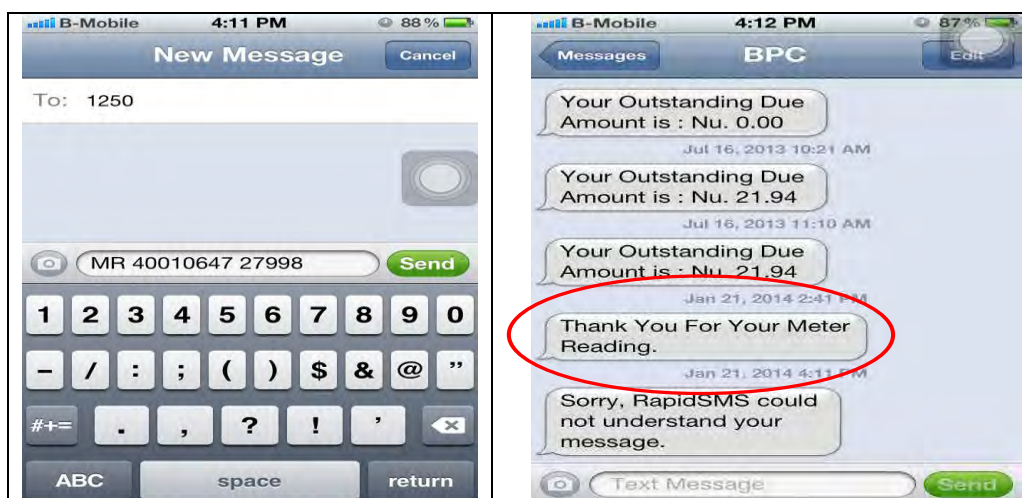


Figure 4-7 Image of Theme #5 Pilot Project

(2) Progress of implementation of the 2<sup>nd</sup> pilot project

(a) Theme #6a “Study on existing manpower and management of existing facilities under DCSD”

◆ Progress of the pilot project implementation

The contents of the proposal have approved by GM, DCSD and adopted all ESD.

The main target was almost achieved; the next target is to improve system every year according to ESD opinion.

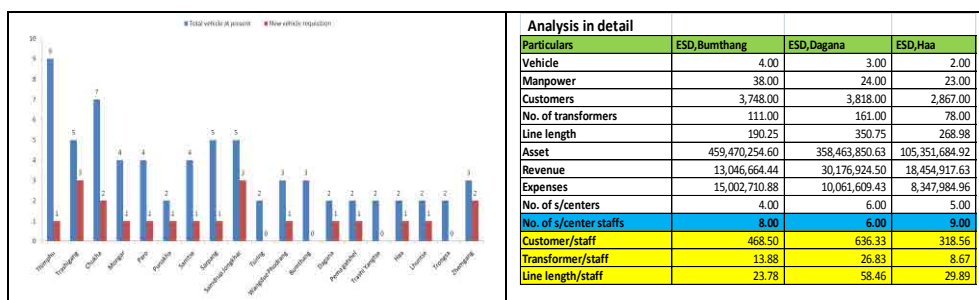


Figure 4-8 Image of Theme #6a Pilot Project

(b) Theme #6b “Effectiveness of existing Service Centers”

◆ Progress of the pilot project implementation

The project team has proposed to GM, DCSD in November 2013, and plans to discuss with each ESD from now on. They made a logbook and finished the pilot project in Thimphu ESD. They plan to install the logbook in all ESDs and prepare the TOR for

establishment of SC in September 2014 and the standard for establishment of SC in September 2014.

The main target was almost achieved; the next target is to prepare the TOR and clarify the policy of outsourcing of SC job to VEEET in coordination with O&M division.

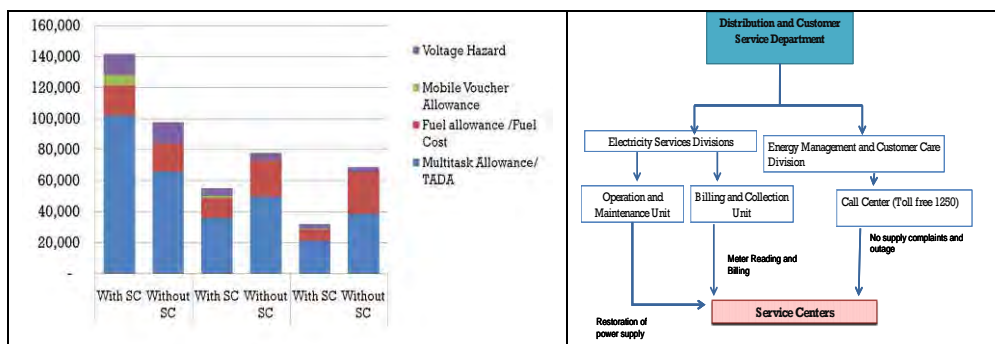


Figure 4-9 Image of Theme #6b Pilot Project

(c) Theme #7 “Study on metering, billing, collection procedures, process and technologies and prepare a road map for implementation including cost benefit analysis”

◆ Progress of the pilot project implementation

The project team has obtained approval from the executives about three monthly Billing idea. The Automatic Meter Reading for HV/MV & LT Bulk has obtained approval and installed in February 2014.

The main target was almost achieved; the next target is to obtain the approval from the executives about three monthly Billing and to prepare the lateral spread plan to the whole of Bhutan after analyzing the effect of this pilot project.

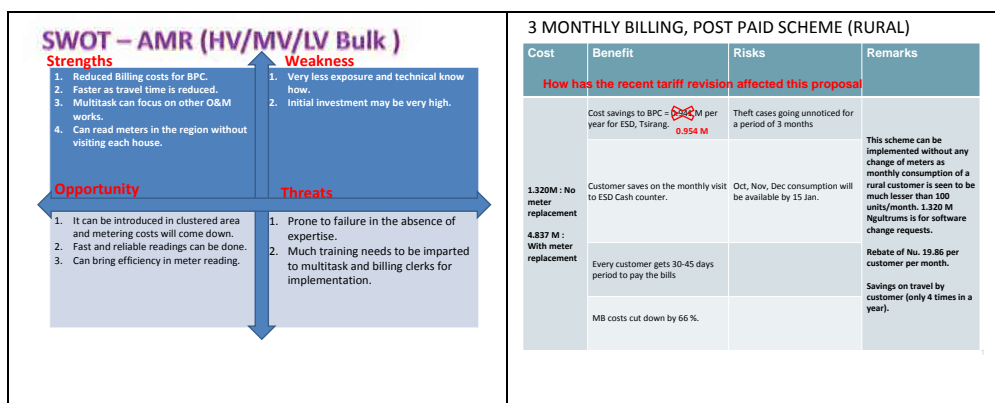


Figure 4-10 Image of Theme #7 Pilot Project

(d) Theme #8 “Fault Locating and Rectification of Arial Bundle Conductor (ABC) and Under Ground (UG) cables”

◆ Progress of the pilot project implementation

For UG, the project team has bought a T2LUPIN and a HV Bridge and conducted T2LUPIN and HV Bridge training. They conducted fault locating at four points and plan to conduct the training again. And they also conducted cable jointing training. They plan to conduct ABC cable fault locating training using Megger's equipment at Popjika after monsoons season.

