

**THE STUDY FOR ESTABLISHMENT OF ELECTRIC  
POWER  
TECHNICAL STANDARDS AND GUIDELINES  
IN  
KINGDOM OF CAMBODIA**

**FINAL REPORT**

**MAIN REPORT**

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**FEBRUARY 2004**

**ELECTRIC POWER DEVELOPMENT CO., LTD.  
TOKYO-JAPAN**

**CHUBU ELECTRIC POWER CO.,INC.  
NAGOYA-JAPAN**

<b>MPN</b>
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<b>04-042</b>

**JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)**  
**MINISTRY OF INDUSTRY, MINES AND ENERGY(MIME)**  
**KINGDOM OF CAMBODIA**

**THE STUDY FOR ESTABLISHMENT OF ELECTRIC  
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## **PREFACE**

In response to a request from Government of the Kingdom of Cambodia, the Government of Japan decided to conduct the Study for Establishment of Electric Power Technical Standards and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent a study team led by Mr. Takuya Takaoka of Electric Power Development Co., Ltd. and organized by Electric Power Development Co., Ltd. and Chubu Electric Power Co., INC. to Cambodia eight times from November 2002 to February 2004.

The study team held discussions with the officials concerned of the Government of Cambodia, and conducted field studies in Cambodia. After its return to Japan, the team conducted further studies and compiled the results in this report.

I hope this report will contribute to the promotion of Electric Power Technical Standards optimization in the country and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the persons concerned for their close cooperation throughout the study.

February 2004

Tadashi IZAWA  
Vice-President

February 2004

Mr. Tadashi Izawa  
Vice-President  
Japan International Cooperation Agency  
Tokyo, Japan

Dear Mr. Izawa,

### Letter of Transmittal

We are pleased to submit our report on “The Study for Establishment of Electric Power Technical Standards and Guidelines in the Kingdom of Cambodia.”

This report contains the “Electric Power Technical Standards” and the “Guidebook for Power Engineers,” which describe the standards to be applied in the power sector in Cambodia.

In view of the importance of such standards and the sound development of the electric power sector in Cambodia, we recommended that the Cambodian Government promulgate these standards as soon as possible.

We wish to take this opportunity to express our sincere gratitude to your agency, the Ministry of Foreign Affairs, and the Ministry of Economy, Trade and Industry. We also wish to express our deep gratitude to the Ministry of Industry, Mines and Energy, the Electricity Authority of Cambodia, Electricité de Cambodge, the Embassy of Japan in Cambodia, the JICA Cambodia Office, and other agencies concerned in Cambodia for the close cooperation and assistance extended to us during our study period.

Sincerely,

Takuya Takaoka

Team Leader

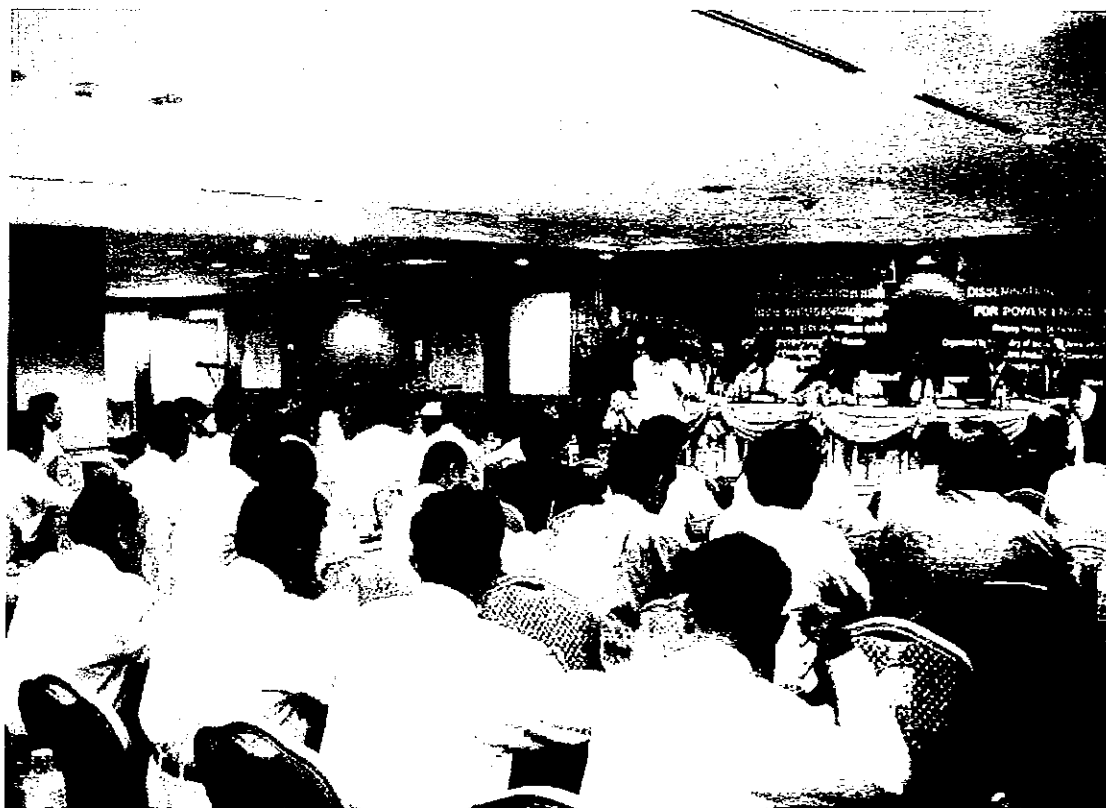
The study team for Establishment of  
Electric Technical Standards and  
Guidelines in the Kingdom of Cambodia

**SEMINAR (4, Feb. 2004)**

**1 Seminar - (1 Opening)**



**2 Seminar - (2 Opening)**



**3 Seminar - (3 Reception)**



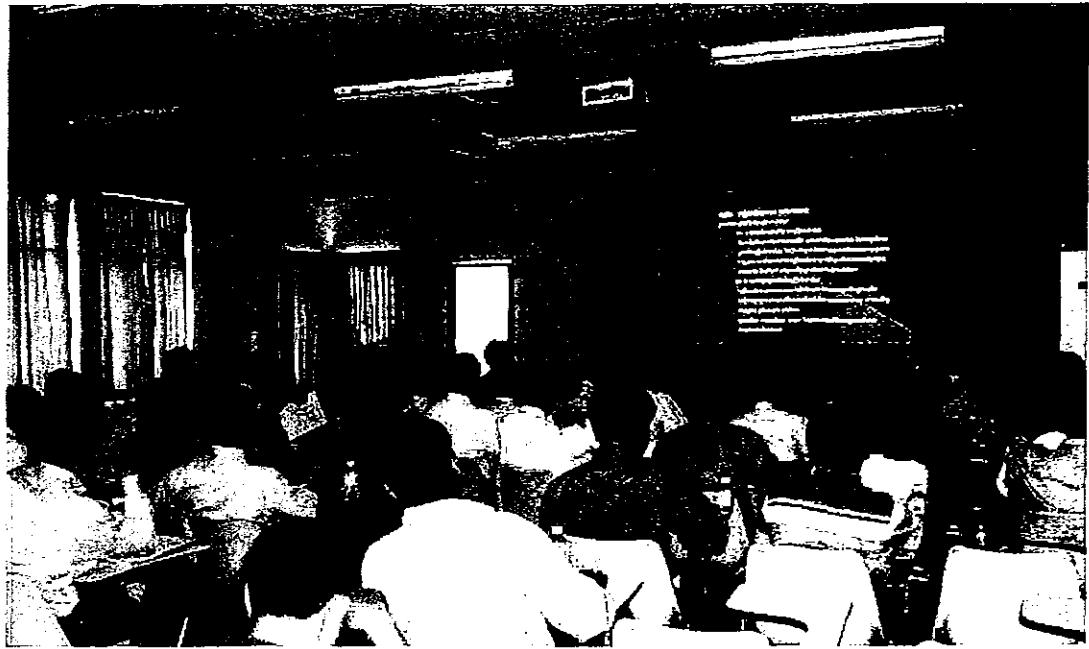
**4 Seminar - (4 Seminar participant)**



5 Workshop - 1 (Title)



6 Workshop - 2





### 6 Workshop - 3



### 7 Workshop - 4



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## **1. GENERAL CONDITIONS**

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## **1. GENERAL CONDITIONS**

### **1.1 Purpose of the Study**

According to the ARTICLE 5 \*Note1) of ELECTRICITY LAW OF THE KINGDOM OF CAMBODIA, Electricity Authority of Cambodia (EAC) shall perform their work in conformity with the Technical Standards for the Electrical Equipment which would be issued by Ministry of Industry, Mines and Energy(MIME).

However, the Technical Standards have actually not been issued yet, therefore, EAC could not fulfill their obligation such as regulation, administration and supervision for the Electric Power Services which are stipulated by the ELECTRICITY LAW.

On the other hand, the EAC has not been able to audit nor inspect applications for the License of the Power Company, which were offered by power companies who wanted newly join the electric service business, even though these application contained EAC rules such as autonomous security/safety rules and electric supply rules.

And, in this country, most electric power equipment has been imported with a variety of technical levels. In such circumstances, the power service companies would purchase and install some electric power equipment with poor quality unless the minimum acceptable technical standards are established. Therefore, in the Electric power sector, it has been strongly desired to establish as early as possible the Technical Standards for the Electric Power Equipment.

The purpose of this Study is to prepare the draft of “Electric Power Technical Standards” and the “Guidebook for Power Engineer”(Guidebook) \*Note 2) which will explain and supplement the Standards necessary for the actual work, in order to transfer such technology to the Cambodian counterpart in the process of the Study.

Furthermore, based on the information collected during the Study, the analysis of the present status of the Electric Power Sector and identification of the issues to be solved are to be made by the study team. The study team will also make suggestions for the actual application and timely revisions of the Standards taking future Cambodian power sector into consideration.

**Note 1)** Attachment 1.1-(1) illustrates the structural idea of “Electric Power Technical Standards of Cambodia” and “Guidebook” which also shows the original description of the ARTICLE 5 of ELECTRICITY LAW OF THE KINGDOM OF CAMBODIA, the function of Electric Power Technical Standards, and the missions of MIME and EAC.

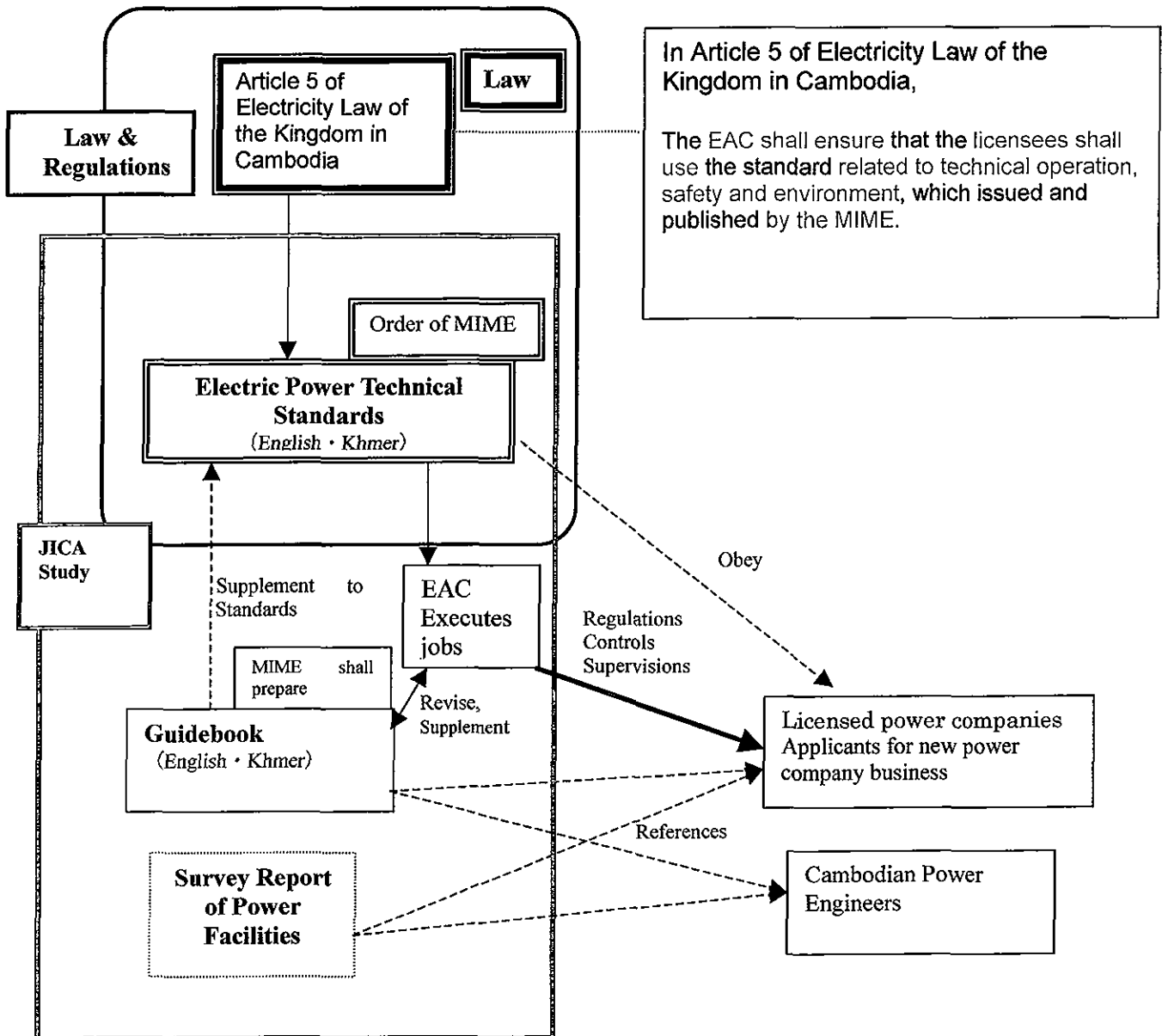
**Note 2)** Naming of “Guidebook”: At the beginning of the Study, in accordance with an agreement by the Study team and Cambodian counterpart (C/P), the Study team processed their work in order to prepare the draft of Electric Power Technical Standards and the draft of Guidelines on the condition that the MIME shall finalize these drafts for the legislation. Meanwhile the Cambodian counterpart (C/P), consisting of selected members of MIME, EAC and Cambodian Power Company (EDC, Electricite de Cambodia), could not make a concrete idea of the Guideline because of various different interpretations could not be duly adjusted among members.

The technical references (Guideline) are indispensable for proper application of the Electric Power Technical Standards and therefore will be published in a big volume consisting of examples, drawings, illustrations, arithmetic formulas and supplementary descriptions in reference to each article of the Standards. Then the translation of these references into Khmer language and the subsequent legislative work together with that of the Electric Power Technical Standards would be a time consuming job, which would be disadvantageous for realizing the expeditious legislative action most wanted in this occasion.

It would be quite a challenging task to revise frequently the technical references in accordance with a progress in the technology once the technical references were legislatively ruled.

From the above mentioned reasons, it was concluded that the technical references (Guidelines) shall not necessarily be legislatively ruled but be published in a quality and structure necessary for catching up the new technologies and due application of the Electric Power Technical Standards. In this context, the name of the technical references was renamed as “Guidebook” from the “Guidelines”. (This was recorded in the M/M of the agreements of the fifth site survey and duly signed)

Attachment 1.1-(1) Structure of “Electric Power Technical Standards” and “Guidebook”





## **1.2 Area of the Study**

The Study is for the country of Cambodia.

In addition, the study team was visited the neighboring countries, Thailand, Vietnam and Laos for the collection of the reference data and information for the study.

## **1.3 Scope of the Study**

The Study was made based on the Scope of Work attached to the Minutes of Meeting which was signed on 24<sup>th</sup> June 2002, and the Study items as shown below.

- (1) The Current Status of Electric Power Facilities, the review of the Future Vision of Electric Power Sector.
- (2) Setting the target of the technical matters related to Electric Power Supply Services.
- (3) Drawing up a necessary suggestion on the enforcement of the Electric Power Technical Standards.
- (4) Drafting the Electric Power Technical Standards, Guidelines.
- (5) Translation into Khmer for the above

## **1.4 Descriptions of the Study Items**

- (1) Items of the Study and Policy

For successful study results, study items and their basic implementation policies are shown in 1) to 5) below.

- 1) Current status of the existing power supply system equipment in Cambodia;

The survey team will make site survey of the current status of the existing power supply equipment (the survey on the major equipment) for the purpose of compiling a handbook of the power supply system equipment lists. Detailed survey on the existing

power system equipment will also be made by Cambodian local consultants under sub-contracts.

The survey team will make the draft of the Electric Power Technical Standards and confirm their applicability, manageability and appropriateness with reference to the basic data confirmed in the survey results on the above mentioned existing equipment.

- 2) *Survey and analysis on the future prospect of the Power Sector, and the clarification of issues and setting of the sector goal;*

The survey team will survey jointly with the counter part on the actual status of the organization, the equipment and the power demands in the power sector. They will analyze these survey results and list up practical issues that would affect the application and management of the Electric Power Technical Standards (draft) in the future when the power supply equipment are expanded. They will make the standards that would be substantially kept relevant for decades without necessity of frequent revisions and supplements even after the standards are put into the legislation.

- 3) *Survey on the technical standards in neighboring countries;*

The survey team will survey on the electric power technical standards in Thailand, Vietnam and Lao PDR. The survey team will take adequately these survey results into considerations in preparing the Electric Power Technical Standards (draft) so that the Standards would be well practicable to the connection with the neighboring countries' power grid systems which will soon be developed.

- 4) *Preparation of the drafts of the Electric Power Technical Standards and the Guidebook;*

The above both drafts contents shall be directed so that the standards would be practically suitable to the actual current status of Cambodian society and be kept relevant longer in future. The Electric Power Technical Standards (draft) will be so arranged that the minimum requirements would be secured under generalized rules

without much detailing in fixed figures or methods, as practically as possible, for the standard performance of the power equipment.

The Electric Power Technical Standards (draft) contents shall be so arranged that they would secure international aspects, neutrality and fairness.

The Electric Power Technical Standards (draft) contents shall also be so arranged that the safety and environments would be adequately considered.

5) Transfer of technologies to the counter part (MIME/EAC/EDC);

The survey team will make the counter part consisting of the selected members of MIME/EAC/EDC prepare themselves the drafts of the Electric Power Technical Standards and the Guidebook, and complete them jointly with the survey team.

6) Transfer of the technologies to the power sector people;

The survey team will host the work shop (public hearing) where the team will explain the necessity of the Electric Power Technical Standards (draft) and the Guidebook to the power sector people mostly in Khmer language for the purpose of getting their willingness to meet these standards. The technology transfer will be realized through the Q&A and comments raised by the attendants.

(2) General scope of the survey

1) Implementation periods

**(First year)**

[Preparatory work in Japan]: November 5, 2002 (Tue) ~ November 19, 2002 (Tue)

<First site survey>: November 20, 2002 (Wed) ~ December 7, 2002 (Sat)

[First work in Japan]: December 8, 2002 (Sun) ~ February 8, 2003 (Sat)

<Second site survey>: February 9, 2003 (Sun) ~ March 1, 2003 (Sat)

[Second work in Japan]: March 2, 2003 (Sun) ~ March 31, 2003 (Mon)

**(Second year)**

[Third work in Japan]: May 20, 2003 (Tue) ~ July 31, 2003 (Thu)

<Third site survey>: May 23, 2003 (Fri) ~ July 31, 2003 (Sat)

<Fourth site survey>: July 4, 2003 (Fri) ~ July 12, 2003 (Sat)

<Fifth site survey>: August 1, 2003 (Fri) ~ August 16, 2003 (Sat)

[Fourth work in Japan]: August 20, 2003 (Wed) ~ October 6, 2003 (Mon)

<Sixth site survey>: October 10, 2003 (Fri) ~ October 18, 2003 (Sat)

[Fifth work in Japan]: October 20, 2003 (Mon) ~ November 27, 2003 (Thu)

<Seventh site survey>: November 28, 2003 (Fri) ~ December 6, 2003 (Sat)

[Sixth work in Japan]: December 8, 2003 (Mon) ~ January 23, 2004 (Fri)

<Eighth site survey>: January 25, 2004 (Sun) ~ February 7, 2004 (Sat)

2) Description of the implementation

**(First year)**

[Preparatory work in Japan]

(a) Collection of the existing references and data, and their analysis and evaluation

Issues and tasks of the survey were selected through the analysis and evaluation of the references and data collected by the preparatory survey team

(b) Preparation of the subcontract documents for local consultants

The subcontract documents were prepared for the purpose of getting local consultants

survey the status of power system installations in Cambodia.

(c) *Preparation of the inception report and the questionnaire*

The survey team prepared the inception report both in English and Japanese as the result of studying the basic policy, contents, method and progress schedule of the survey, taking the S/W, M/M and the preparatory survey report into considerations.

(d) *Preparation of the procurement contract documents for local equipment and materials in FY 2002.*

Collection of information and preparation of the procurement contract documents (draft) were made for the local equipment and materials to be procured in the First site survey in FY 2002.

<First site survey>

(a) *Presentation and discussion on the inception report.*

The survey team explained the inception report to the counter part and made necessary discussions for the implementation.

(b) *Site survey and collection of the references and data on the current status of the existing power equipment*

The team surveyed on the current status of the power equipment in Cambodia and identified the conditions of the operation and the maintenance. The team collected the information and written references at Cambodian sites.

(c) *Procurement of the local equipment and materials to be used for the site survey*

The team procured the equipment and materials to be used for the site survey through competitive bid procedures. As some local equipment and materials were delayed behind the expected delivery time, these items were scheduled to be delivered in the second site survey period.

(d) Procedures of the selection and contract for the subcontractors

The team selected and made contracts with local consultants with the scope of the subcontract defined as “the survey of the power supply installations in Cambodia”.

[First work in Japan]

The team screened and analyzed the references and data collected in the site survey, and processed the preparation of the Electric Power Technical Standards (draft) and Guidebook including the study on the data collected beforehand in Japan.

<Second site survey>

(a) Presentation of the work to the counter part and discussions

The team made a presentation partly on the Electric Power Technical Standards (draft) and the Guidelines (draft), and explained them in detail and made discussions.

(b) Collection of the information on electric power technical standards in neighboring countries.

The team surveyed the current status of electric power technical standards in three neighboring countries (Thailand, Vietnam, and Lao PDR).

(c) Acceptance of the site survey reports under subcontracts made by local consultants

The team examined and accepted the site survey reports on the current Cambodian power supply installations which were ordered as subcontracts in the first site survey occasion.

(d) Procurement of the equipment and materials to be used for the site survey

The team processed the procurement of the equipment and materials that were behind schedule at the first site survey, and accepted all the equipment and materials originally planned.

[Second work in Japan]

The team studied on the current technical level and goal for the power supply system, and made a progress report.

(Second year)

[Third work in Japan]

(a) Preparation of the Electric Power Technical Standards (draft) and the Guidebook

The team prepared the drafts of the Electric Power Technical Standards and the Guidebook, taking the third site survey results into considerations.

(b) Preparation of the policy proposal

The team prepared the policy proposal which would be necessary for legislative implementation and revisions of the Electric Power Technical Standards and the Guidebook.

(c) Preparation of the explanatory references which would be necessary for the technology transfer

The team prepared the descriptive references which would be necessary for the technology transfer sessions to the counter part on legislative implementation and revisions of the Electric Power Technical Standards and the Guidebook.

<Third site survey>

(a) Presentation of the work to the counter part and discussions

The team explained to MIME on the study made in the second phase work in Japan, which includes current technical level, issues, future visions, a scenario to realize the visions, and the proposed technical goal level. The team made necessary revisions of the report in reference to the comments raised by the MIME.

- (b) Submission, presentation and discussions of the progress report

The team submitted and explained the progress report to the counter part. They discussed on the report, which was recorded in the minute of the meeting.

<Fourth site survey>

- (a) Presentation of the work to the counter part and discussions

The team explained the Electric Power Technical Standards (draft) and the Guidebook to MIME and got their comments.

<Fifth site survey>

- (a) Workshop on the technology transfer

The team made presentation on the Electric Power Technical Standards (draft) and the Guidebook for the purpose of the technology transfer and exchanged comments necessary for the legislative implementation and revisions

- (b) Presentation of the work to the counter part and discussions

The team explained the Electric Power Technical Standards (draft) and the Guidebook to MIME and got their comments. The team made necessary revisions upon MIME's agreement.

The team asked the counter part to examine the Khmer language version of the Electric Power Technical Standards (draft) and the Guidebook. The team asked the counter part to make themselves necessary revisions in translation and typographical errors.

[Forth work in Japan]

- (a) Preparation of the Electric Power Technical Standards (draft) and the Guidelines (draft)

The team made necessary revisions and supplements to the Electric Power Technical Standards (draft) and the Guidelines (draft) taking the results of the technology transfer



presentation held in the fifth site survey into considerations.

(b) Preparation of the policy proposal

The team prepared the policy proposal necessary for the legislative implementation and revision of the Electric Power Technical Standards (draft) and the Guidelines (draft).

(c) Training of the counter part personnel

During the period of the survey, the team accepted three personnel (one from each of MIME, EAC and EDC) as the counter part trainees and completed the training program.

<Sixth site survey>

(a) Acceptance of the translated version of the Electric Power Technical Standards (draft) and the Guidelines (draft)

The team jointly examined the Khmer version contents in comparison with the English version.

(b) Supports to the first workshop held by MIME

The team supported MIME host the workshop.

[Fifth work in Japan]

(a) Revisions on the Electric Power Technical Standards (draft) and the Guidelines (draft)

The team made necessary revisions and supplements to the Electric Power Technical Standards (draft) and the Guidelines (draft) taking the results of the sixth site survey and the first workshop into considerations.

(b) Revision work for the Khmer version

The team ordered the counter part to revise the Khmer version in accordance with the above revised English version.

<Seventh site survey>

(a) Presentation of the work to the counter part and discussions

The team explained to, discussed with, and agreed with MIME on the revised version of the Electric Power Technical Standards (draft) and the Guidelines (draft).

(b) Support to the second workshop (public hearing)

The second workshop was held forty five days after the first workshop. The team supported MIME who hosted the workshop.

The Guidelines (draft) in both English version and Khmer version were also introduced to the audience.

(c) Revisions on the Electric Power Technical Standards (draft) and the Guidelines (draft)

The team revised the Electric Power Technical Standards (draft) and the Guidelines (draft) taking the second workshop results into considerations.

[Sixth work in Japan]

(a) Revisions on the Electric Power Technical Standards (draft) and the Guidelines (draft)

The team revised the Electric Power Technical Standards (draft) and the Guidelines (draft) taking the seventh site survey and second workshop results into considerations.

(b) Preparation of the draft final report

The team prepared the draft final report.

<Eighth site survey>

Support to the seminar for the Guidebook

The tam supported the counter part host the seminar for Guidelines (draft).

{Submission of the final report}

The team completed the final report and submitted copies to the departments in concern.

Figure-1 Flow chart of the survey work

Figure-1 illustrates Flow chart of the survey work.

### **1.5 Results of the Workshop**

MIME hosted the two workshops (also as the public hearing means) for the purpose of legislative procedure to publish the Electric Power Technical Standards as the regulation.

#### **(1) First workshop**

- 1) Time Schedule : 8:00~12:00, October 15, 2003
- 2) Place : MIME meeting room
- 3) Host : MIME (Supported by JICA survey team)
- 4) Attendant list : Refer to "LIST OF PARTICIPANT"
- 5) Purpose : To get the government people (MIME, EAC, EDC, etc.), power business people and inhabitants understand and accept the Electric Power Technical Standards (draft) by explaining the contents of the Standards to them.

6) Contents : Workshop contents and time are shown below.

Time	Contents		
08:00 ~ 08:30	Reception		
08:30 ~ 09:10	Opening remarks	Dr. Sat Samy	Deputy director General of Energy
		Tetsuya Takaoka	Representative of JICA survey team
		H. E. Ith Praing	Secretary of State MIME
09:10 ~ 09:30	Recess		
09:30 ~ 09:50	Summary of the Electric Power Technical Standards (draft)	Tetsuya Takaoka	
09:50 ~ 11:30	Presentation of the Electric Power Technical Standards (draft)		
	1- Hydro Electrical Power	Mr. Soun Ponnarith MIME	
	2- Power Generation	Mr. Aun Hemrith EDC	
	3- Transmission/Distribution System	Mr. Houng Chantha EDC	
	4- Renewable Energy	Mr. Toch Sovanna MIME	
	5- House Wiring	Mr. Chan Socheat MIME	
11:30 ~ 11:50	Q & A		
11:50 ~ 12:00	Closing remarks	H. E. Ith Praing	Secretary of State MIME

7) Results of the workshop : Majority of the people participating the Cambodian power business joined at the workshop. The counter part explained them the Electric Power Technical Standards (draft) in Khmer language. The attendants generally seemed understand and be willing to follow the Standards.

(2) Second workshop

- 1) Time schedule : 8:00~12:00, December 3, 2003
- 2) Place : MIME meeting room
- 3) Host : MIME (Supported by JICA survey team)
- 4) Attendant list : Refer to "LIST OF PARTICIPANT"
- 5) Purpose : To get the government people (MIME, EAC, EDC, etc.), power business people and inhabitants understand in depth to help them accept the Electric Power Technical Standards (draft) by explaining the contents of the Standards to them, similarly in the first workshop. To introduce them also the Guidebook.
- 6) Contents : Workshop contents and time are shown below.

Time	Contents		
08:00 ~ 08:30	Reception		
08:30 ~ 09:10	Opening remarks	Dr. Sat Samy	Deputy director General of Energy
		Tetsuya Takaoka	Representative of JICA survey team
		H. E. Khlaut Randy	Under Secretary of State MIME
09:10 ~ 09:30	Recess		
09:30 ~ 10:10	1- Summary of the Guidebook	Tetsuya Takaoka	
	Presentation of the Electric Power Technical Standards (draft)		
10:10 ~ 11:25	2- Power Plant	Mr. Nong Rithya EAC	
10:25 ~ 10:40	3- Hydro Electrical Power	Mr. Soun Ponnarith MIME	
10:40 ~ 10:50	4- Renewable Energy	Mr. Toch Sovanna MIME	
10:50 ~ 11:05	5- Transmission System	Mr. Houng Chantha EDC	
11:05 ~ 11:20	6- Distribution System	Mr. Houng Chantha EDC	
11:20 ~ 11:30	7- House Wiring	Mr. Lieng Vuthy MIME	
11:30 ~ 11:50	Q & A		
11:50 ~ 12:00	Closing remarks	H. E. Ith Praing	Secretary of State MIME

- 7) Results of the workshop : Similarly in the first workshop, majority of the people participating the Cambodian power business attended the workshop. The counter part explained them not only the Electric Power Technical Standards (draft) but also the Guidebook in Khmer language. The attendants were generally active in asking practical questions. It was observed that the participants would be well prepared to actually accept the Standards.
- (3) Seminar regarding “Guidebook for power engineers (Guidebook)”
- 1) Time schedule : 8:00~17:00, February 4, 2004
  - 2) Place : MIME meeting room
  - 3) Host : MIME (Supported by JICA survey team)
  - 4) Attendant list : Refer to “LIST OF PARTICIPANT”
  - 5) Purpose : The purpose of seminar is explaining a guidebook for the representative and engineer who manage the electric power equipment in each local administration area, and letting you understand the contents.