The main target was achieved; the next target is to study fault locating of ABC cable.



Figure 4-11 Image of Theme #8 Pilot Project

(e) Theme #9 “Effective utilization of GIS in DCSD”

◆ Progress of the pilot project implementation

The project team has obtained approval for the purchase of GIS system includes software, hardware and basic training from the executives. Six engineers have already finished the GIS training at PEA in Thailand. It is under procedure of purchase of GIS system.

The main target was almost achieved; the next step is to carry out the installing the GIS system and the training as per the schedule.

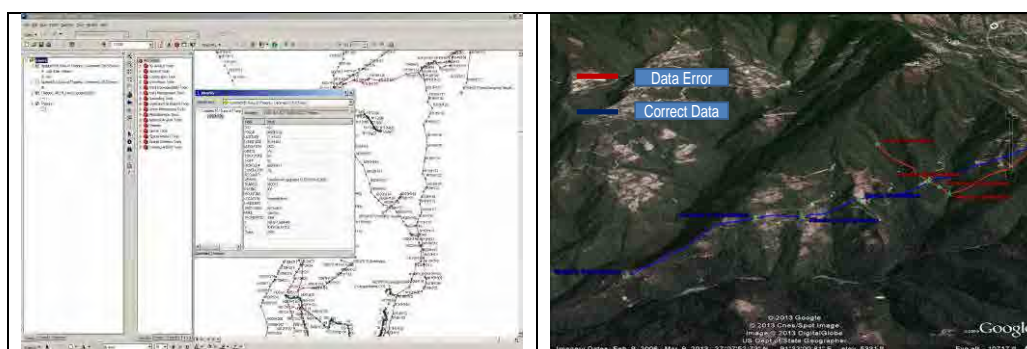


Figure 4-12 Image of Theme #9 Pilot Project

(f) Theme #10 “Study on sustainability and effective usage of existing Mini/Micro Hydels of BPC”

◆ Progress of the pilot project implementation

Based on the cost-benefit analysis result, the project team has obtained approval from the executives about the budget of repairing the damaged mini HPP and grid connection of the micro HPP. Khalanzi mini HPP is under repair. Ura, Rukubji, Tangsibji, Trongsa and Tamshing micro HPP are scheduled for grid connection by the end of 2014. In addition, since automation of Chenary, Gidakon, and Thimpu mini HPP is high-cost, it is taken as a future study. They plan to prepare the SOP and distribute to all hydropower plans by September 2014.

The main target was achieved; the next target is to prepare the SOP and distribute to all hydropower plans .



Figure 4-13 Image of Theme #10 Pilot Project

(g) Theme #11 “Study of Distribution Transformer (DT) metering in BPC”

◆ Progress of the pilot project implementation

The project team is preparing the pilot project at Paro ESD area. They are preparing bidding material by September and plan to buy the smart meters by November, install them by January 2015 and check the effect of the pilot project. They are cooperating with the smart grid team.

The main target was almost achieved. The next step is carrying out the plan as per the schedule.

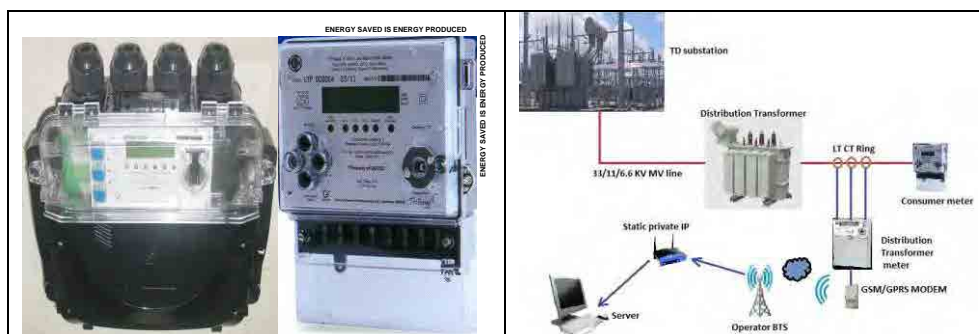


Figure 4-14 Image of Theme #11 Pilot Project

#### **4.5. Upgrading of the O&M Manual for Rural Electrification**

Management with an O&M Manual that includes basic operating procedures will be important for the Counterpart in order to keep up the voluntary enhancement of BPC's O&M ability for the Rural Electrification after this Project ends. From this perspective, the TA Team supported their upgrading of the O&M Manual for Rural Electrification via the following actions.

In reflecting the issues of PI Activities conducted simultaneously, the aforementioned Manual is modified or revised during this Project Period.

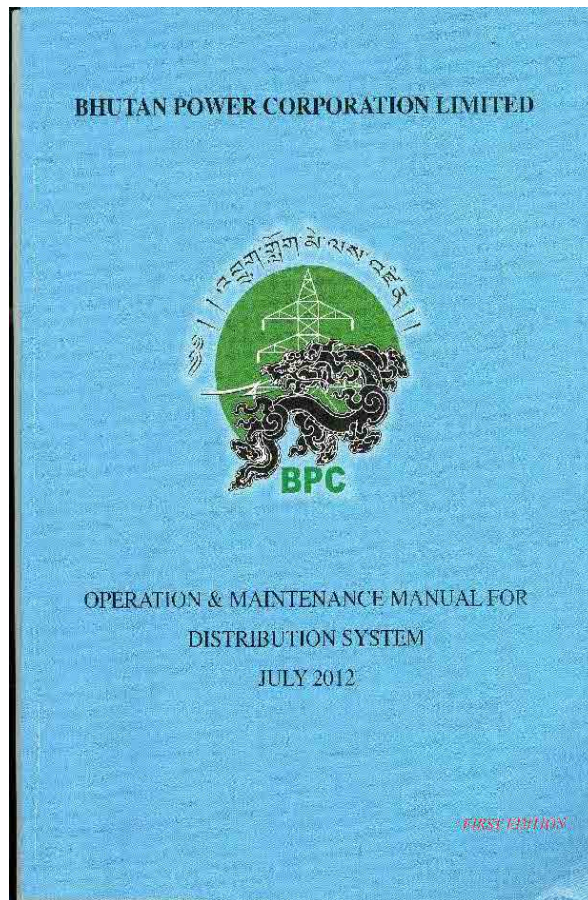
- Preparation for the Upgrading of the O&M Manual for Rural Electrification
- Support for the modification or revision of O&M Manual
- Support for the Diffusion Activities of O&M Manual

The compliance issues on BPC's work should be specified and ensured by its Manual, which promotes the improvement and standardization of work procedures, leading to the enhancement of BPC's Quality of Services. Thus, it is better for every Branch to have Manuals with the same contents and descriptions, though it is allowed to have a different one for a particular work only applied in a part of the area.