- 6) Contents : Seminar contents and time are shown below

Time	Contents		
08:00 ~ 08:30	Reception		
08:30 ~ 09:20	Opening	Dr. Sat Samy	Deputy director General of Energy
		Tetsuya Takaoka	Representative of JICA survey team
		H. E. Ith Praing	Secretary of State Minister of MIME
09:20 ~ 09:50	Recess		
09:50 ~ 10:20	1- Summary of the Guidebook	Tetsuya Takaoka	
	Presentation of the Guidebook for Power Engineers		
10:20 ~	2- Power Generation, Q & A	Mr. Aun Hemrith EDC	
~	3- Hydro Electrical Power, Q & A	Mr. Soun Ponnarith MIME	
~ 12:00	4- Renewable Energy, Q & A	Mr. Toch Sovanna MIME	
12:00 ~ 13:30	Lunch Time		
13:30 ~	5- Transmission System, Q & A	Mr. Houg Chantha EDC	
~ 15:00	6- Distribution System, Q & A	Mr. Houg Chantha EDC	
15:00 ~ 15:30	Coffee Break		
15:30 ~ 16:10	7- House Wiring, Q & A	Mr. Lieng Vuthy MIME	
16:10 ~ 17:00	Impressions to	H. E. Ith Praing	Secretary of State Minister of

- 7) Results of the seminar : The 1st time, the representative and engineer who participated in the 2nd workshop and who manage the electric power equipment in each local administration area in addition to the electric power persons involved in Cambodia (Phnom Penh suburbs) participated, and explanation of the guidebook by the Khmer language was made from the counter part. From the attendant, relief of conductors of a power line currently installed in the district, distance, etc. had a different question from center of Phnom Penh. The guidebook was made into the concrete example and the earnestness that is going to find out the problem, which should tackle from now on, was imagined.

**1.6 Counter Part Member List**

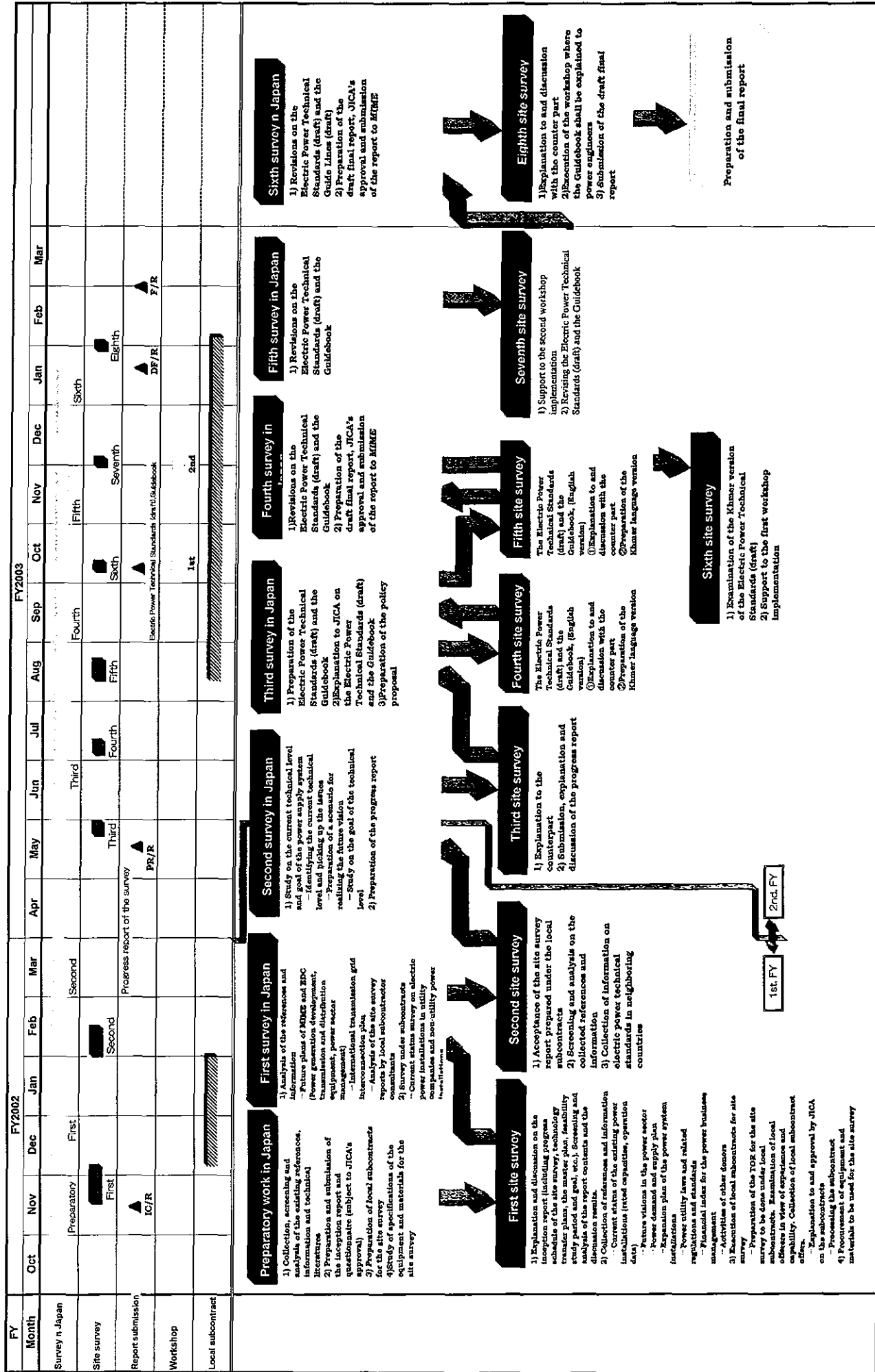
1	Dr.Ith PRAING	M I M E	1	Dr.Ty NORIN	EAC
2	Dr. Sat SAMY	M I M E	2	Teng SAROEUN	EAC
3	Toch SOVANNA	M I M E	3	Nong RITHYA	EAC
4	Tun LEAN	M I M E			
5	Lieng VUTHY	M I M E	1	Yim NOLSON	EDC
6	Chan SOCHEAT	M I M E	2	Praing CHULASA	EDC
7	Thach SOVANNREASEY	M I M E	3	Chan PISETH	EDC
8	Suon PONNARITH	M I M E	4	Houng CHANTHA	EDC
			5	Lim CHANDARA	EDC
			6	Aun HEMRITH	EDC

**1.7 Survey Team Member List**

In charge of	J I C A Survey Team	Counter part
General Manager/Power engineering, Power laws in general	Takuya Takaoka	Dr.Sat SAMY Dr.Ith PRAING Dr.Ty NORIN Mr. Yim NOLSON
Thermal generation	Katsuya Takaoka	Mr.Aun HEMRITH Mr.Teng SAROEUN
Hydraulic generation	Tsutomu Nishikawa	Mr.Toch SOVANNA Mr.Suon PONNARITH
Power transmission	Yoshihiro Takechi	Mr.Huong CHANTHA
Power distribution	Keiji Shiraki	Mr.Huong CHANTHA
Indoor wiring	Toshiomi Sahara	Mr.Chan SOCHEAT Mr.Lieng VUTHY
Off-grid renewable energy rural electrification	Takanori Omori	Dr. Sat SAMY Mr. Toch SOVANNA



# Flow - Chart of the JICA Study



**“LIST OF PARTICIPANT”**

**LIST OF PARTICIPANT**  
*1<sup>ST</sup> Workshop*  
**On Electric Power Technical Standards in Cambodia**  
*Wednesday 15 October 2003*

**Name of Participants on Workshop**

No.	Name and Surname	Ministry and another Institution
1	H.E.Suy Sem	Minister of Ministry of Industry, Mines and Energy (MIME)
2	H.E.Ith Praing	Secretary State, MIME
3	H.E.Hol Lim	Under Secretary State, MIME
4	H.E.Khlaut Randy	Under Secretary State, MIME
5	H.E.Ngoun Nov	General Director of Industry, MIME
6	Dr. Sat Samy	Deputy General Director of Energy, MIME
7	Mr. Chan Socheat	Deputy Director of Energy Technical Dept, MIME
8	Mr. Lieng Vuthy	Chief of Energy Efficiency and standard Office, MIME
9	Mr. Toch Sovanna	Chief of Renewable Energy Office, MIME
10	Mrs. Chum Sopha	Deputy Chief of Study Research Office, MIME
11	Mr. Heang Bora	Deputy Chief of Energy Efficiency and Standard Office, MIME
12	Mr. Nong Chhavyvann	Officer of Energy Efficiency and Standard Office, MIME
13	Mr. Choun Thea	Officer of Energy Efficiency and Standard Office, MIME
14	Mr. Leang Khemarith	Deputy Chief of Renewable Energy, MIME
15	Mr. So Veasna	Vice Chief of Standard Office, MIME
16	Mr. Y Savoth	Officer of Study Research Office, MIME
17	Mr. Tun Lean	Deputy General Director of Energy, MIME
18	Mr. Chhim Theaream	Officer of Planning Office, MIME
19	Mr. Tach Keang Mony	Officer of Rural Electrification Office, MIME
20	Dr. Bun Narith	Director of Hydro-Electricity Dept, MIME
21	Mr. Suon Ponnarith	Deputy Chief of Hydro-Electricity Dept, MIME
22	H.E.Tan Kim Vinn	Managing Director, EDC
23	Mr. Yim Nolson	Deputy Managing Director, EDC
24	Mr. Houg Chantha	Head of Technical Office, EDC
25	Mr. Oun Hiemrith	Deputy Chief of 5-6 Power Plants, EDC
26	H.E.Ty Norin	Chairman, EAC
27	Dr. Ouch Thong Seng	Vice Chairman, EAC
28	Mr. Nong Rithya	Legal Officer, EAC
29	Mr. Sa Roeun	Legal Officer, EAC
30	Mr. Kaoru Nishiwaki	JICA Expert, MIME
31	Mr. Keo Vatanak	Director of Small-Scale Industry and Handicraft Dept, MIME
32	Mr. Sat Samoth	Director of Technical Standard of Industry, MIME
33	Mr. Poeng Sylaiy	Director of Standard Industry Dept, MIME
34	Mr. Jing Chhormoney	Vice Dean of Architecture and Urban Planning University
35	Mr. Meak Poenlork	Deputy Chief of Construction Dept, Ministry of Land Management and Urban Planning and Construction
36	Mr. Jy Sitha	Ministry of Land Management and Urban Planning and Construction
37	Mr. Chhim Chamreoun	Deputy Chief of Construction Office of Mong Rithy Co., Ltd.
38		Director of Bayon Hospital
39		Director of Cambodia Technical Institute
40		Director of Donbosco Technical School

**LIST OF PARTICIPANT**  
**1<sup>ST</sup> Workshop**  
**On Electric Power Technical Standards in Cambodia**  
**Wednesday 15 October 2003**

**Name of Participants on Workshop**

No.	Name and Surname	Ministry and another Institution
41		Director of Sun Tex Garment
42	Mr. Catry Dominique	Chairman Comin Khmer Co., Ltd.
43	Mr. Keo Sovat	Director of Industrial Affair Department
44	Mr. Sun Seng Hourt	Phnom Penh Department of Industry, Mines and Energy
45	H.E.Mok Mareth	Minster of Ministry of Environment
46	Mr. Andrew	Wind Business Manager
47	Mr. Seng Thung	Consultant
48	Mr. Hak Vandy	Director of Industry, Mines and Energy Department in Candal Province
49	Mr. Sok Born	Director of Industry, Mines and Energy Department in Kompong Speu Province
50	Mr. Soun Dy	Director of Industry, Mines and Energy Department in Kompong Cham Province
51	Mr. Horn Soy	Director of Industry, Mines and Energy Department in Kompong Chhnang Province
52	Mr. Thai Ford	Director of Khmer Solar Co., Ltd.
53	Mr. Sok Sila	Jupiter Co., Ltd.
54		CUPL
55		Ministry of Rural Development
56	Mr. Noboru Yumoto	PROACT International Inc.
57	Mr. Takuya Takaoka	Electric Power Development Co., Ltd.
58	Mr. Katsuya Takaoka	Electric Power Development Co., Ltd.
59	Mr. Tsutomu Nishikawa	Chubu Electric Power Co., Ltd.
60	Mr. Yoshihiro Takeshi	Electric Power Development Co., ltd.
61	Mr. Keiji Shiraki	Chubu Electric Power Co., Ltd.
62	Mr. Toshiomi Sahara	Chubu Electric Power Co., Ltd.
63	Mr. Takanori Omori	Electric Power Development Co., Ltd.
64	Mr. Kouichi Meguro	Electric Power Development Co., Ltd.
65	Mr. Akira Niwa	Senior Advisor, Institute for International Cooperation, JICA
66	Mr. Yuriko Doi	Staff, Second Tech, Cooperation Div, Mining and Industrial Development Cooperation Dept., JICA
67		JICA Expert in Phnom Penh
68		JICA Expert in Phnom Penh
69	Mr. Curtis	
70	Mr. Orm Sarak	Chef of Electricity Power Plants in Kompong Chhnag Provincial
71		Neak Leung
72		Ipp Kompong Speu
73		Ipp Kompong Cham

**LIST OF PARTICIPANT**  
*Second Workshop On*  
*On Electric Power Technical Standards in Cambodia*

**Name of Participants on Workshop**

« Establishment of Electric Power Technical Standards and Guideline in Kingdom of Cambodia »

03 December 2003 at Ministry of Industry, Mines and Energy (New building)

No.	Name and Surname	Ministry and another Institution
1	H.E. Ith Praing	Secretary of Sate, MIME
2	H.E. Khlaut Randy	Under Secretary of State, MIME
3	H.E. Ngoun Nov	General Director of Industry MIME
4	Dr. Sat Samy	Deputy General Director of Energy, MIME
5	Mr. Chan Socheat	Deputy Director of Energy Technique, MIME
6	Mr. Lieng Vuthy	Head of Energy Efficiency and Standard Office, MIME
7	Mr. Toch Savanna	Head of Renewable Energy Office, MIME
8	Mrs. Chum Sopha	Deputy Head of Research Office, MIME
9	Mr. Heang Bora	Deputy Head of Energy Efficiency and Standard Office, MIME
10	Mr. Nong Chhavyvann	Officer of Energy Efficiency and Standard Office, MIME
11	Mr. Choum Thea	Officer of Energy Efficiency and Standard Office, MIME
12	Mr. So Veasna	Deputy Head of Energy Efficiency and Standard Office, MIME
13	Mr. Tun Lean	Deputy General Director of Energy, MIME
14	Mr. Victor Sona	Deputy Director of Energy Development, MIME
15	Dr. Bun Narith	Director of Hydro-Electricity Department, MIME
16	Mr. Suon Ponnarith	Deputy Head of Hydro-Electricity Department, MIME
17	Mr. Yim Nolson	Deputy Managing Director of EDC
18	Mr. Houg Chantha	Head of Technical Office, EDC
19	Mr. Oun Hemrith	Deputy Head of 5-6 Power Plants, EDC
20	H.E. Ty Norin	Chairman of EAC
21	Mr. Nong Rithya	Legal Officer, EAC
22	Mr. Teng Saroeun	Legal Officer, EAC
23	Mr. Hing Kunthap	Advisor of Department of Energy Technique, MIME
24	Mr. Andrew Willinson	Advisor of Department of Energy Technique, MIME
25	Mr. Kaoru Nishiwaki	JICA Expert, MIME
26	Mr. Catry Dominique	Chairman of Comin Khmer Co., Ltd.
27	Mr. Seng Thaug	Consultant CEC
28	Mr. Thai Ford	Director of Khmer Solar Co., Ltd.
29	Mr. Sok Sila	Jupiter Co., Ltd.
30	Representative	Cambodia Utility, Phnom Penh City
31	Representative	GTS Independent Power Producer (IPP), in Kampong Cham Province
32	Mr. Chea Sopha	IPP, in Siem Reap and Battambang Province
33	Mr. Huor Pheng	IPP, in Kampong Thmar, Kampong Thom Province
34	Representative	CETIC, Kirirum Small Hydro Power Station, in Kampong Speu Province
35	Representative	PRANASY, IPP, in Battambang Province.
36	Representative	MSP, IPP, in Pay Lin City

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37	Mrs. Kim Neang	Van Long Company, Kampot Province
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39	Representative	Turbo Industrial, Kampong Thom Province
40	Mr. Mak Thon	IPP Kirivong Takeo Province
41	Representative	Duty Fre Shop, Koh Kong and Oudo Meanchey Province
42	Mr. Srey Sokhom	IPP, Samrong Yon, Takeo Province
43	Mr. Keo Kuhoy	IPP, Trang, Takeo Province
44	Mrs. Bun Liv	IPP, Nek Loeung, Prey Veng Province
45	Mr. Ky Sophea	IPP, Pea Reang, Prey Veng Province
46	Mr. Teo Kok Eng	IPP, Treal Kanpong Thom Province
47	Mr. Chhou Lay	IPP, Prey Kabas, Takeo Province
48	Mr. Nov Sokha	IPP, Nek Loeung, Kandal Province
49	Mr. Kong Phat	IPP, Thma Sar, Takeo Province
50	Mr. Khun Sambo	IPP, Prey Chhor, Kampong Cham Province
51	Representative	Global Power System, Prey Veng Province
52	Representative	Peace Cambodia Investment, Takeo Province
53	Mr. Chang Bunna Ret	IPP, Phaav, Kampong Cham Province
54	Mr. Ku Sour	IPP
55	Mr. Samreth Sothy	IPP, Sre Ambel, Koh Kong Province
56	Mr. Sok Thy	IPP, Viel Regn, Sihanouk Ville
57	Mr. Ly Bunthy	IPP, Stoeung Hav, Sihanouk Ville
58	Mr. Ngen Kung	IPP, Baray, Kampong Thom Province
59	Mrs. Chhuy Phoeut	IPP, Puok, Siem Reap Province
60	Mrs. Porch Kim	IPP, Ka Andoeuk, Kampong Trabek, Prey Veng Province
61	Mr. Kim Chandara	IPP, Phar Baray, Kampong Thom Province
62	Mr. Ty Sokun	IPP, Sala Lekh Pram, Kampong Tralage, Kampong Chhnang Province
63	Mr. Seng Sokun	IPP, Phsar Svay Antor, Prey Veng Province
64	Mr. Mom Dara	IPP, Phsar Skun, Stotep, Choeung Prey, Kampong Cham Province
65	Representative	Vico Company, Kean Svay, Kamdal Province
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67	Representative	Nareth Electric Development Limited, Por Sat Province
68	Representative	Rural Electrical Enterprise, Kratie Province
69	Mr. Noboru Yumoto	PROACT International Inc.
70	Mr. Takuya Takaoka	JICA
71	Mr. Katsuya Takaoka	JICA
72	Mr. Tsutomu Nishikawa	JICA

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<b>No.</b>	<b>Name and Surname</b>	<b>Ministry and another Institution</b>
73	Mr. Yoshihiro Takeshi	JICA
74	Mr. Keiji Shiraki	JICA
75	Mr. Toshiome Sahara	JICA
76	Mr. Takanori Omori	JICA
77	Mr. Kouichi Meguro	JICA
78	Mr. Kazukiyo Kano	JICA
79	Mr. Orm Sarak	Chef of Electricity Power Plants in Kampong Chhnang Province
80	Mr. Chikahiro Masuda	Assistant Resident Representative, JICA Cambodia Office
81	Mr. Curtis	EDC, NGOs
82	Mr. Long Nget	IPP, Phar Thnal Tateng, Ang Snoul, Kamdal Province
83	Mrs. Ouch Por	IPP, Prey Kabas, Takeo Province
84	Mr. Laur Nguon	IPP, Phar Kampong Kantout, Kamdal Steng, Kamdal Province

**LIST OF PARTICIPANT**  
***Seminar on Dissemination of Electric Technical Standards***  
***in The Kingdom of Cambodia***

*Wednesday 04 February 2004*  
*at Conference room of MIME (4<sup>th</sup> floor new building)*

**Name of Participants on Workshop**

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2	H.E. Khlaut Randy	Under Secretary of State, MIME
3	H.E. Ngoun Nov	General Director of Industry, MIME
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5	Mr. Chan Soheat	Deputy Director of Energy, Technique, MIME
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7	Mr. Toch Sovanna	Head of Renewable Energy Office, MIME
8	Mrs. Chum Sopha	Deputy Head of Research Office, MIME
9	Mr. Heang Bora	Deputy Head of Energy Efficiency and Standard Office, MIME
10	Mr. Nong Chhavyvann	Officer of Energy Efficiency and Standard Office, MIME
11	Mr. Choun Thea	Officer of Energy Efficiency and Standard Office, MIME
12	Mr. So Veasna	Deputy Head of Energy Efficiency and Standard Office, MIME
13	Mr. Tun Lean	Deputy General Director of Energy, MIME
14	Mr. Victor Sona	Deputy Director of Energy Development, MIME
15	Dr. Bun Narith	Director of Hydro-Electricity Department, MIME
16	Mr. Suon Ponnarith	Deputy Head of Hydro-Electricity Department, MIME
17	Mr. Yim Nolson	Deputy Managing Director of EDC
18	Mr. Houg Chantha	Head of Technical Office, EDC
19	Mr. Oun Hemrith	Deputy Head of 5~6 Power Plants, EDC
20	H.E. Ty Norin	Chairman of EAC
21	Mr. Nong Rithya	Legal Officer, EAC
22	Mr. Teng Saroeun	Legal Officer, EAC
23	Mr. Hing Kunthap	Advisor of Department of Energy Technique, MIME
24	Mr. Andrew Willianson	Advisor of Department of Energy Technique, MIME
25	Mr. Kaoru Nishiwaki	JICA Expert, MIME
26	Mr. Catry Dominique	Chairman of Comin Khmer Co., Ltd.
27	Mr. Seng Thaug	Consultant CEC
28	Mr. Thai Ford	Director of Khmer Solar Co., Ltd.
29	Mr. Sok Sila	Jupiter Co., Ltd.
30	Representative	Cambodia Utility, Phnom Penh City
31	Representative	GTS Independent Power Producer (IPP), in Kampong Cham Province
32	Mr. Chea Sopha	IPP, in Siem Reap and Battambang Province
33	Mr. Huor Pheng	IPP, in Kampong Thmar, Kampong Thom Province
34	Representative	CETIC, Kirirum Small Hydro Power Station, in Kampong Speu Province
35	Representative	PRANASY, IPP, in Battambang Province
36	Representative	MSP, IPP, in Pay Lin City
37	Mrs. Kim Neang	Van Long Company, Kampot Province
38	Representative	Ann Co., Company, Banteay Meanchey Province
39	Representative	Turbo Industrial, Kampong Thom Province



**LIST OF PARTICIPANT**  
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*Wednesday 04 February 2004*

*at Confernce room of MIME (4<sup>th</sup> floor new building)*

**Name of Participants on Workshop**

No.	Name and Surname	Ministry and another Institution
40	Mr. Mak Thon	IPP Kirivong Takeo Province
41	Representative	Duty Fre Shop, Koh Kong and Oudo Meanchey Province
42	Mr. Srey Sokhom	IPP, Samrong Yon, Takeo Province
43	Mr. Keo Kuhoy	IPP, Trang, Takeo Province
44	Mrs. Bun Liv	IPP, Nek Loeung, Prey Veng Province
45	Mr. Ky Sophea	IPP, Pea Reang, Prey Veng Province
46	Mr. Teo Kok Eng	IPP, Treal Kanpong Thom Province
47	Mr. Chhou Lay	IPP, Prey Kabas, Takeo Province
48	Mr. Nov Sokha	IPP, Nek Loeung, Kandal Province
49	Mr. Kong Phat	IPP, Thma Sar, Takeo Province
50	Mr. Khun Sambo	IPP, Prey Chhor, Kampong Cham Provice
51	Representative	Global Power Sytem, Prey Veng Province
52	Representative	Peace Cambodia Investment, Takeo Province
53	Mr. Chang Bunna Ret	IPP, Phaav, Kampong Cham Province
54	Mr. Ku Sour	IPP
55	Mr. Samreth Sothy	IPP, Sre Ambel, Koh Kong Province
56	Mr. Sok Thy	IPP, Viel Regn, Sihanouk Ville
57	Mr. Ly Bunthy	IPP, Stoeung Hav, Sihanouk Ville
58	Mr. Ngen Kung	IPP, Baray, Kampong Thom Province
59	Mrs. Chhuy Phoout	IPP, Puok, Siem Reap Province
60	Mrs. Porch Kim	IPP, Ka Andoeuk, Kampong Trabek, Prey Veng Province
61	Mr. Kim Chandara	IPP, Phar Baray, Kampong Thom Province
62	Mr. Ty Sokun	IPP, Sala Lekh Pram, Kampong Tralage, Kampong Chnang Province
63	Mr. Seng Sokun	IPP, Phsar Svay Antor, Prey Veng Province
64	Mr. Mom Dara	IPP, Phsar Skun, Stotep, Choeung Prey, Kampong Cham Province
65	Representative	Vico Company, Kean Svay, Kamdal Province
66	Representative	Sovany Electric Development Limited Kampong Chnang Province
67	Representative	Nareth Electric Development Limited, Por Sat Province
68	Representative	Rural Electrical Enterprise, Kratie, Province
69	Mr. Noboru Yumoto	PROACT International Inc.
70	Mr. Takuya Takaoka	Electric Power Development Co., Ltd.
71	Mr. Katsuya Takaoka	Electric Power Development Co., Ltd.
76	Mr. Takanori Omori	Electric Power Development Co., Ltd.
78	Mr. ChikahiroMasuda	Assistant Resident Representative, JICA Cambodia Office
79	Representative	JICA Cambodia Office
80	Mr. Curtis	
81	Mr. Long Nget	IPP, Phar Thnal Tateng, Ang Snoul, Kamdal Province
82	Mrs. Ouch Por	IPP, Prey Kabas, Takeo Province
83	Mr. Laur Nguon	IPP, Phar Kampong Kantout, Kamdal Steng, Kamdal Province

**LIST OF PARTICIPANT**  
*Seminar on Dissemination of Electric Technical Standards*  
*in The Kingdom of Cambodia*  
*Wednesday 04 February 2004*  
*at Conference room of MIME (4<sup>th</sup> floor new building)*

**Name of Participants on Workshop**

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85	Representative	JICA Cambodia Office
86	Mr. Curtis	
87	Mr. Long Nget	IPP, Phar Thnal Tateng, Ang Snoul, Kamdal Province
88	Mrs. Ouch Por	IPP, Prey Kabas, Takeo Province
89	Mr. Laur Nguon	IPP, Phar Kampong Kantout, Kamdal Steng, Kamdal Province
90	Mr. Song Seng Huort	Director of Industry, Phnom Penh
91	Mr. Head Office	Head Office of Electricity, Phnom Penh
92	Mr. Hak Vandy	Director of Industry, Kandal Province
93	Mr. Head Office	Head Office of Electricity, Kandal Province
94	Mr. Director	Director of Power Plant, Kandal Province
95	Mr. Horn Soy	Director of Industry, Kampong Chhnang Province
96	Mr. Head Office	Head Office of Electricity, Kampong Chhnang Province
97	Mr. Orm Sovanrak	Director of Power Plant, Kampong Chhnang Province
98	Mr. Sok Born	Director of Industry, Kampong Speu Province
99	Mr. Head Office	Head Office of Electricity, Kampong Speu Province
100	Mr. Director	Director of Power Plant, Kampong Speu Province
101	Mr. Vegn Hen	Director of Industry, Takoe Province
102	Mr. Head Office	Head Office of Electricity, Takoe Province
103	Mr. Director	Director of Power Plant, Takoe Province
104	Mr. Moch Chhun Horn	Director of Industry, Kampot Province
105	Mr. Head Office	Head Office of Electricity, Kampot Province
106	Mr. Director	Director of Power Plant, Kampot Province
107	Mr. Director	Director of Industry, Krong Keap
108	Mr. Head Office	Head Office of Electricity, Krong Keap
109	Mr. Director	Director of Power Plant, Krong Keap
110	Mr. Director	Director of Industry, Krong Preah Sihanouk
111	Mr. Head Office	Head Office of Electricity, Krong Preah Sihanouk
112	Mr. Director	Director of Power Plant, Krong Preah Sihanouk
113	Mr. Lok Sambat	Director of Industry, Kampong Thom Province
114	Mr. Head Office	Head Office of Electricity, Kampong Thom Province
115	Mr. Director	Director of Power Plant, Kampong Thom Province
116	Mr. Soun Dy	Director of Power Plant, Kampong Cham Province
117	Mr. Head Office	Head Office of Electricity, Kampong Cham Province
118	Mr. Director	Director of Power Plant, Kampong Cham Province
119	Mr. Sok Pheng	Director of Power Plant, Prey Veng Province
120	Mr. Head Office	Head Office of Electricity, Prey Veng Province
121	Mr. Director	Director of Power Plant, Prey Veng Province
122	Mr. Neang San Art	Director of Industry, Svay Ring Province
123	Mr. Head Office	Head Office of Electricity, Svay Ring Province
124	Mr. Director	Director of Power Plant, Svay Ring Province
125	Mr. Thy Sareurn	Director of Industry, Koh Kong Province

## LIST OF PARTICIPANT

### *Seminar on Dissemination of Electric Technical Standards in The Kingdom of Cambodia*

*Wednesday 04 February 2004*

*at Conference room of MIME (4<sup>th</sup> floor new building)*

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No.	Name and Surname	Ministry and another Institution
126	Mr. Head Office	Head Office of Electricity, Koh Kong Province
127	Mr. Director	Director of Power Plant, Koh Kong Province
128	Mr. Mao San	Director of Industry, Pursat Province
129	Mr. Head Office	Head Office of Electricity, Pursat Province
130	Mr. Director	Director of Power Plant, Pursat Province
131	Mr. Chy Chheang	Director of Industry, Battambang Province
132	Mr. Head Office	Head Office of Electricity, Battambang Province
133	Mr. Director	Director of Power Plant, Battambang Province
134	Mr. Vek Ran	Director of Industry, Banteay Meanchey Province
135	Mr. Head Office	Head Office of Electricity Banteay Meanchey Province
136	Mr. Director	Director of Power Plant, Banteay Meanchey Province
137	Mr. Iv Sameth	Director of Industry, Kratie Province
138	Mr. Head Office	Head Office of Electricity, Kratie Province
139	Mr. Director	Director of Power Plant, Banteay, Kratie Province
140	Mr. Phneg Chea	Director of Industry, Stung Treng Province
141	Mr. Head Office	Head Office of Electricity, Stung Treng Province
142	Mr. Director	Director of Power Plant, Banteay, Stung Treng Province
143	Mr. Hem Van Than	Director of Industry, Ratanakiri Province
144	Mr. Head Office	Head Office of Electricity, Ratanakiri Province
145	Mr. Director	Director of Power Plant, Ratanakiri Province
146	Mr. Kung Peseth	Director of Industry, Mondokiri Province
147	Mr. Head Office	Head Office of Electricity, Mondokiri Province
148	Mr. Director	Director of Power Plant, Mondokiri Province
149	Mr. Chhorn Chan Tha	Director of Industry, Odormeanchey Province
150	Mr. Head Office	Head Office of Electricity, Odormeanchey Province
151	Mr. Director	Director of Power Plant, Odormeanchey Province
152	Mr. Sam Leang Ny	Director on Industry, Preah Vihear Province
153	Mr. Head Office	Head Office Electricity, Preah Vihear Province
154	Mr. Director	Director of Power Plant, Preah Vihear Province
155	Mr. Y Hoeun	Director of Industry, Paylen Krong
156	Mr. Head Office	Head Office of Electricity, Paylen Krong
157	Mr. Director	Director of Power Plant, Paylen Krong
158	Representative	Ministry of Construction
159	Representative	Ministry of Environment
160	Representative	Ministry of Water Resources
161	Representative	Ministry of Rural Development
162	Representative	Ministry of Economic
163	Representative	Ministry of Economic
164	Representative	Cambodia Development Council

## **2. CONCLUSION AND RECOMMENDATION**

## **CONTENTS**

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## 2. CONCLUSION AND RECOMMENDATION

Promulgation of the Electric Power Technical Standards of Cambodia and observance of the Technical Standards lead to improved power supply qualities (concerning voltages, frequency, outages, etc.). Therefore, it could be easy to expand the power system, receive power from the public system, supply power to the system including power purchases from neighboring countries by means of external power system interconnection, and connect the private power consumers that own generating facilities. As a result, people in Cambodia and neighboring countries could enjoy receiving electricity with stability, safety and no interruptions at a reasonable cost. It is recommended that the Ministry of Industry, Mines and Energy (MIME) take immediate steps to promulgate the Technical Standards with maximum efforts.