The TA Team provided some examples of establishing Manuals in Japan and technical support to the BPC Counterparts in order to effectively accelerate the revision of the O&M Manual targeting Rural Distribution Staff. The O&M manual was published on July 1, 2012, and was distributed to all ESDs.

In addition, the O&M manual has following contents.

- Operation of electric distribution system
- Maintenance of electric distribution system
- Safety guidelines with regard to operation and maintenance of distribution system
- Roles and responsibilities
- Inspection check list



**Figure 4-15 O&M Manual Cover**

The TA Team also provided technical support to the BPC Counterparts in order to establish a pocket size O&M manual targeting site distribution technicians such as linemen and multi-task staff. The concept of the pocket size O&M manual is portable size and clear understanding, and its content includes important items taken from the O&M manual. The pocket size O&M manual was published in March 2014 and distributed to the linemen and multi-task staff in April 2014.

The main target, which is to create an O&M manual and pocket size O&M manual, was achieved; and they have made periodically manual revise plan once two or three years. The next target is creating the limit sample and type sample.



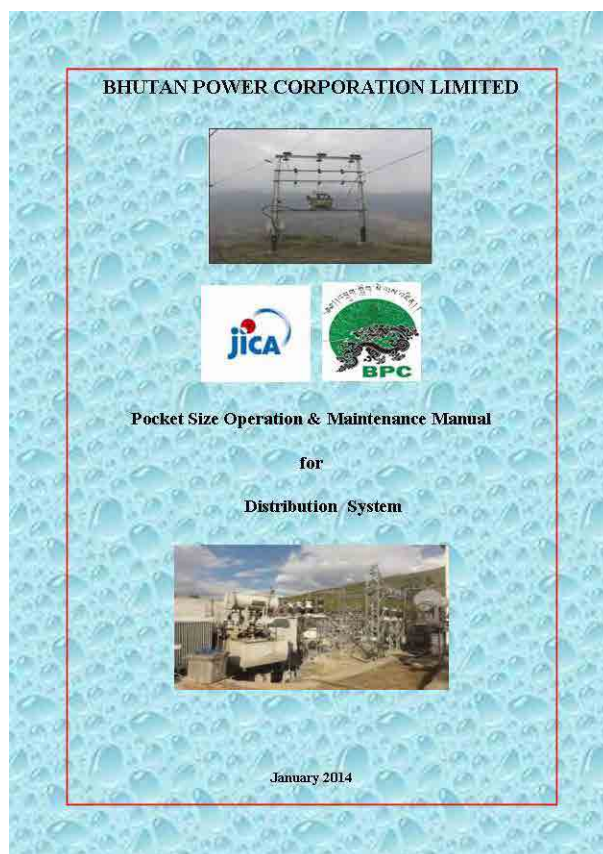


Figure 4-16 Pocket Size O&M Manual Cover

#### 4.6. Upgrading the training capacity of the BPC training center in the management of operations and maintenance of the rural power supply in the distribution field

As well as preparing the O&M manual, even after this project, in order that the counterpart and organizations concerned implement the improvement of management capacity in the operations and maintenance of rural power supply voluntarily and sustainably, it is important that basic training is upgraded and implemented for technical inheritance. From this viewpoint, through the following activities, the TA Team will strengthen the capacity of the BPC training center.

- Supporting preparation to improve the Begana training center by BPC
- Supporting implementation to improve the Begana training center

##### (1) Supporting preparation of the upgrade plan of CMTD, Begana by BPC

Begana training center is under DCSD and it is in the same group as the maintenance division. As a result, the maintenance facility of a distribution transformer is in the same building as the training center. In addition, there is no training facility with an electric pole,

a distribution transformer or other electric facilities to simulate a real situation and this is a problem for the current training center. As for the formulation of a concrete implementation plan for the improvement of the training center, the TA Team introduced cases such as the operation of a training center in a Japanese power company through workshops and supported the formulation of an improvement plan of the training center by the BPC DCSD. In particular, the TA Team provided information and support technology for the operations of the above training center needed to formulate the plans. For the organization issue, the proposal that the training center will be under the Human Resources and Administration Department was authorized by management. The detailed study will be continued under the next conditions. The maintenance facility for a distribution transformer will be moved outside of the training center and the place of the training center will be the same in the current Begana training center.

The most suitable plan as of January 2014 is dividing the transformer repair work of CMTD Begana into two for the purpose of reduction of the workload for the transformer repair work. Specifically, a transformer repair workshop is newly installed. CMTD Begana proposes a new system whereby the transformers of the east half are repaired at the newly installed workshop and the transformers of the west half are repaired at the present workshop in Begana.

For the training course, CMTD Begana has already been selected by analyzing the required work. The proposed training course is shown in Table 3-4. Although “Induction for new recruits”, “Refresher Courses” and “Customer care” have been performed from the former, standardization is planned. The others are courses which are planned to be newly established.

If the following courses are to be introduced, CMTD do not have adequate human resources to conduct specialized courses. Relevant experts must be sourced from our valued network at site and training of the trainers (ToT) courses should be imparted to these employees so that they develop an adequate skill set to effectively impart training.

DCSD in coordination with CMTD, and managers in ESDs should choose the right employees who can be used as resource persons. The selection process should be scrutinized properly as there are only very few skilled persons who can become good resource persons. The complete success of the proposal also rests with these people.

**Table 4-4 Proposed Training Course**

<b>General courses</b>		
1.	Induction for new recruits	three months, and three-month OJT
2.	Refresher Courses	2 week
<b>Specialized courses</b>		
3.	Safety	at least 1 week
4.	Meters	2-3 weeks
5.	Cable jointing	2-3 weeks
6.	Transformers	3-4 weeks
7.	Maintenance & troubleshooting of mini/micro power plants	2-3 weeks
8.	Basics on protection & control system	Basic training: 2 weeks
9.	Construction standards of overhead lines (ACSR, LV ABC, HV ABC), underground cabling, earthing, etc.	1-2 weeks
10.	Use of the equipment and tools at site	1-2 weeks
11.	Customer care	1 week

Based on the necessary requirements for the proposed training course, CMTD, Begana proposed the upgradation of Begana training center. The site area and the proposed layout of Begana training center is shown in Figure 3-16 and Figure 3-17.

CMTD, Begana has already proposed some of the necessary facilities and has already set up these facilities at Begana training center in FY 2012 and FY 2013.

The upgrade plan for CMTD, Begana including road map was prepared in January 2014 and proposed to the board members at the JCC meeting on 22nd of January 2014, but the project team did not get the approval for the plan.



Figure 4-17 Begana Training Center Site Area



Figure 4-18 Proposed Layout of Begana Training Center

(2) **Supporting the implementation of the upgrade plan of CMTD, Begana**

Some training facilities have been installed in the Begana training center by the end of 2013. The installed training facilities include the electric poles with a distribution transformer and the facilities for MV lines and LV lines. The special shortened electric poles which each trainee can reach from the ground have also been installed and they have been used for training for linemen and multi-task staff.

The TA team visited the Begana training center during site survey, and checked the progress of the upgrading, and monitored it periodically to ensure that this project proceeds smoothly and according to the circumstances and is supporting the technology required.

The road map for the upgrade plan of CMTD, Begana is shown in Table 3-4. CMTD, Begana plan to get the approval from the board of BPC for each item that can be proposed.

The main target, which is creating a proposal on the upgrade of CMTD, Begana, was achieved. Moreover, installation of required facilities is gradually but steadily carried out.

The next step is carrying out the plan as per the schedule.

**Table 4-5 Road map for Upgrade plan of CMTD, Begana**

Roadmap for upgradation of Central Maintenance and Training Division, Begana		2014												2015												2016	2017	2018
Year		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			
<b>A</b>	<b>Maintenance Unit</b>																											
1	Relocation of maintenance unit																											
a	Comprehensive study on relocation																											
b	Approval for relocation of maintenance unit																											
c	Relocation of maintenance unit																											
d	Recruiting and training new employees																											
e	Stabilizing office																											
2	Higher capacity transformer repair (5MVA)																											
a	Comprehensive study to increase repair of 5MVA and below transformers																											
b	Present finding to the management																											
c	Approval to increase capacity (up to 5MVA)																											
d	Finding good companies in the neighboring countries																											
e	OJT of employees at factory premises																											
f	Purchase of equipment																											
g	Purchase of tools																											
h	Repair of higher capacity transformers																											
3	Revised criteria for annual inspection																											
a	Comprehensive study on present criteria's and framing new criteria																											
b	Pilot project in one or two ESDs																											
c	Presenting the findings to management																											
d	Continuously develop future course of action																											
4	Technical Expertise Development																											
i	Develop direction for protection, metering & control system specialists after close consultation with GM DCSD																											
b	Invite Trainers to impart customized trainings																											
c	Select institute where they can have advance level training																											
d	continuously develop future course of action																											
ii	Develop direction for UG cable specialists after close consultation with GM DCSD																											
b	Develop proper terms of reference																											
c	Selection of employees for to form team																											
d	Invite trainers to impart customized trainings																											
e	Select institute where they can have advance level training																											
f	continuously develop future course of action																											
iii	Develop direction for Mini/Micro/DG/Mechanical specialists after close consultation with GM DCSD																											
b	Develop proper terms of reference																											
c	Selection of employees to form team																											
d	Invite trainers to impart customized trainings																											
e	Select institute where they can have advance level training																											
f	continuously develop future course of action																											
iv	Develop direction for developing overhead line and earthing specialists after close consultation with GM DCSD																											
b	Develop proper Terms of reference																											
c	Selection of employees to form team																											
d	Invite Trainers to impart customized trainings																											
e	Select institute where they can have advance level training																											
f	continuously develop future course of action																											

Technical Cooperation Project for Improvement of Efficiency for Rural Power Supply (Phase II)

Roadmap for upgradation of Central Maintenance and Training Division, Begana																								
Year	2014												2015	2016	2017	2018								
Details of upgradation activities	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<b>v</b>	Develop direction for developing Motor specialists after close consultation with GM DCSD																							
<b>a</b>	Develop proper terms of reference																							
<b>b</b>	Selection of employees for to form team																							
<b>c</b>	Select institute where they can have advance level training																							
<b>d</b>	Continuously develop future course of action																							
<b>f</b>																								
<b>B</b>	<b>Distribution Training Center</b>																							
<b>1</b>	<b>Policy Development</b>																							
<b>a</b>	Research on pros and cons of new policy after discussing with HRAD and DCSD training coordinator																							
<b>b</b>	Develop a draft policy																							
<b>c</b>	Present the draft policy to the management																							
<b>d</b>	Approval of the policy																							
<b>e</b>	Implementation of policy																							
<b>2</b>	Following standard course development after close consultation with field staffs, O&M manager HQ and HRAD.																							
<b>a</b>	Induction for new recruits																							
<b>b</b>	Refresher courses																							
<b>c</b>	Safety																							
<b>d</b>	Meters																							
<b>e</b>	Cable jointing																							
<b>f</b>	Transformers																							
<b>g</b>	Basics on protection & control system																							
<b>h</b>	Construction standards of overhead lines (ACSR, LV ABC, HV ABC), underground cabling, earthing, etc.																							
<b>i</b>	Use of the equipments and tools at site																							
<b>j</b>	Continuous development of courses as per the field requirement																							
<b>3</b>	<b>Human resource development</b>																							
<b>a</b>	Develop a proposal for in-house resource person development																							
<b>b</b>	Selection of employees from field after close consultation with competent higher authorities																							
<b>c</b>	Develop terms of reference for the resource persons																							
<b>d</b>	Impart adequate trainings in-country and ex-country (ToT)																							
<b>e</b>	Continuously develop future direction for the resource persons																							
<b>4</b>	<b>Infrastructure-Training Facility</b>																							
<b>a</b>	UG cables training field																							
<b>b</b>	Overhead cables (HVABC, AAAC)																							
<b>c</b>	Protection system																							
<b>d</b>	SHP training field development																							
<b>5</b>	<b>Infrastructure-Others</b>																							
<b>a</b>	Construction of G+2 classroom cum hostel																							
<b>b</b>	Development of gym facilities																							
<b>c</b>	Procurement of outdoor games equipment																							
<b>6</b>	<b>Tools and Equipment</b>																							
<b>a</b>	UG cable fault locator																							
<b>b</b>	ABC cable fault locator																							
	Spot billing equipment with laser printer																							





## **Chapter 5 Project Performance and Achievements**

### **5.1. Enhancement of capacity to handle areas identified under PI activities**

#### **(1) Current Status of C/Ps and Other Target Groups**

- PI activities members conducted PI activities such as problem analysis, planning, project proposals and monitoring for effectiveness confirmation through pilot projects by themselves.
- The TA Team worked with BPC to grasp and analyze the present situation in consideration of the organizational and technical aspects at each stage. Since the tasks were primarily conducted on-site in Bhutan, the opportunity for technology transfer and overall human resource development was deemed important.
- The TA Team conducted coaching so that the 1<sup>st</sup> batch of pilot project members could follow the 2<sup>nd</sup> batch of pilot project members' instructions.
- The leaders of PI activities have experience of conducting the PI activity and the pilot project; therefore, they have sufficient ability to conduct the PI activity and the pilot project by BPC.
- In the workshops, the opportunity to carry out the presentation to BPC counterparts was prepared, and participants strove for capability improvements considered on their own, leading to the PI activities. As a result, the problem-solving capability of the counterparts has improved, and has reached a level where they can propose solutions on their own.

#### **(2) Achievement Indicators**

##### **(a) Total number of participants in PI activity**

The number which participated in twelve themes, through two PI activities and pilot projects, is shown in Table 5-1.