### 2.1 Promulgation of the Electric Power Technical Standards

The following are the results expected to be seen immediately after the promulgation of the Technical Standards.

#### 2.1.1 Effects Related to Operation

- 1) Realization of an integrated power system in Cambodia  
Rated frequency and rated voltages with allowances have been designated by the Technical Standards. Therefore, the present, regionally-separated power systems could easily be interconnected in accordance with the basic power sector policy in Cambodia.
- 2) Prohibition of electrical work by unqualified persons will lead to reduced energy losses in transmission/distribution systems. The electric tariff could then be reduced since the cost of the power will be reduced
- 3) By the common rules of electric power, anyone may easily connect power facilities to the system, and the Technical Standards will assure a continuous electricity supply. Consequently, the stability of the power supply system will be improved, and the demand increases by the new connections will improve the business.

- 4) For the above reasons, prospective customers who own private generating facilities will connect to the public power system. The growth of public power demand will be greatly increased.

#### **2.1.2 Effects Related to Safety**

- 1) By complying with the Technical Standards, electrical accidents such as those caused by leakage or electric shock, fire, or damage to electric power facilities can be avoided.
- 2) After promulgation of the Technical Standards of Cambodia, products with poor quality from outside Cambodia would not be brought into the country.

#### **2.1.3 Effects Related to Environmental Preservation**

A clause in the Technical Standards addresses environmental preservation, and their promulgation is expected to lead to a cleaner environment in regard to electric power facilities.

### **2.2 Implementation of the Electric Power Technical Standards**

It is not practical to apply the Technical Standards to all power facilities immediately after their promulgation. Therefore, a provisional clause (Clause 5) is included in the standards. It has been decided to allow a certain amount of time for replacement of facilities not in compliance with the Technical Standards perhaps two years for environmentally harmful facilities and facilities not causing harm could be operated as is until their time of replacement. Most existing facilities could be handled by this provisional clause. Enforcement is to be at the discretion of the EAC in accordance with the Electricity Law.

### **2.3 Promotion and Observance of the Electric Power Technical Standards**

The most important issue is to promote the Technical Standards and ensure that licensees conform to these standards. When the Electric Power Technical Standards of Cambodia are promulgated,

the EAC's work will become more practical and tangible. In order for the EAC's work to be efficient, trial-and-error practice is not recommended. Instead, standardized procedures should be developed for routine work through the preparation of appropriate job manuals. The preparation of such manuals should progress as a reasonable priority in view of schedule requirements.

#### **2.4 Qualified Electrical Engineers and Electricians**

Based on useful Japanese practices, the JICA Study Team has proposed employing qualified electrical engineers, along with qualified electricians, to supervise power facilities. These ideas have been accepted by MIME/EAC/EDC and put into the Technical Standards (Draft) (Clause 4: 4-3 and 4-4).

The Technical Standards (Clause 4-3) require the licensee to employ a qualified electrical engineer to supervise power facilities in accordance with the Technical Standards. However, the details and selection criteria have not yet been determined. In this connection, it is recommended that legislative procedures be studied regarding qualified electrical engineers, taking into consideration the situation in Cambodia and practical procedures.

Since the Technical Standards (Clause 4-4) require electric work to be carried out by qualified electricians, it is recommended that the details concerning qualified electricians be studied urgently, so that persons who complete a training course with a predetermined skill level can be licensed.

#### **2.5 Maintenance of the Survey Report of Electric Power Supply Facilities**

The Survey Report of Electric Power Supply Facilities in Cambodia is a single report for compiling facility data of various kinds, and it will be used by various people. Therefore, MIME should update the report from time to time.



## 2.6 Maintenance of the Guidebook for Power Engineers

The Guidebook for Power Engineers should be maintained by MIME in coordination with EAC/EDC and others concerned.

The JICA Study Team's counterparts proposed that more detailed engineering sheets be added to the Guidebook, but the engineers who wish to use the more-detailed data and information must be proficient in English. Therefore, as a practical matter it would be better for them to use specialized *engineering books and/or materials* published in the developed countries. In this connection, there is no technical assistance for preparing a Guidebook for power engineers in Khmer.

## 2.7 Application to the Rural Electrification

During the public consultation, there was an opinion to exempt the electric power facilities in rural areas from the Electric Power Technical Standards of Cambodia since most of these facilities do not comply with the standards. However, this could be handled by the Provisional Clause (Clause 5) of the Technical Standards. This clause can be applied to the existing power facilities regardless of whether they are located in rural areas or cities. Further details are as follows.

- 1) The Technical Standards have been prepared based on the purpose of the Electricity Law of Cambodia in reference to Article 5.

The EAC is to ensure that licensees use the Technical Standards related to technical operation, safety and the environment. Therefore, no consideration is made of whether the license applies to a rural area or a city.

- 2) In Cambodia, the power system is to be integrated as a National Grid in the future, therefore, it should not consider whether rural or city areas. In view of safety and protection from possible disasters, it should not be distinguished whether rural or city areas and the discrimination of the people where they are living are not preferable in view of the human rights. In the reasons stated above, the basic concept to prepare the Technical Standards is that new facilities should be complied with the Technical Standards.

- 3) In the remote area, there is a subsidy from the government for rural electrification; therefore, the licensees whose businesses are economically non-viable could get the governmental subsidy for the electrification.

## **2.8 Detailed Rules for the Electric Power Technical Standards**

- 1) A proposal was made to prepare detailed rules and regulations for the Electric Power Technical Standards. It is understood that such detailed descriptions would be necessary because the Technical Standards were general rules. However, if created under the Electric Power Technical Standards of Cambodia, such detailed rules may present people with more regulations, and more complexity, and this is unrealistic. "Simple is best" may be the best course.
- 2) Another proposal was made to create Cambodia Industry Standards (CIS) in this connection. Considering that Cambodia is not an industrial country and relies on imports for most industrial products, the Government of Cambodia would have to establish an inspection organization and inspection stations to check all imported products for compliance if such industrial standards were published. This would be very expensive for the Government and would impede the delivery of imported goods. As such a situation can be anticipated, it can be concluded that it is too early to prepare such industrial standards. As an alternative, it would be more practical and time-saving to stipulate by law that MIME would approve imported goods as acceptable in Cambodia when those goods meet the industrial standards of specified industrialized countries.

## **2.9 Technical Assistant to the Power Sector**

After the JICA Study, activity in the power sector, including that by MIME/EAC/EDC and licensees will be put on a more practical and material level by the Technical Standards even before the promulgation. This is because the fundamental contents of the Technical Standards will not be

changed significantly.

It is believed that the power sector of Cambodia needs strong international technical cooperation in order for the results of the JICA Study to be maximized, since very rapid power sector development progress is expected. The reasons are as follows.

- 1) In addition to promoting the promulgation of the Technical Standards, MIME must undertake studies to enable qualified electrical engineers to supervise power facilities and qualified electricians to staff them as soon as possible.
- 2) In advance of the promulgation of the Technical Standards, the EAC, to improve its efficiency, must standardize routine work, since many unexpected tasks and jobs will disturb that work.
- 3) After promulgating the Technical Standards, the power sector of Cambodia will develop very quickly and various new issues, both engineering and legal, are expected to be faced by the EAC.
- 4) The EAC will face these engineering issues:
  - a) Power system planning
  - b) Power system operation
  - c) Interconnection with Vietnam (the first 230kV system)
  - d) Power demand/supply planning for power dispatching

**3. PRESENT SITUATION  
OF  
THE POWER SECTOR IN CAMBODIA**

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### 3. PRESENT SITUATION OF THE POWER SECTOR IN CAMBODIA

#### 3.1 Power Sector in Cambodia

##### 3.1.1 Electricity Law of the Kingdom of Cambodia

The Electricity Law was promulgated by Royal Decree No. NS/RKM/0201/03 dated February 02, 2001.

The Law aims;

- (1) To establish consumers' right to enjoy the electric power to be supplied with a reasonable tariff rate and adequately reliable quality.
- (2) To promote the private ownership of electric power supply service facilities.
- (3) To establish a competition of the power sector business under the condition most appropriate to the electric power sector.
- (4) To establish Electricity Authority of Cambodia (EAC) who has the right and the duty to regulate the electric power supply business, and to impose a power supplier or a consumer a penalty as necessary relating to the power generation and supplying equipment.
- (5) To generate a market condition benign to investments and business of the electric power industry.

The Law consists of 13 Chapters and 79 Articles as shown below;

Chapter 1	General Provisions
Chapter 2	Framework of the Electric Power Supply and Services
Chapter 3	Establishment of the Electricity Authority of Cambodia
Chapter 4	Functioning of Electricity of Cambodia
Chapter 5	Type of Licenses
Chapter 6	Licensing of Electric Power Utilities
Chapter 7	Tariffs
Chapter 8	Other Regulations on the Electric Power Services
Chapter 9	Enforcement of the Authority
Chapter 10	Administration
Chapter 11	Penalties, Sanctions and Fines
Chapter 12	Transitional Provisions
Chapter 13	Final Provisions

### 3.1.2 Organization of the Power Sector Administration in Cambodia

The Ministry of Industry, Mines and Energy (MIME) and the Electricity Authority of Cambodia (EAC) are in charge of the Electricity Sector Administration in Cambodia under the control of the Royal Government of Cambodia. Constitutional configuration of the electricity sector administration and the electricity industry in Cambodia is shown in Fig. 3.1.1.

#### (1) Ministry of Industry, Mines and Energy (MIME)

##### 1) Role of MIME

The Ministry of Industry, Mines and Energy (MIME) is roughly composed of administration departments and the following three directorates:

- Directorate of Industry, in charge of industry, handicraft, industrial standard, water supply etc.;
- Directorate of Mineral Resources, in charge of natural resources such as mineral resources; and
- Directorate of Energy, in charge of the electricity and energy sectors.

Exceptionally the Cambodia National Petroleum Authority (CNPA), which is a government authority independent from MIME, is responsible for development and regulation of petroleum and natural gas in the energy sector in Cambodia.

The Energy Directorate of MIME is responsible for setting and administrating the government policies, strategies, planning, and technical standards in the power sector in Cambodia.

##### 2) Organization of the Energy Directorate of MIME

Under the Minister of MIME (H.E. Suy Sem), the Secretary of State (H.E. Ith Praing) and the Under Secretary of State (H.E. Khlaut Randy) are in charge of the energy sector.

The Energy Directorate is composed of the following three departments:

- Department of Energy Technique (DET);
- Department of Energy Development (DED); and
- Department of Hydro-Electricity (DHE).

Eighty-two (82) staff members are enrolled in the Directorate. (see Figs.3.1.2 and 3.1.3) Each department consists of three offices and each office has a total enrollment of 6 to 11 staff members. The directors, the organization, and the number of staff in each department are as follows:

- (a) Department of Energy Technique (DET): 27 staffs
  - Deputy General Director: Dr. Sat Samy
  - Standard and Energy Efficiency Office
  - Renewable Energy Office
  - Research Office
- (b) Department of Energy Development (DED): 27 staffs
  - Deputy General Director: Mr. Tun Lean
  - Planning Office
  - Rural and Provincial Electricity Office
  - Cooperation Office
- (c) Department of Hydro-Electricity (DHE): 28 staffs
  - Director: Dr. Bun Narith
  - Hydropower Planning Office
  - Hydropower Project Office
  - Mekong River Office

(2) Electricity Authority of Cambodia (EAC)

1) Role of EAC

MIME had been responsible to act overall administrative matters as the government organization on the Power Sector in Cambodia. By the Electricity Law of Cambodia promulgated on February 02, 2001 EAC was established as a legal public entity, being granted the right from the Royal Government to be an autonomous agency to regulate the electricity services and top govern the relation between the delivery, receiving and use of electricity. EAC became the first Asian autonomous electric power service control entity whose income comes from licensing fees to be paid by the electric power service entities.

The followings are the major duties on EAC given by the Law:

- (a) To issue, suspend, revoke or deny the licenses for the supply of electricity services;
- (b) To approve tariff rates and charges and terms and conditions of the electric power services of licensees;
- (c) To order to implement guidance procedures and standards for investment programs by



licensees:

- (d) To review the financial activities and corporate organization structure of licensees, as needed;
- (e) To approve and enforce the performance standards for licenses;
- (f) To evaluate and resolve consumers' complains, and arbitrate complaints and disputes relating to violation of the conditions of the license;
- (g) To approve and enforce a management a uniform system of accounts for all licensees
- (h) To prepare and publish reports of power sector and relevant information received from licensees for the benefit of the Government and public interest;
- (i) To issue rules and regulations and to make appropriate orders, and to issue temporary and permanent injunction for electric power services;
- (j) To impose penalties, for violations of this Law, standards and regulations of the Electricity Authority of Cambodia;
- (k) To require the electric power services and the customers to obey the rules relating to the national energy security, economic, environment and other Government policies.

## 2) Organization of EAC

On February 17, 2001, His majesty King of Cambodia has assigned Dr. Ty Norin, the Deputy Managing Director of Electricite de Cambodia (EDC) as the Chairman of EAC in accordance with the Electricity Law of Cambodia. EAC has created the EAC's new organization and prepared the necessary rules and regulations for starting the electric power sector administration jobs as are designated by the Law.

The top decision making organization of EAC is EAC Board meeting consisting of the Chairman and the two Deputy Chairmen. Under the Board meeting, a secretariat is organized. Executive Director is assigned as the top of the secretariat which is composed of the five departments each of which has two rooms.

Figure 3.1.4 shows the organization chart of EAC. As of December 2002, there are 35 members of the EAC staff including the Chairman.