**Table 5-1 Total number of participants in PI activities**

Term	Team No.	Leader	Members	Advisors	Total
1st	1	1	3	1	5
	2	1	3	1	5
	3	1	3	0	4
	4	1	5	0	6
	5	1	5	0	6
2nd	6a	1	3	1	5
	6b	1	2	1	4
	7	1	4	1	6
	8	1	3	1	5
	9	1	4	1	6
	10	1	2	1	4
	11	1	4	2	7
Total	-	12	41	10	63

(b) Total number of participants in PI Activities Presentations and Workshops

Nine PI activities presentations, including the final presentation, and seven workshops were held. The number of participants is shown in Table 5-2. The total number of participants is 512.

**Table 5-2 Total number of participants in PI Activities Presentations and Workshops**

	No.	Date	BPC	JICA	TA Team	Total
PI Activities Presentation	1	2012/5/16	32	1	6	39
	2	2012/7/17	16	1	6	23
	3	2012/9/11	23	1	6	30
	4	2013/2/4	11	1	5	17
	5	2013/5/13	30	1	6	37
	6	2013/7/22	31	1	2	34
	7	2013/9/25	34	3	6	43
	8	2014/1/22	23	3	5	31
	9	2014/5/20	17	1	5	23
	Total			217	13	47
Workshop	1	2012/5/15	32	1	6	39
	2	2012/7/16	36	1	6	43
	3	2013/2/6	47	1	5	53
	4	2013/5/14	25	1	6	32
	5	2013/7/18	20	1	2	23
	6	2014/5/20	17	1	5	23
	7	2014/7/15	15	1	6	22
	Total			192	7	36
Total	-	-	409	20	83	512

## **5.2. Upgrading of the O&M Manual for Rural Electrification**

### **(1) Current Status of C/Ps and Other Target Groups**

- The project team prepared and proposed the O&M manual and pocket size O&M manual by themselves.
- The TA Team provided some examples of establishing Manuals in Japan and technical support to the BPC Counterparts in order to effectively accelerate the revision of the O&M Manual targeting Rural Distribution Staff. Therefore, the project team has learned the technical requirements necessary for the operation and maintenance.
- In the PI progress presentation meeting, they provided the necessary information about the O&M manual to the PI activity leader and discussed it with them. Therefore, they have reached a level where they can propose solutions on their own.
- All ESDs have received the O&M manual and pocket size O&M manual. The project team provided the necessary assistance in order to understand these manuals' role. Therefore, they have sufficient ability to conduct the proper operation and maintenance at site by BPC.

### **(2) Achievement Indicators**

#### **(a) Distribution number of O&M manual and pocket size O&M manual**

The O&M manual was published on July 1, 2012, and was distributed to all ESDs at a Progress Review Meeting from 30<sup>th</sup> of July to 31<sup>st</sup> of July, 2014. The pocket size O&M manual was published in March 2014 and distributed to the linemen and multi-task staff in April 2014. The distribution numbers and distribution list are shown in Table5-3.

**Table 5-3 Distribution numbers of O&M manual and pocket size O&M manual**

HQ,ESD	O&M Manual	Pocket Size O&M Manual
DCSD, HQ	30	35
UED	0	10
CMTD, Begana	10	11
ESD/RCO, Thimphu	10	126
ESD, Trongsa	10	22
ESD, Wangdue	10	40
ESD, Bumthang	10	26
ESD, Punakha	10	34
ESD, Samdrupjongkhar	10	41
ESD, Pemagatshel	10	23
ESD, Trashiyangtse	10	26
ESD, Paro	10	40
ESD, Haa	10	18
ESD, Zhemgang	10	19
ESD, Samtse	10	55
ESD, Mongar	10	36
ESD, Trashigang	10	63
ESD, Tsirang	10	35
ESD, Lhuentse	10	23
ESD, Dagana	10	18
ESD, Gelephu	10	49
ESD, Phuentsholing	10	82
VEEET	0	120
other	20	48
Total	250	1,000

(b) Introduction training for O&M manual

The project team held the following workshops for introduction for O&M.

**Table 5-4 Introduction training for O&M manual**

Manual	Date	Target
O&M Manual	2012/7/24	All ESDs' O&M in charge
O&M Manual	2012/7/30-2012/7/31	All ESD managers
Pocket Size O&M Manual	2014/2/5-2014/2/7	All ESD managers

(c) Training using O&M manual

The project team held the following training for introduction for O&M.

**Table 5-5 Training using O&M manual**

Manual	Date	Courses
O&M Manual	2012/7/21	Refresher training course
O&M Manual	2012/7/29	Refresher training course
O&M Manual	2012/8/4	Refresher training course
O&M Manual	2012/8/11	Refresher training course
O&M Manual	2012/8/18	Refresher training course
O&M Manual	2012/8/25	Refresher training course
O&M Manual	2012/9/1	Refresher training course
O&M Manual	2012/9/5	Refresher training course
Pocket Size O&M Manual	2014/3	Refresher training course
Pocket Size O&M Manual	2014/5	VEEET training

### 5.3. Upgrading the training capacity of the BPC training center in the management of operations and maintenance of the rural power supply in the distribution field

#### (1) Current Status of C/Ps and Other Target Groups

- The project team prepared and proposed the upgrade plan of CMTD, Begana including road map by themselves.
- The upgrade plan of CMTD, Begana including road map technique was guided through the meetings with the counterparts, the two workshops and ten PI progress presentation meetings. Therefore, they have learned the necessary technical requirements for upgrading the training capacity of the BPC training center.
- The BPC installed the necessary facilities for proper training on a parallel with preparing the upgrade plan of CMTD, Begana. Therefore, they have sufficient ability to conduct the proper upgrading of CMTD, Begana as per the schedule.









#### (2) Achievement Indicators

##### (a) Installed Facilities

The upgrade plan of CMTD, Begana including road map was prepared in January 2014 and proposed to the board members at the JCC meeting on 22nd of January 2014, but the project team did not get approval for the plan. The BPC installed the necessary facilities for proper

training on a parallel with preparing the upgrade plan of CMTD, Begana. The installed facilities are shown in Table 5-6.

**Table 5-6 Proposed Training Course**

Facility	Double pole structures	OH lines composite lines	OH lines composite lines at ground level
Quantity	5	2	1
Photo			
Facility	Pole mounted transformer	Platform mounted transformer	OH line with single pole structure
Quantity	1	1	2
Photo			
Facility	3ph LV ABC composite lines	1ph LV ABC composite lines	
Quantity	1	1	
Photo			

The upgrading situation, before and after, of CMTD, Begana is shown in Figure 5-1. The recreation facilities, such as basketball court and accommodation facility, under construction can be confirmed. In addition, the training area situation is shown in Figure5-2.