- (a) Administration and Personnel Department
  - Administration Office
  - Personnel Office
- (b) Electricity Regulation Department
  - Transmission and Distribution Regulation Office

- Generation Regulation Office
- (c) Financial and Pricing Department
  - Financial and Pricing Office
  - Accounting Office
- (d) Legislation Department
  - Legislation Office
  - Investigation Office

3) Issuance of Electricity Licenses for the electric power supply service

Figure 3.1.1 and Figure 3.1.5 show the results of the issuance of the Electricity Licenses for the electric power supply service as of February 2003.

EAC has issued a total of 24 licenses including 13 consolidated licenses, 7 generation licenses and 4 distribution licenses, started from February 1, 2002 when the licenses were issued to EDC and CUPL.

### 3.1.3 Energy Sector Development Policy

The Royal Government of Cambodia formulated and announced the Energy Sector Development Policy in October 1994. Its contents are as follows:

- (1) To provide an adequate supply of energy throughout Cambodia at reasonable and affordable price;
- (2) To ensure a reliable, secure electricity supply at prices, which facilitate investment in Cambodia and development of the national economy;
- (3) To encourage exploration and environmentally and socially acceptable development of energy resources needed for supply to all sectors of the Cambodian economy; and
- (4) To encourage efficient use of energy and to minimize detrimental environmental effects resulting from energy supply and use.

### 3.1.4 Cambodia Power Sector Strategy 1999-2016

In January 1999, MIME developed a long-term power sector strategy, "Cambodia Power Sector Strategy 1999-2016" (herein after referred as "Power Sector Strategy"), for Cambodia to meet the growing demand for electric power over the next 20 years in January 1999. The Strategy was formulated based on the study in June 1998 on "Power Transmission Master Plan & Rural Electrification Strategy" supported by the World Bank. The Power Sector Strategy is an essential

basis for the power sector planning in Cambodia.

The Power Sector Strategy consists of a long-term power sector strategy and an action plan until 2016. The contents are as follows:

**The table of contents for "Cambodia Power Sector Strategy 1999-2016"**

1. Introduction
2. Power Sector Development Policy
3. Sector Reforms and Rehabilitation of Power Sector
4. Objectives of the Cambodian Power Sector Strategy
5. Investment Strategy in the Power Sector
6. Priorities for Generation and Transmission
  - 6-1. Generation Master Plan
  - 6-2. Transmission Master Plan
  - 6-3. Provincial Towns' Electrification Plan
  - 6-4. Rural Electrification
  - 6-5. Electricity Trading with Neighboring Countries
7. Establishment of Power Sector Regulatory Framework
  - 7-1. Electricity Law
  - 7-2. Establishment of Electricity Authority of Cambodia (EAC)
8. Commercialization of the Supply of Electricity
  - 8-1. Commercialization of EDC and Marketing Strategy
  - 8-2. Commercialization of Provincial Electricity Supplies
9. Private Sector Participation in Power Projects
  - 9-1. Experience Gained from the Past Five Years
  - 9-2. Private Sector Participation Policies
10. Environment Policy and Legislation in Cambodia

### **3.2 Structure of Power Industry**

There are 3 main types of suppliers of power industry in Cambodia. All power businesses have been required to acquire licenses since February 2002 under the Electricity Law of The Kingdom of Cambodia. (Refer to Figure 3.1.1)

(1) Electricité du Cambodge (EDC)

EDC is the major power utility in Cambodia and supplies power to the main provincial capitals and other urban towns. A greater part of the electric power businesses are operated by EDC.

(2) Provincial Department of Industry, Mines and Energy (DIME)

Each DIME belongs to MIME and supplies power to provincial capitals and local cities. The service areas of DIME will be taken over by EDC in the future.

(3) Small private power companies

There are small private power companies which supply power to small towns or communities.

(4) Types of License

- 1) Generation License
- 2) Transmission License
- 3) Dispatch License
- 4) Distribution License
- 5) Bulk Sales License
- 6) Retail License
- 7) Subcontract License
- 8) Consolidated License

**3.2.1 Electricité du Cambodge (EDC)**

EDC is a wholly state owned limited liability company under the control of MIME and the Ministry of Economy and Finance (MEF). In February 2002, EDC obtained the Consolidated License from EAC. It supplies power in 9 areas shown in Table 3.1.1 and Fig.3.1.5 as of February 2003.

The following 7 areas are to be added to EDC service area after the completion of the Provincial Power Supply Project supported by Asian Development Bank (ADB):

- (1) Banlung (Ratnak Kiri Province);
- (2) Kampot;
- (3) Prey Veng;
- (4) Sisophon (Bantey Mean Chey Province);
- (5) Stung Treng;
- (6) Svay Rieng; and

(7) Kampong Speu

EDC is scheduled to supply power to all 20 provincial capitals and 4 municipalities in Cambodia in the future.

The organization of EDC is shown in Fig. 3.2.1. The number of employees is 1,334 in Phnom Penh, 339 in the other service areas (Sihanoukville, Siem Reap, Kampong Cham, Takeo and Battambang), which is 1673 in total as of May 2003.

### 3.2.2 Ministry of Industry, Mines and Energy (MIME)

The Provincial Departments of Industry, Mines and Energy (DIME) presently provide electricity services to provincial capitals and municipalities besides the areas where EDC provides electricity services.

(1) Areas where DIMEs provide services from generation to distribution (3 provincial capitals)

- Kratie
- Prey Veng
- Banlung (Ratanak Kiri Province)

(2) Areas where private companies (IPP), who are approved by MIME under BOT contracts, provide generation services (4 provincial capitals)

- Kampot
- Kampong Chhnang
- Pursat
- Sisophon (Banteay Meanchey Province)

(3) The other areas

A private company in Koh Kong supplies electricity imported from Thailand. Private companies supply electricity in the other provincial capitals and municipalities. (see remarks column in Table 3.2.1. Combination of an IPP (BOT) and a private company in Sisophon (Banteay Meanchey Province). No relevant information is available for Kaeb and Otdar Meanchey Province)

### 3.2.3 Private Supplier

The twenty three entrepreneurs already acquired electric enterprise license from EAC up to as shown in Table -3.1.1.

(1) Twelve consolidated licensees for the electricity power service, other than EDC.

- (2) Seven generation licensees (IPPs)
- (3) Four power distribution licensees (electric power supply business by 22kV power lines from Thailand)

In addition to the above, approximately six hundred unlicensed small-scale electric power suppliers (by means of small diesel generators or battery chargers) are doing small scale power service businesses. (refer to "Rural Electrification Strategy and Implementation Strategy").

#### **3.2.4 A local Electric Power Supply System**

The electric power supply services are classified into the following three categories for the local or remote areas:

- (1) The village with 1,000 or more houses : A small-scale generator (diesel) and a low-voltage distribution network
- (2) The village with less than 300 houses : Individual systems (battery for every house etc.)
- (3) The village with 300 houses or more but with less than 1000 houses : Mixture of (1) and (2)

#### **3.2.5 History of the Electricity Industry in Cambodia**

Electricity was introduced to Cambodia for the first time in 1906 by Compagnie des Eaux Electricité (CEE), Union d'Electricité d'Indochine (UNEDI), and Campangnie Franco-Khmer d'Electricité (CFKE). CEE was responsible for supplying the electricity to Phnom Penh and its suburb, while UNEDI was operating throughout country except Battambang Province where CFKE supplied electricity.

In October 1958, Cambodian Government purchased the licenses from the CEE's and UNEDI's and newly established the Electricité du Cambodge (EDC). During the long war, EDC's facilities were destroyed and neglected.

In 1979, EDC was re-integrated into an administrative structure under the Ministry of Industry and then transferred under management of the Phnom Penh Municipality in 1991, by the name Electricité de Phnom Penh (EDP) to manage electric supply in Phnom Penh. The electric power services in the provinces were managed by the Department of Industry of the Provincial Authorities.

In 1992, EDP was re-named again as Electricité du Cambodge and attached to the Ministry of Energy. After the national election in 1993, EDC was transferred to the Ministry of Industry, Mines and Energy (MIME) and is responsible for development, management, and operation of the power system in Phnom Penh. Power utilities in the provinces are under control of the Provincial Authorities that receive budgetary support through MIME.

In March 1996, by the Royal Government decree, Electricité du Cambodge (EDC) was re-born as a wholly state-owned limited liability company to generate, transmit, and distribute electric power throughout Cambodia. EDC is a public entity and is responsible for its own management, finance, and business. EDC is responsible for its profit and losses and liable for its debts to the extent of the value of its assets.

By the time of EAC establishment in February 2001, EDC had expanded its service areas to seven areas composed of Phnom Penh and Takmau (one system) in Kandal province, Sihanoukville, Siem Reap, Kampong Cham, Takeo, and Battambang.

In February 2001, the Electricity Law was enacted and the Electricity Authority of Cambodia (EAC) was established to control the electric power business. EAC has issued twenty four licenses in total as of February 2003 to the electricity services (electricity utilities) composed of 13 consolidated licenses, seven generation licenses, and four distribution licenses as shown on Table 3.1.1.

### **3.3 Electricity Supply Facilities**

#### **3.3.1 Generation Facilities**

In early 90's the war and conflicts ended in Cambodia. A decade has passed since donors' assistance were restarted for this country. The first stage of the rehabilitation and recovery of Cambodia has just been completed. But the electricity system still remains small size and a large power plant has not developed yet even for the capital city Phnom Penh.

The total installed capacity of generation facilities in the whole Cambodia has reached approximately 190MW, most of which consists of thermal power plants mainly with small size diesel generators. The installed capacity of generation facilities in Phnom Penh where the maximum demand occurs dominates in the proportion of the generation capacity in the whole country. (around 72%, see Table 3.2.1). The hydroelectric power plants were developed in only 13 MW total with two sites.

##### **(1) Thermal Power Plant**

- 1) EDC's supply areas
  - Phnom Penh and Ta Khmau

The power generation facilities in Phnom Penh and Ta Khmau of Kandal Province are shown on Figure-3.3.1 for EDC and Figure-3.3.2 for IPPs.

The total installed capacity of EDC and IPPs(3 companies including a hydro) is 133,800 kW, and the total possible capacity is 121,300 kW.

EDC and IPPs(3 companies) have already got their licenses from EAC for the electric power service.

The total installed capacity of thermal power generation facilities is 121,800 kW and the total possible capacity is 109,300 kW, which covers 90% of Phnom Penh's region capacity.

All power stations except power station C2 (EDC) are diesel engine driven type. The power station C2 is conventional BTG plant. Petroleum oil is used for all of these generators. C2 of EDC and CUPL of IPP's are using heavy fuel oil and other EDC plants and Jupiter(IPP) are using light diesel oil. For the purpose of avoiding the high cost of the light diesel oil, EDC revised C6 power station into the heavy oil combustion station in October 2000.

- Sihanoukville, Siem Reap, Kampong Cham, Takeo and Battambang

The power generating facilities for the above areas are shown in the Figure-3.3.3, Figure 3.3.4, Figure 3.3.5, Figure 3.3.6, and Figure 3.3.7.

All facilities are using light diesel oil for diesel engines.

2) Other capitals of Provinces and special municipality

All power generating facilities in the province other than Phnom Penh are almost diesel engine plant using light diesel oil.

The electric power in Koh Kong province is purchased from Thailand. These generators are shown on Table 3.2.1

3) Remote Areas

For many villages (communes) at remote areas, the electricity is distributed directly from small diesel engine power stations to the consumers.

(2) Hydroelectric Power Facilities

Only two hydroelectric power plants with total capacity 13MW have been developed in Cambodia by February 2003.

1) Kirirom I Hydroelectric Power Plant

Kirirom I Hydroelectric Power Plant is located in Kirirom of Koh Kong Province, at 120km west from Phnom Penh along the national road No.4. The power plant is a dam



and waterway type. The owner of the power plant is a Chinese IPP firm, CETIC International Hydropower Development Co., Ltd. The company sells the electricity to EDC in Phnom Penh through an 115kV transmission line with 120 km long.

The power plant was originally built with a fund and technical cooperation of Yugoslavia. The plant facilities such as electrical and mechanical equipment were destroyed two years and a half after commissioning in the war in Cambodia, and had been neglected until recent year as well as its dam and reservoir. The rehabilitation of the power plant has been hoped and studied since the termination of the war, with a progress in electricity demand in Cambodia. On July 28, 2000, MIME and the China Electric Power Technology Import & Export Co. (CETIC) signed the Implementation Agreement (IA) on the rehabilitation project of Kirirom I Hydroelectric Power Plant. In addition, the Power Purchase Agreement (PPA) on the project was signed by EDC and CETIC. The agreement is based on the BOT contract. The power plant is supposed to be transferred to EDC after its 30-year operation.

The construction work of the power plant was started in April 2001 and the power plant was commissioned with a generation license issued by EAC on April 5, 2002. The 115kV transmission line to Phnom Penh (GS1) with 1 circuit 120km long and the 115/22kV substation at Kampong Spueu on the route of the transmission line were built, and were handed over to EDC after their completion.

The outline of Kirirom I Hydroelectric Power Plant is shown in Table 3.3.8.

#### 2) O Chum Hydroelectric Power Plant

Developed in 1994 by the Vietnamese Government, 960kW O Chum Hydroelectric Power Plant has been supplying the provincial capital of Banlung in Rattanak Kiri with electricity. The power plant is operated and managed by the Department of Industry, Mines and Energy (DIME) of Rattanak Kiri together with distribution facilities.

The outline of O Chum Hydroelectric Power Plant is shown in Table 3.3.9.

### 3.3.2 Transmission System

Electric power facilities in Cambodia are categorized by the voltage level as shown below.

- 1) High-voltage (higher than 35kV),
- 2) Medium-voltage (higher than 600V and 35kV or less)
- 3) Low-voltage (600V or less)

As for high-voltage electrical power facilities, 115kV transmission system is operated in and around Phnom Penh City, which were installed with two projects described below. This system is owned by EDC. Among consolidated Licensees, EDC is the only one Nation wide Transmission

Licensee. Table 3.3.10 and 3.3.11 show the facility list of high-voltage transmission lines and substations, respectively.

(1) Transmission Lines and three Substations in Phnom Penh City

Based on the Transmission Master Plan in the Power Sector Strategy, EDC built and put three 115/22kV substations (North:GS1, South:GS2, West:GS3) in the suburbs of Phnom Penh City and a 115kV transmission system into operation in May 2000, being financed by World Bank, for the purpose of supplying electric power to Phnom Penh city effectively.

(2) Kirirom 1 transmission Line and Kampong Spueu Substation

To transmit power generated at Kirirom 1 Hydro Power Plant to Phnom Penh City and Kampong Spueu, CETIC built, in parallel with the power station development, a 115kV transmission line (129km total length) which connected the power station with GS1 substation in Phnom Penh City via Kampong Spueu where a 115/22kV substation was also built. The transmission line and the substation were transferred to EDC after the completion.

### **3.3.3 Power Distribution Facilities**

(1) Outline of EDC's facilities

Outline of distribution facilities in Phnom Penh and Takhmau of Kandal Province is shown in Table 3.3.12 and those in Siem Reap, Sihanoukville, Kampong Cham and Takeo is shown in Table 3.3.13. Distribution line with voltage between 6.6kV and 22kV is defined as the medium voltage line. EDC is planning to change all medium voltage lines into 22kV lines.

Three districts, Ponhea Krek, Memot of Kampong Cham Province, and Bavit of Svay Rieng Province, which are close to Vietnam, are provided with power from Vietnam via 22kV distribution lines. (see Table 3.1.1)

(2) Interconnection distribution lines between Cambodia and Thailand

There are seven interconnection distribution lines between Cambodia and Thailand in Osmarch (Otdar Meanchey), Ochraov (Banteay Meanchey), Sampou Loun, Phnom Preuk, Kamrieng (Battambang), Phum Phsar Prum (Pailin) and Koh Kong. (see Table 3.1.1)

(3) Others

New projects of interconnection distribution lines between Cambodia and Vietnam are in progress in Snoul, Svay Rieng, Kiri Vong and Kampong Trach.

### 3.3.4 Renewable Energy

In Cambodia, the electric power supply using the renewable energy, mainly photovoltaic generation, has been implemented by assistance of donors, such as NEDO (Japan) and SIDA (Sweden). Local companies are already operated to import and sell the photovoltaic panels.

(1) The pilot project of a solar home system (NEDO)

This is a pilot investigation project using photovoltaic generation by NEDO. Six sets of 240Wp (total 1,440Wp) photovoltaic generator with 90Ah batteries for each set are installed for seven households in a TAKEO state PUNOMUCHISO village. The whole system has a capacity to light forty two households with one fluorescent light each for 4 to 5 hours every day. Operation was started from December, 2000 and monitoring was carried out till March, 2001. By this investigation, the valuable data were obtained for considering rural electrification of future Cambodia. These data were utilized in the subsequent " Assistance Project for the Establishment of the Energy Master Plan for Cambodia ".

(2) Energy master plan support project (NEDO)

NEDO supported the energy master plan project of MIME in response to the request of the Cambodia government. (Assistance Project for the Establishment of the Energy Master Plan for Cambodia) The implementation period was from September, 2001 to March, 2002.

This project assists Cambodia establish the energy master plan and study the possibility of application of alternative energy sources under conditions of Cambodia. As alternative energies, photovoltaic generation, wind power, bio-mass power generation and small hydro were studied.

The result of energy master plan is as follows.

- 1) An energy supply policy for every sector
- 2) Oil alternative energy source application policy (photovoltaic power, wind power, small hydro, and bio-mass power generation)
  - Proposed site selection

- Feasibility study on proposed sites
  - Advice for alternative energy source application (including the possibility and the effect of application)
- 3) Energy-saving technology dissemination policy
- (3) Hybrid System Pilot Project (NEDO)

The outline of the power generation equipment for the hybrid system, by which NEDO is planning the demonstrative research, is shown below.

Photovoltaics and Micro hydro hybrid system

- Site : Tek Chhar, KOMPONCHAMU state
- Equipment capacity : Photovoltaics 80kWp (4x20kWp)  
Micro hydro generation 40kW
- Expected commissioning : 2003

Wind power and biomass hybrid system

- Site : Mong Reth Thy Dairy Farm, Sihanoukville
- Equipment Capacity : Photovoltaics 50KWp Bio-gas Power Generation 60KW
- Expected commissioning : 2003

### 3.3.5 Battery Charge Business

A battery charge business means here;

To operate a shop who receives monetary fees for the service of charging batteries in such manner that the shop regularly charges (the power source is mostly small diesel generators) a customer's batteries (every two or three days) and collect money for this service. Background of the business is such that many rural area inhabitants can not enjoy grid power because they live far away from grids or are not afford to buy grid power even if they reside near grids. These people prepare themselves auto or bike batteries for the purpose of lighting lamps (small fluorescent lamps) and feeding radios. Charging these batteries became a source of business which is so called as "battery charging business" here.

It is estimated that there are about 3,000 battery charge shops (assumed minimum 2,000, maximum of 4,000 shops) throughout the country.

Typical battery charge shop example is shown below.

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Company name	: Intentionally unidentified
Place	: BATTAMBAN
Business since	: 1994
Battery charge equipment	: 45 set capacity
Monthly power consumption	: 1,000 kWh

### 3.4 Power Purchase

The following agreements of cooperation in Power Sector have been made between neighboring countries (Vietnam, Laos, and Thailand) :

- (1) Vietnam : Agreement on the Power Sector Cooperation (June.1999);
- (2) Laos : Agreement on Power Sector Cooperation (October.1999);
- (3) Thailand : Agreement on the Power Sector Cooperation Program (February.2000)

Currently several Cambodian border areas of Thailand and Vietnam are supplied with electric power from these countries through distribution lines based on the above agreements.

Electricity businesses through transmission lines have not been started yet.

For Lao PDR, substantial negotiations have not been started yet for transmission lines nor distribution lines.

#### 3.4.1 Power Purchase from Thailand

As of February 2003, four electric companies purchase electricity from Thailand through medium voltage distribution lines and supply electric power to seven areas, as shown in Table 3.4.1.(for site location, refer to Fig. 3.1.5)

#### 3.4.2 Power Purchase from Vietnam

Power Purchases from Vietnam have been carried out in three places, Baveth (Svay Rieng Province), Ponhea, Krek, and Memot (Kampong Cham Province) since January, 2002.

Additional four areas will be provided with electricity in near future.

All areas are designed to be supplied through the 22kV medium-voltage distribution lines.

Each plan is shown in Table 3.4.2.

(Their locations are referred in Fig. 3.1.5)

### 3.5 Record of the Electricity Supply

Past records of the electricity generation in provincial capitals and municipalities from 1994 to 2002 are shown in Table 3.5.1 and Figs.3.5.1 and 3.5.2. The annual generated power in 2002 were 561,253MWh in the areas; 477,574MWh in Phnom Penh (around 85% of the total). The growth rate of the annual generated power was 17.5% in total and 17.3% in Phnom Penh.

Records of the electricity supply in the EDC's service areas in 2001 and 2002 are shown in Table 3.5.2.

The maximum output (sending end) in Phnom Penh was 86.6MW in 2001 and 91.9MW in 2002. The annual generated power was 426,970MWh, 477,574MWh in 2001, 2002 respectively. The annual power demand was 364,150MWh, 418,088MWh in 2001, 2002 respectively. The annual growth rate during the period was 6.1% for the maximum output, 11.9% for the annual generated power, and 14.8% for the annual power demand. The reason the growth rate for the maximum output was smaller than those for the annual energy was that the generation capacity expansion was insufficient during the period causing a power shortage.

In the EDC's service areas except for Phnom Penh, the maximum power output (sending end) was not increased between 2001 and 2002 because of no expansion of generation facilities, but the generated power for off-peak hours was increased. Thus, the electricity supply in the areas is restricted.

The daily load curves (sending end) on the day when monthly maximum demand occurred are shown for 2002 in Fig.3.5.3. Load factors were 56.3% in 2001 and 60.3% in 2002.

### 3.6 Electricity Tariff

At present in Cambodia, there are no substantial networks except the Phnom Penh network. Demand areas and topographical areas are not mutually connected by transmission lines and are electrically isolated each other.

Since the electricity tariff is calculated based on each area's independent cost accounting, tariff varies area to area.

Exchange rate is 3,920 Riel /US\$ in this report.

#### 3.6.1 Electricity Tariff in EDC's Service Area

The electricity tariffs in EDC service areas (Phnom Penh (including Takhmau), Siem Reap, Sihanoukville, Kampong Cham, Takeo, Battambang, Baveth, Ponhea Krek, and Memut) are shown in Table 3.6.1.

They are all straight kWh based tariff, where a binomial tariff has not been adopted.

Electricity tariff in Phnom Penh ranges from 350 to 650 riel/kWh (approximately 9~17 cent/kWh, except for foreigners and governmental institutions) and varies with customer sectors. As for the residential tariff, the kWh-increasing tariff (kWh unit price increases with the increase in a monthly kWh consumption) system is adopted. A subsidy policy exists to subsidize poor families (350 Riel/kWh for the monthly consumption less than 50kWh). On the other hand, the kWh-declining tariff (kWh unit price decreases with the increase in a monthly kWh consumption) system is adapted to the commercial and industrial sectors for the purpose of promoting energy sales.

In Siem Reap and Sihanoukville where the electricity demands are relatively high, the kWh-declining tariff systems are adopted. The tariff in Siem Reap ranges from 635 to 800 riel/kWh (approximately 16~22 cent/kWh). The tariff in Sihanoukville varies with the customer sector and ranges from 500 to 784 riel/kWh (approximately 13~20 cent/kWh), whereas the residential tariff is single tariff at 500 riel/kWh

The tariffs in the other EDC's service areas are classified to 2 types. One is around 900 riel/kWh (approximately 23cent/kWh) in provincial capitals such as Kampong Cham, Takeo and Battambang, and the other is 650 riel/kWh (approximately 16 cent/kWh) in the areas where are not provincial capitals but local towns such as Baveth, Ponhea Krek, and Memut. The electricity in the former area is supplied through small distribution network systems with small scale diesel generators, in the latter areas supplied with the cross border purchased power through medium voltage lines from Vietnam.

As mentioned above, the smaller the electricity system is, the higher is the electricity tariff. But even in the low consumption local areas, the tariffs are lower in the areas where the electricity is supplied from neighboring countries such as Vietnam.

### **3.6.2 Electricity Tariffs Except for EDC's Service Area**

The electricity tariffs in the provincial capitals except for EDC's service areas mentioned above ranges from around 1,000 to 2,000 riel/kWh (approximately 24~51 cent/kWh) (see Table 3.2.1) . They are too high because the distribution network systems are too small with small scale diesel generators including IPP's.

The tariff in Koh Kong is 500 and 600 riel/kWh (for residential use and business use, approximately 13 and 15 cent/kWh respectively) where the electricity is supplied with medium voltage lines across the border of Thailand. The tariff in Ratanak Kiri (Banlung) is 200 and 400 riel/kWh (for residential use and business use, approximately 13 and 15 cent/kWh respectively) which are the lowest in Cambodia because the electricity is supplied by a small scale 1MW hydroelectric power plant (O Chum) , naturally without fuel costs, developed by Vietnamese government.

### **3.6.3 Comparison of Tariffs with Neighboring Three Countries**

Tariff of Electric Power in Cambodia is quite expensive in comparison with neighbor countries (Thailand, Vietnam, Lao PDR). The EDC Phnom Penh tariff is about three times of Thailand (PEA, MEA), 5.5 times of Lao PDR (EdL), and double of Viet Nam (EVN). Such differences are substantially bigger than the above mentioned values when low GDP and income per capita are taken into considerations, which implies the electricity is quite expensive for average people. Such high costs are caused largely by small scale diesel generators and imported fuel oil. Therefore, unexplored indigenous energy resources, such as hydro-electric, natural gas and petroleum, should urgently be developed.

### **3.7 Development Plan for Electricity Supply Facilities**

The electric power supply development plan of Cambodia is based on a World Bank's study "Power Transmission Master Plan & Rural Electrification Strategy (1998)". With this background, MIME released "Cambodia Power Sector Strategy 1999~2016"(hereinafter referred as Power Sector Strategy) in January 1999. The Power Sector Strategy was partially revised in November 2001.

The followings are the outline of the development plan for electricity facilities based on the revised Power Sector Strategy.

#### **3.7.1 Electricity Demand Forecast**

The electricity demand forecast in the Power Sector Strategy is shown in Tables 3.7.1, Figure 3.7.2, and Figs.3.7.1 through Figure 3.7.4. According to the forecast, the maximum power demand in the whole country is estimated to reach 746MW in 2016, which is 7.7 times the 97MW in 1998, and the annual generated power is estimated to reach 2,634GWh in 2016, which is 5 times the 522GWh in 1998. The annual average growth rate is around 12% for the maximum power output and around 9.4% for the annual generated power. For the Phnom Penh system in this forecast, the maximum power output is estimated to reach 484MW in 2016, which is 8.1 times the 60MW in 1998, and the annual generated power is estimated to reach 1,829GWh in 2016, which is 5.7 times the 321GWh in 1998. The annual average growth rate of Phnom Penh system is around 12.2% for the maximum power output and around 10.1% for the annual generated power.

However, the actual electricity demand in 2000 was not so increased as forecasted because of the Asian Economic Crisis in 1997, the political turmoil in Cambodia in July 1997, the power tariff increase in April 1999, unreliable public service such as frequent shutdown, low quality in voltage and frequency. These situations caused the increased reliance on privately owned generators of big customers such as manufacturing enterprises, which in turn caused such under forecast results.



### 3.7.2 Development Plan for Generation Facilities

The generation facility development plan for Cambodia is identified as the “Generation Master Plan” in the “Power Sector Strategy”. The outline of the Generation Master Plan and the recent situation of the development are described below.

#### (1) Outline of the Generation Master Plan

The Generation Master Plan was developed on the following criteria:

- Peak load thermal generation stations shall be installed in Phnom Penh;
- Small and medium size diesel generators shall be installed in the provincial towns and cities for base and peak generation.
- Installation of small hydro stations shall be prioritized near consumer areas, such as Kirom, Prek Thnot, Kamchay project. Then the installation of medium capacity hydro stations shall be proceeded, such as Stung Atay, Middle Stung Russei Chrum and Battambang.

The development plan in the Generation Master Plan is as follows:

#### 1) Stage 1 (1999-2003)

- Private developers shall establish a 60MW generating plant (IPP2) in Phnom Penh.
- Rehabilitation of Kirirom hydropower plant to 12MW shall be commissioned in 2002;
- Rehabilitation of Prek Thnot hydropower projects shall be excuted

#### 2) Stage 2 (2004-2008)

A 90MW (stage 1) combined cycle base load thermal generation plant shall be developed in Sihanoukville in year 2007.

Feasibility studies shall be made for the following projects

- Battambang 1 & 2
- Kamchay (47-125MW) (commissioning date 2008)
- Stung Atay
- Stung Mateuk
- Lower and Middle Stung Russei Chrum (commissioning in Stage 3)
- Sambor (commissioning after 2016)
- Large hydros to assume the electric power exports

- 3) Stage 3 (2009-2016)
  - Development of 110MW Stung Atay hydro station by 2011
  - Development of 90MW gas turbine in year 2010 at Sihanoukville (stage 2) and 90MW (Stage 3) in subsequent 3-5 years
  - Development of 125MW Russei Chrum hydropower station by 2016.

Figure.3.7.5 and Figure 3.7.6 show the development plan of the Generation Master Plan along with the development plan of the Transmission Master Plan.

Recent status of the original Generation Master Plan is shown below. The near term plans are altered from the original.

(2) Thermal Power Generation Plant

1) Jupiter Power Co., LTD

Ten diesel generators with the total capacity 15MW were installed at the former C1 power station site in Phnom Penh in November 2000 and have been supplying electric power to EDC since then. Additional four generators with 6MW output were installed after December 2003.

2) 15MW Diesel Power Project

In order to meet a quick increase in power demands in Phnom Penh, a new IPP is scheduled to build a 15MW diesel generation plant to sign the power purchase agreement in 2003.

3) IPP 2 (Cambodia Power Company)

Originally, Beacon Hill with 100% equity as IPP planned a 60MW Naphtha fired combined cycle gas turbine power plant to be built at the former C4 Power Station site in Phnom Penh.

However, the proposed tariff was too high to be accepted by Cambodian Government. Consequently the project has been suspended because the Government is reluctant to make decision.

4) Sihanoukville Combined Cycle Gas Turbine Project

JICA development study team made a feasibility study to identify the most suitable development plan in introducing a 180MW combined cycle thermal plant at Sihanoukville, for the purpose of establishing the reliable power supply system

connecting the capital city Phnom Penh with Sihanoukville, in concert with the long run and reliable Generation Master Plan which was based upon World Bank study of 1996~1997. The feasibility study was made from Feb.2000 to Jan. 2002.

The outline of the feasibility study is shown on Figure-3.7.3.

The main issues were identified in this study as shown below.