**Figure 5-1 Bird's-eye View of CMTD Begana (left: end of 2012 right: December 2013)  
(Google earth)**



**Figure 5-2 Training area of CMTD Begana (left: May 2012 right: May 2014)**

(b) Progress of the Roadmap

The progress of the roadmap is shown in Table 5-7. The yellow bar shows planned activities, the black bar shows the accomplished activities and the green bar shows the ongoing activities.

Table 5-7 Progress of the Roadmap

Year	2014												2015												2016	2017	2018
Details of upgradation activities	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D			
<b>A Maintenance Unit</b>																											
<b>1 Relocation of maintenance</b>																											
a Comprehensive study on																											
b Approval for relocation of maintenance unit																											
c Relocation of maintenance unit																											
d Recruiting and training new employees																											
e Stabilizing office																											
<b>2 Higher capacity transformer repair (5MVA)</b>																											
a Comprehensive study to increase repair of 5MVA and below transformers																											
b Present finding to the																											
c Approval to increase capacity (up to 5MVA)																											
d Finding good companies in the neighboring countries																											
e OJT of employees at factory premises																											
f Purchase of equipment																											
g Purchase of tools																											
h Repair of higher capacity transformers																											
<b>3 Revised criteria for annual inspection</b>																											
a Comprehensive study on present criteria's and framing																											
b Pilot project in one or two																											
c Presenting the findings to management																											
d Continuously develop future course of action																											
<b>4 Technical Expertise Development</b>																											
a Develop direction for protection, metering & control system specialists after close consultation with																											
b Invite Trainers to impart customized trainings																											
c Select institute where they can have advance level training																											
d continuously develop future course of action																											



Technical Cooperation Project for Improvement of Efficiency for Rural Power Supply (Phase II)

Year		2014												2015												2016	2017	2018	
Details of upgradation activities		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D				
ii	a																												
	b																												
	c																												
	d																												
	e																												
	f																												
iii	a																												
	b																												
	c																												
	d																												
	e																												
	f																												
iv	a																												
	b																												
	c																												
	d																												
	e																												
	f																												

Technical Cooperation Project for Improvement of Efficiency for Rural Power Supply (Phase II)

Year		2014												2015												2016	2017	2018	
Details of upgradation activities		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D				
v	a																												
	b																												
	c																												
	d																												
	f																												
<b>B</b>	<b>Distribution Training</b>																												
<b>1</b>	<b>Policy Development</b>																												
a	Research on pros and cons of new policy after discussing with HRAD and DCSD training coordinator																												
b	Develop a draft policy																												
c	Present the draft policy to the management																												
d	Approval of the policy																												
e	Implementation of policy																												
<b>2</b>	<b>Following standard course development after close consultation with field staffs, O&amp;M manager HQ and HRAD.</b>																												
a	Induction for new recruits																												
b	Refresher courses																												
c	Safety																												
d	Meters																												
e	Cable jointing																												
f	Transformers																												
g	Basics on protection & control system																												
h	Construction standards of overhead lines (ACSR, LV ABC, HV ABC), underground cabling.																												
i	Use of the equipments and tools at site																												
j	Continuous development of courses as per the field requirement																												

Year	2014												2015												2016	2017	2018
Details of upgradation activities	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D			
<b>3 Human resource development</b>																											
a Develop a proposal for in-house resource person																											
b Selection of employees from field after close consultation with competent higher																											
c Develop terms of reference for the resource persons																											
d Impart adequate trainings in-country and ex-country																											
e Continuously develop future direction for the resource																											
<b>4 Infrastructure-Training Facility</b>																											
a UG cables training field																											
b Overhead cables (HVABC, AAAC)																											
c Protection system																											
d SHP training field																											
<b>5 Infrastructure-Others</b>																											
a Construction of G+2 classroom cum hostel																											
b Developemnt of gym																											
c Procurement of outdoor games equipment																											
<b>6 Tools and Equipment</b>																											
Spot billing equipment with lazer printer																											

#### 5.4. Project Performance and Achievements based on PDM Indicators

The project performance and achievements based on PDM indicators are shown in Appendix 8. All outputs were almost achieved based on PDM indicators.

The pilot projects are underway, because they are tackling the new PI activities as the routine work.

About output 3 “Training capacity of CMTD, Begana is upgraded”, the upgradation of CMTD, Begana, currently underway, is not completed because the budget of BPC has restrictions; it is difficult to carry out all the plans at once. Therefore, they did not finish submitting the completion report; instead of the completion report, they have submitted the upgrade plan of CMTD, Begana including road map and installed facilities gradually every year, and the upgrading is promoted steadily.

From the above-mentioned point, it can be said that output 3, “Training capacity of CMTD, Begana is upgraded”, was achieved.

## 5.5. Public Relations activities in Bhutan

The training for T2LUPIN, which was proposed by the PI team and adopted in the project, was broadcast by the national broadcaster of Bhutan. Moreover, this project's activity was reported on by "KUENSEL", which is the main paper of Bhutan.

# HOME

PAGE 8 KUENSEL | Friday, July 04, 2014

## Japanese assistance in rural electrification and power service delivery

Tashi Dema

Dagana residents were frustrated when the usual erratic power supply caused a total blackout on the night of June 30, depriving the residents of their opportunity to watch a World Cup match.

**JICA**

While many called Bhutan Power corporation officials,

complaining of the blackout, some even chose to pour out their frustrations on social websites, calling the BPC officials and their service useless. The problem, BPC officials in Thimphu said, was caused, as the 33KV line that transmits electricity from Dajuy in Thering to Dagana has to go through rough terrain and thick jungle.

BPC's general manager for distribution and customer



Linesmen tries to locate fault (Photo: Xuri Orui, JICA expert)

### Fuel Prices

(IN NU)

Dzongkhag	Diesel	Petrol	Kerosene	LPG
Thimphu(DECL)	57.87	70.03	14.94	508
PLang(Darachen)	57.6	68.01	13.86	456

Prices as of yesterday

KEEP THIMPHU CLEAN AND GREEN

**NOTIFICATION**

**THIMPHU THROMDE**  
Post Box No. - 215  
Thimphu - 11001: Bhutan  
TTCSD/Re-4402/14-2013/7061

This is to notify the general public that, we have been accepting the private cheque payment in order to maintain zero cash transactions in the office. However, the clients paying through cheques have not been sincere while issuing cheques. There has been an instance of Ngultrum five million worth dishonoured cheques in the office, which has created lots of inconvenience.

Therefore, we would like to request the general public to avoid issuing dishonoured cheques and if found, the matter shall be dealt as per the **Negotiable Instrument Act 2002 section, XVI Para 131**. Further, we would like to remind the defaulters of land tax and other charges that, the outstanding taxes have already been noted by the Royal Audit Authority and the defaults of taxes for three consecutive years will be dealt as per the **Land Act 2007 Section 226** (to be sent for annulment of thram to National Land Commission Secretariat).

Therefore, in order to avoid action as per rules in vogue, all concerned are requested to pay their taxes on time and at the earliest.

Thrompon

KEEP THIMPHU CLEAN AND GREEN

service department, Norbu Tshering, said the lines got snapped because of falling trees and landslides.

"This is the main challenge BPC faces in power supply delivery," he said.

Norbu Tshering said that, to avoid such power blackout in future, BPC is already cleaning the right of way.

But the problem, BPC officials said, is expected to solve once they replicate the guidelines framed to improve power supply delivery with Japan International Cooperation Agency (JICA) support.

Through the USD 1.8M technical cooperation project, which is in its second phase, BPC officials are finding out the usage of auto reclose circuit breaker (ARCB) to ensure that problems caused from tagged power lines do not cause problems along the main line.

ARCB is a circuit breaker equipped with a mechanism that can automatically close the breaker after it has been opened to a default. The device is used on overhead distribution systems to detect and interrupt momentary faults.

Tshering Norbu said that they are doing a pilot project along the power distribution line from Wangduephodrang to Gogona to study a methodology for optimum usage of ARCB. "We'll find out what is the optimum length needed for ARCB and place the device accordingly," he said.

He also said BPC is installing fault lines through the project, which will make it easy for linesman to detect where the problem is.

A JICA expert, Xuri Orui, working with BPC, said, in the first phase of the project, they prioritised meter reading,

where they focused on smart message service (SMS) as it cut down cost for BPC, as villagers could read the meters and send SMS to officials.

She also said JICA helped rural electrification in Bhutan, by not only framing the master plan, but also in electrifying 15,712 households in 2007 to 2011, and 3,549 houses till date from 2011, through loan.

Xuri Orui also said JICA and BPC prepared the operations and management manual for linesmen, who take care of distribution system in rural areas.

"This manual is a pocket-sized, portable and waterproof laminated for linesmen, who have to work even in the rain and snow," she said. "The manual is simplified with pictures so that linesmen in the field can easily understand it."

### FLIGHTS

**DRUKAIR**

Date	Route	Flight No.	Departure	Arrival
July 5	Bangkok to Paro via Bangkok	KB 131	05:50 am	10:00 am
July 5	Paro to Bangkok via Bangkok	KB 130	11:00 am	04:00 pm
July 5	Paro to Delhi via Kathmandu	KB 204	08:00 am	10:45 am
July 5	Delhi to Paro via Kathmandu	KB 205	11:45 am	03:35 pm
July 5	Paro to Singapore via Kolkata	KB 500	07:20 am	03:35 pm

Note: All timings in local. Timings are subject to change. Call Drukair toll free No. 1900 for latest flight information.

**BHUTAN AIRLINES (TASHI AIR)**

July 5	Bangkok to Paro via Kolkata	B3-701	06:30 am	09:45 am
July 5	Paro to Bangkok via Kolkata	B3-700	10:35 am	03:50 pm

Figure 5-3 Article from KUENSEL about this Project.

## **Chapter 6 Conclusion and Recommendations**

The main target of this project is to enhance the efficiency of rural power supply. Therefore the TA Team tackled the necessary assistance for BPC's capacity building on organizational and technical improvement in order to enhance the efficiency of rural power supply.

The BPC counterparts have acquired the method of PI activities, proposed the pilot projects and conducted the pilot projects. Moreover, the BPC counterparts prepared an O&M manual and pocket size O&M manual, and distributed them to all ESDs and conducted training. In addition, the BPC counterparts have prepared the upgrade plan of CMTD, Begana including road map and installed the necessary facilities for proper training.

The TA Team expects that the output of this project will be reflected into the enhancement of the efficiency of rural power supply and capacity building on organizational and technical improvement.

### **6.1. Enhancement of capacity to handle areas identified under PI activities**

PI activities members conducted PI activities such as problem analysis, planning, project proposals and monitoring for effectiveness confirmation through pilot projects by themselves. In the workshops, they had the opportunity to carry out the presentation to BPC board members. The problem-solving capability of the counterparts has improved, and has reached a level where they can propose solutions on their own. Moreover, they have learned other countries' technology and new technology through the counterpart training in Japan and the third country survey. The TA Team proposes the issue solving activities system in BPC, such as PI activities, in order to solve the problems in BPC using this project experience.

### **6.2. Upgrading of the O&M Manual for Rural Electrification**

The O&M manual summarizes the operation and maintenance management method of facilities and is an item with which O&M staff can conduct operation and maintenance work at the ESD area. The TA Team advised that the counterpart make this manual easier to use by showing the criteria or indications. Moreover, the pocket size O&M manual, which can be carried in a person's pocket, adopted visual information, including charts and tables, as much as possible, and is considered easy-to-use.

The manual needs to be revised suitably, in order to reflect the facility trend, and new technology and know-how. The TA Team proposes that the BPC itself will create a revision system for the manuals and any necessary new manuals.

### **6.3. Upgrading the training capacity of the BPC training center in the management of operations and maintenance of the rural power supply in the distribution field**

The role of the upgrade plan of CMTD, Begana including road map is the following. One is the policy of the future training center in order that the counterpart and organizations concerned implement the improvement of management capacity in the operations and maintenance of rural power supply voluntarily and sustainably; another is the policy of the future transformer repair factory in order to repair the transformer efficiently.

They proposed the necessary training courses, personnel, facilities and optimal arrangement of the transformer repair factory. Since the budget of BPC has restrictions, it is difficult to carry out all the plans at once. Therefore, they proposed the gradual installation of facilities every year, and upgrading is promoted steadily. The PI team expects that the plan will continue to progress steadily according to the road map.

On the other hand, Druk Holding requested the study for business separation of mini/micro hydro power plants from BPC, so BPC needs to reach a conclusion from now on. Since the CMTD, Begana is also performing mini/micro hydro power plant repair work, the TA Team proposes conducting a cost-benefit analysis and performing the optimal proposal.

### **6.4. Lessons Learned from the project management**

PI activity is essentially a process in which middle management identifies an issue that exists in its office, plans the solution based on some analysis, and implements the solution after obtaining the management's approval. Consequently, PI activity should be carried out by middle management as part of its routine work in the workplace.

#### **(1) Validity of inputs**

One long-term expert and six short-term experts have carried out this project. While the long-term expert resided in BPC, which is a counterpart of this project, and had communication with BPC for the whole period, the short-term experts visited BPC for about two weeks every two months.

The process of the PI activity is shown as follows.

- At the time of their first site-visit, the PI activity members decided the PI activity themes by discussing with the short-term experts and the long-term expert, and the short-term experts offered advice on how to approach the solution.
- After two months of the first visit, the short-term experts ascertained the progress of the PI activity, modified the course of the study, and pointed out items missing from the study as an interim check. (After more two months, the 2<sup>nd</sup> interim check was implemented.) Whenever the counterpart had questions during this period, they could get advice and guidance from the short-term experts by e-mail, through the long-term expert.
- When the short-term experts visited the site again, they checked the final proposal and lectured on the effective way to perform the presentation. Finally, the PI activity members

gave presentations about their study to their management, and they succeeded in obtaining the approval of the management

Through the above-mentioned process, the PI activity members could study and obtain the solution for an issue autonomously, instead of depending on the experts' support. The long-term experts checked the progress of the project frequently, and gave advice to the members properly, by communicating with the short-term experts on hints for the solution by e-mail.

This process enabled the PI activity members to finish the study as scheduled and propose their solution to their management. Consequently, the TA Team believes that the system in which a long-term expert resides at the site and short-term experts visit the site for the short term (about two weeks) at fixed intervals (about every two months) is very effective in growing the autonomy of the PI activity members.

## **(2) Selection of the PI activity theme and nomination of the PI activity members**

In the first phase, performing a brainstorming with the TA Team to focus on middle management members in DCSD identified the issues to be considered as BPC.

The TA Team had initially intended this to be carried out focusing on about two themes at once. However, the TA Team struggled to pair the themes down because a large number of PI activity themes were submitted. Because BPC had requested that as many themes as possible be selected, the TA Team selected five. One short-term expert was responsible for one PI activity theme that the expert had sufficient knowledge about, and the TA Team leader had the responsibility for all themes and managed them.

The PI activity themes were selected based on the priority in which the management of BPC desired to solve the issues.

The management of BPC selected the PI activity members mainly from DCSD, including ESD engineers, and some members belonged to other departments in consideration of the content of the PI activity theme. The PI activity members got the office order from the human resources department. The selected PI activity members, who are expected to be the leaders of BPC from the management, had enough knowledge and skill. The PI activity members for whom the PI activity theme fitted their own routine work tackled the PI activity quite positively. On the other hand, the members for whom the theme did not fit their own routine work felt that the PI activity was additional work. Therefore, there was a gap in how to tackle the PI activity.

The middle management should tackle not only the routine work but also the issue solving work that the management requests, and should deem the issue solving work to be routine work. The TA Team tried to change their mindset so that they would think the issue solving work is routine work. However, many members think that the issue solving work is additional work. Therefore, the TA Team recommends system reforms in which the management evaluates the issue solving work and an individual's evaluation rises by the addition of points in his/her performance evaluation.

In addition, the TA Team viewed the upgrading of the O&M manual and the upgrading of the training capacity of the training center as PI activity. The person in charge of carrying out these activities was decided clearly, and they understood this work to be routine work and tackled these activities positively.

### **(3) Counterpart Training in Japan**

The TA Team held two counterpart training sessions in Japan, in March and November 2013. The TA Team and BPC discussed the selection of the participants for the first counterpart training in Japan and decided to select those who had made a remarkable contribution to this project. However, this selection method has many points of uncertainty, and the selection process was not clear. In contrast to the selection method for the first counterpart training in Japan, the TA Team changed the selection method for the second counterpart training in Japan in order to promote the PI activities. The TA Team announced the selection method and evaluation criteria to all PI team members. The evaluation score is the total of the evaluation of an individual member and the evaluation of a team, and high scoring members were selected as the participants for the counterpart training in Japan. As a result, although the participants must have been selected based on a fair standard and clear selection process, many complaints were expressed by the members defeated in the selection process. The cause of many of the complaints was the problem of the evaluation score arrangement. Since the evaluation points of the BPC general manager were not large, it was impossible for the candidates desired by a BPC general manager to participate in counterpart training in Japan.

A participant in the counterpart training in Japan comes to participate in PI activity more positively after returning to Bhutan. Therefore, a mechanism in which more members can participate in the counterpart training in Japan is desirable. Moreover, the counterpart training in Japan was a very big incentive for the trainees, and PI activity was advancing so that they could gain participation. Although it differs from the original purpose, in order to advance PI activities positively, the counterpart training in Japan is functioning effectively, and is an item required as a means for obtaining good output from project activity. In addition, for participants' selection, it is thought that it is better to select not only on simple evaluation score, but to take recommendations from the counterpart organization.

### **(4) Third Country Survey**

In addition to the counterpart training in Japan, there was a proposal for a third country survey, from a trainee at the start of the second PI activity. The purpose of a third country survey is to gain hints on issue solution by visiting a third country that is a little more advanced than Bhutan. Since the cost of the third country survey was not included in the original plan, it needed additional cost. However, the TA Team judged that the third country survey would be effective for PI activities because the possibility that they would get a solution for the issue would be high, and, based on the request from the trainee, after adjusting with JICA, it carried it out in June and July 2013.



The detailed method of the third country survey is as follows.

- Selection of the place to visit. (First, they checked the effectiveness of visiting; second, they discussed with the TA Team; third, they decided the final visit place. The seven PI teams visited different places respectively.)
- Arrangement of the schedule and the logistics by themselves. (The survey period is about one week.)
- All PI activity members participated. (Total number of the participants was 30.)
- Preparation of all necessary material such as questionnaire and discussion material, by themselves.
- Preparation of the third country survey report and presentation to the board members after survey.
- One TA Team member joined and supported the survey, and discussed with PI members about PI themes.

Since the cost of the third country survey was not included in the original plan, it needed additional cost. However, the TA Team recommends the third country survey because there are the following advantages.

- The PI team members got hints on issue solution about PI theme.
- By discussing with the engineer in the third country and by preparing the questionnaire etc. by themselves, the trainees gained confidence.
- The PI team members could discuss with the TA Team about PI theme in detail.
- The PI team members gained a connection with the engineer in the third country.

Therefore, the TA Team recommends the third country survey for similar capacity-building projects in future. In addition, the third country survey is effective for the upgrading of the O&M manual and the upgrading of the training capacity of the training center because the PI member for the O&M manual got a pocket size O&M manual in New Zealand and prepared the pocket size O&M manual by referring to it.

#### **(5) Workshops**

The TA Team held six workshops in order to introduce the technology and know-how of Japan. They were carried out in a lecture style using presentation material. There were many participants and there were many questions. In particular, the fault locating demonstration attracted much attention because the TA Team found the fault point of a defective underground cable using T2LUPIN and high voltage bridge equipment with ESD engineers and technicians. Moreover, the fault locating demonstration was taken up by local media, such as national broadcasting of Bhutan and the main newspaper, and was very significant from the public relations side of the project. Although a workshop using real equipment requires cost because of transportation cost

and safety measures, since the effectiveness is very high, the TA Team recommends this kind of training and demonstration using real equipment.

### **6.5. Recommendations for Achievement of Overall Goal**

Restating the above, PI activity is essentially a process in which middle management identifies an issue that exists in its office, plans the solution based on some analysis, and implements the solution after obtaining the management's approval. Consequently, PI activity should be carried out by middle management as part of its routine work in the workplace.

If PI activity and other activities are carried out according to the minutes of the meeting for BPC future plan, attached as Appendix 9, the Overall Goal might be achieved.

The TA Team expects that the BPC will carry out PI activity and other activities according to the minutes of meeting for BPC future plan attached as Appendix 9.