- Feasibility Study for the Transmission Line between Takeo and Sihanoukville should be made urgently according to the development time schedule with the commissioning of the Stage 2 assumed in 2006.
- The project will only be feasible when the fuel is competitive price natural gas, however, the development schedule of the natural gas is not clear at this moment. Even if the natural gas is explored, this power project alone will not create enough gas demand to make gas price competitive, which implies that the gas demand should be developed by additional market in order to make the gas price competitive.

Therefore, the Government of Cambodia should develop the demand of natural gas together with the developer of natural gas.

- The future power development plan relies too much on hydro projects. A reasonable energy mix plan with hydro projects and thermal projects should be encouraged.

5) Siam Reap diesel power project

Siam Reap is a tourist city where exist Angkor Wat ruins of the world heritage. The tourist industry has been drastically developing with the rehabilitation and stabilization of the Kingdom of Cambodia.

Consequently, the demand of electric power has been increased drastically. In order to meet the demand increase, the Government of Cambodia requested the grant aid to Japanese Government for the extension of power plant and installation of new transmission lines between the old and new power plants.

The Japanese Government responded to this, and JICA have started their study for the basic design of the development of Siam Reap power generation facilities. The heavy fuel oil fired diesel generators with an output 10.5MW (3x3.5MW) are planned. The transmission line from the station to the existing distribution grid is included (about 16km).

The commissioning of this project will be in 2004.

6) Kampot coal fired power plant

DELCOM COMPANY (registered in Malaysia), who has already been joining power generating industry as IPP 1(CUPL company) in Phnom Penh, has proposed a 300MW

thermal power plant to be fueled with imported coal at Kampot in Oct. 2001.

Another Malaysia private company proposed a 120MW coal fired thermal plant, and a Thailand company proposed a 300MW coal fired thermal power.

Further, some large scale coal fired thermal power projects have been proposed at Koh Kong.

However, none of the above projects have been materialized yet.

(3) Development Plan for Hydroelectric Power Facilities

1) Kamchay Hydroelectric Power Project

MIME and the Experco International Co. of Canada signed the Memorandum of Understanding (MOU) on April 12, 2001 for feasibility studies. Under the MOU, Experco made the feasibility study on Kamchay Hydroelectric Power Project in cooperation with the Hydro-Quebec subsequent to the pre-feasibility study which was made in February 1995 supported by the Canadian International Development Agency Industrial Cooperation Division (CIDA). The feasibility study includes a study on a high voltage transmission line connecting to a substation in Kampot. The study was started in April 2001 and completed in June 2002. This project is scheduled to be commissioned between 2008 and 2010.

The study results in the final report of June 2002 is shown in Table 3.7.4.

2) Prek Thnot Multi Purpose Dam Project

Agreement of March 21, 1969 on the grant for the implementation of Prek Thnot river power development and irrigation project implementation: Grant aid of 1,517 million yen and Yen Credit Loan of 1,517 million yen.

The project, installation of a multi-purpose dam at the upstream of the Prek Thnot river which meets the Bassac river; a tributary of the Mekong river, was started in the early 1960's before the war. The construction work was composed of the building of a combined dam with an earth-fill type dam and a rock-fill type dam with maximum height of 28m and length of 10.3km, the building of a hydroelectric power plant with maximum output of 18MW at just the downstream of the dam, and the building of an intake weir for irrigation.

The Government of Japan (GOJ) carried out the study on the power sector in 1961 and 1962, and decided to contribute a Grant Aid and a Yen Loan of 4.215 million yen each for the construction fund. Afterwards, the international bidding was conducted in 1968. The construction work was started in August 1969. However, the Sihanouk Regime was expelled by a coup d'etat in March 1970 and the General Lon Nol occupied the regime, and the turmoil was getting worse. The construction work of the dam was suspended in

June 1970 because the war was intensified. All of the Prek Thnot Projects were suspended after the completion of the intake weir at downstream of the dam.

The Government of Cambodia (GOC) has been requesting GOJ for early resuming of the project implementation since the end of conflicts in Cambodia. However, the resuming of the project is difficult because of problems such as the resettlement of so called 20,000 inhabitants in the planned reservoir area, recent emerging environmental issues for a large dam, needs for irrigation and flood control, more considerations needed for alternative options.

3) Stung Meteuk Hydroelectric Power Project

This hydroelectric project site is assumed to include Cambodia and Thailand areas. The project was first proposed by Mekong Committee in 1970's and had been preliminary studied while detailed study has not been processed yet.

A JICA Expert, who was assigned to the Department of Energy Development and Promotion (DEDP), the Ministry of Science, Technology and Environment (MOSTE) of Thailand, conducted a desk study on the project, completed a Master Plan on the Stung Meteuk Basin, and made a proposal to a Secretary of State of DEDP in 1995.

Afterwards, at the Meeting of Cambodian-Thailand Joint Commission on June 20, 1996, the joint development of the project was proposed and agreed, and the Memorandum of Meeting was signed. The Bilateral Agreement between the two countries was signed at the Second Meeting of Joint Commission in March 1997. The Agreement includes establishment of Working Group, security of entry for reconnaissance, and provision of relevant information.

At the early stage of the study, the project was planned to generate electricity at 474.5MW and annual total 937GWh by installing three dams in Cambodia and conveying the water to three power plants in Thailand (No.1, No.2, and No.3 in the order from upstream to downstream), and at the same time to irrigate in 18,000ha areas in Thailand by installing regulating reservoirs for irrigation at each downstream of No.1 and No.2 power plants.

In January 1998, the successor of the JICA Expert conducted a site survey in the Thailand area and reviewed the outlines of the project. In addition, site survey including Cambodia area was conducted in December 1999.

The Electric Power Development Co. (EPDC) carried out a pre-feasibility study on the said project on understanding and cooperation with the both governments. The study pointed out that it would be most viable to develop separately the second project option shown in Table 3.7.5. (October 2001 Report).

In view of the economy, a dam and a reservoir are designed to be located in Cambodia, and a power plant is in Thailand. However, the Government of Cambodia persists in the

development to be completed in Cambodia area alone.

- 4) *Battambang 1 & 2 Hydroelectric Power Project, Stung Atay Hydroelectric Power Project, Middle Stung Russei Chrum Hydroelectric Power Project*  
Installation of flow gauging stations has been considered for these next stage hydroelectric power project sites with a technical assistance from the "Provincial Power Supply Project" supported by ADB.

- 5) *Pre-feasibility Study on Small Scale Hydroelectric Power Project*  
MIME studied the "Pre-Investment Study for Pipeline Development for Small Hydro Projects in Cambodia" (by MERITEC, New Zealand) from October 2000 to June 2001 with a fund from the "Rural Electrification and Transmission Project" supported by the World Bank.

The main purposes of the study are as follows:

- To investigate the potential for 0.5-5.0MW unit capacity small hydro projects
- To identify at least six specific small hydro projects which could be connected with an existing grid.
- To provide a preliminary design, investment requirements and institutional arrangements for the six projects.

The six small hydro projects were identified as most promising and additional potential three project were identified as shown in Tables 3.7.6 and 3.7.7.

### **3.7.3 Transmission Master Plan**

#### **(1) Outline of Transmission Master Plan**

The Transmission Master Plan is designed with the following policies to be taken into considerations.

- To reduce the reliance on imported oil for energy generation (diversification of energy sources)
- To reduce reliance on the transport of oil to Phnom Penh for energy generation.
- To reduce reliance on Mekong river oil transport via Vietnam to Phnom Penh.
- To improve operational efficiency of the power system (to minimize power losses)
- To encourage the least cost development of power demand center areas in local cities by cost-effective mixing of grid expansions and local private generators.
- To encourage competitions in power generation by providing access to competitively

priced external sources of energy in Vietnam, Thailand or Lao PDR.

- To maintain reliability of power supply at the level required and financially feasible by customers
- To promote the export of the electric energy.

The transmission development plan in the Transmission Master Plan and the power development plan in the Generation Master Plan are shown in the Figure 3.7.5 and 3.7.6.

The Transmission Master Plan is altered in near term data similarly in the power supply facilities. Recent situations are shown below.

(2) Phnom Penh -Vietnam 220 kV Interconnection lines

An agreement was signed in 10<sup>th</sup> June 1999 by Cambodia and Vietnam for the cooperation (Power Sector Cooperation) of the two countries' power sector. In the agreement, it is encouraged that Vietnam shall supply power to the border areas in Cambodia via medium voltage lines and shall study and subsequently implement also the power supply to Phnom Penh via a 220 kV interconnection line.

Then through discussions made on January 23 and May 8 in 2000, Cambodian government (MIME) and Vietnamese government (MOI) agreed the PTA (Power Trade Agreement) on July 3, 2000, and EDC and EVN agreed the PPA (Power Purchase Agreement) on 24 of that month. The contents of these agreements are summarized below..

- 1) EVN will transmit power from Thot Not Substation via Chau Doc Substation to EDC. (a power meter will be equipped at Chau Doc Substation)
- 2) The voltage will be maintained normally at 220kV±5% (220kV±10% during abnormal conditions) at Chau Doc Substation.
- 3) EVN will transmit power upto 80MW from 2003 to 2005 and upto 200MW after 2005 at the interconnection point.

Additionally, the following feasibility studies were carried out for "Rural Electrification and Transmission Project" by the Japan-tied PHRD grant through World Bank, Finnida grant and GEF grant as shown below.

- 1) Feasibility Study for the First Transmission Link between Phnom Penh and the bouder to Vietnam through Takeo province (the Southern Region of Cambodia) by Australian Power and Water Pty Ltd in association with Hydro Tasmania: April 2000 to March 2001
- 2) Preparation of Rural Electrification Strategy and Implementation Programme (by Meritec) : April 2000 to March 2001

MIME and EDC established Project Management Unit (PMU) in April 2000 to process the projects.

- (3) 115kV Interconnection lines for Thailand - Sisophon (Banteay Meanchey) - Siem Reap, and Battambang

The Power Cooperation Agreement (MOU) with Thailand was signed in February 2000 and it was agreed that EGCO would carry out a feasibility study of a BOT project to transmit EGAT's power to three Cambodian provinces, Banteay Meanchey, Battambang and Siem Reap. Thereafter, EDC and EGAT signed a PPA agreement in 2002 as the results of discussions in the Cambodia-Thailand Power Cooperation Committee in March and September 2001.

- (4) Takeo - Kampot 230kV Transmission Line

In August 2001 Cambodian Government requested KfW of Germany a grant for a 230kV line connecting Takeo with Kampot (approximately US\$11.6 million). KfW then made a survey on the project and concluded that German Government will accept the request on the condition that a joint finance agreement is signed by ADB and WB for the implementation of the Cambodia-Vietnam interconnection project. This ADB-WB joint finance agreement would be signed in 2003. Therefore, Cambodian Government would request Government of Germany a formal grant request (US\$2.5 million).

- (5) Kampot - Sihanoukville 230kV Transmission Line

In January 2002, NEWJEC studied the route of the transmission line from Kampot to Sihanoukville as Project Finding Mission of ECFA in cooperation with MIME. The findings were reported to MIME in March 2002.

- (6) Phnom Penh - Kampong Cham 115kV Transmission Line

This project is included in the expansion plan of the southern transmission system and studied preliminarily in WB-sponsored "First Transmission Link between Phnom Penh and the Southern Region of Cambodia" by Australian Power and Water Pty Ltd in association with Hydro Tasmania. The project cost is estimated approximately US\$30M.



(7) Phnom Penh - Battambang 115kV Transmission Line

KOICA, an assistance organization of Korea, will make the feasibility Study for transmission line project on a grant base.

(8) An expansion (to dual lines) of 115kV Transmission Lines in Phnom Penh

The portion of WB in the above mentioned ADB-WB joint finance agreement is reported to include the expansion of the second circuit project of 115kV transmission lines in Phnom Penh City.

(9) Phnom Penh- Stung Treng - Lao PDR - Vietnam 230 kV Interconnection line

This transmission project is studied by GMS (Great Mekong Sub-region).

(10) Thailand- Northern Cambodia- Vietnam 500 kV Interconnection line

This transmission project is studied by ASEAN.

### 3.7.4 Distribution Lines Expansion Projects

EDC supplies power to seven municipalities, Phnom Penh, Takhmau, Siem Reap, Sihanoukville, Kampong Cham, Battambang, and Takeo (special municipalities and provincial capitals) and three districts (Ponhea Krek, Memut of Kampong Cham, Baveth of Svay Rieng). EDC is planning to supply power to other special municipalities and provincial capitals as its service areas.

(1) Provincial Power Supply Project

In order to expand generating facilities and distribution facilities in provincial cities, MIME promotes the Provincial Power Supply Projects supported by ADB.

MIME drew up the rehabilitation programs of power facilities in eight provincial capitals; "Eight Provincial Towns Power Rehabilitation II Project" by Fichtner in April 1999. MIME later reviewed this program and made "the Updating of eight Provincial Town Power Rehabilitation II Projects" by Fichtner; in March 2000. With this background MIME finally completed the "Provincial Power Supply Project". The eight provincial capitals are Banlung (Ratanak Kiri Province), Kampot (including Kep), Kampong Speu, Prey Veng, Sisophon (Banteay Meanchey), Svay Rieng, Stung Treng and Takeo (including Angtassom). These provincial capitals are to become the service areas of EDC. Takeo became already a service area of EDC in June 2002.

The total budget of this project is 24.17 million US\$. 18.62 million US\$ of them is loaned by ADB. ADB signed the Loan Agreement with the Government of Cambodia and the Project Agreement with EDC in April 2001. The Ministry of Economic and Finance and EDC signed the Subsidiary Loan Agreement in June 2001.

The Aide France Development (AFD) decided to grant 3.29 million US\$ for Stung Treng project portion in November 2001.

The cost break up of this project and the outline of the ADB project in eight provincial capitals are shown in Table 3.7.7.

The period of this project is 42 months from the loan agreement. The project is scheduled to be completed in October 2004.

### 3.7.5 Rural Electrification Plan

About 84% of Cambodian people live in rural area, and there are big difference between urban area and rural area about income, illiteracy, schooling, and infrastructure such as roads, safe drinking water.

In rural area, its only 8.6% people can access to electrical grid while 53.6% in urban area, which is a barrier to level up the average rate of electrification throughout Cambodia (15.1% as of 1998).

Improvement of the rate of electrification by means of the rural electrification promotion is indispensable for raising a living standard of rural areas, improving a rural economic, and minimizing differences between the two areas.

Rural electrification is greatly taken up also in "Power Sector Strategy."

#### (1) Rural Electrification Strategy and Implementation Program

MIME obtained support of the World Bank and carried out "Rural Electrification Strategy and Implementation Program" (by MERITEC) from April, 2000 to March, 2001 in "Rural Electrification and Transmission Project." As the result, the following was set up as a long-term target of rural electrification.

- Rural 70% household will be electrified by 2030.
- 90% of village will be electrified by 2030. Here, the electrification of a village means that almost all the community facilities and 50% of household are electrified.

Moreover, it was decided as a goal in coming ten years that 25% of household (about 750,000) will be connect with electric power by 2010.

The methods of rural electrification are categorized in five types as shown below.

3. PRESENT SITUATION OF THE ELECTRICITY IN CAMBODIA

- Network Extension : Extension of the existing grid, and power import from neighboring countries to border areas.
- Isolated System : Installation of independent isolated power network
- Community or Consumer Co-op Isolated System : For low income areas or a remote areas
- Individual Household System : Pico hydraulic power or photovoltaics
- Battery Systems with Communal Charging : Community level storage battery system

(2) Renewable Energy

MIME held "Workshop on Cambodia Renewable Energy Action Plan" (REAP) in January, 2002 and started making an action plan towards the renewable energy introduction in Cambodia, with the cooperation of the World Bank and ESMAP. The following themes are taken up in this workshop.

- Local energy use situation investigation
- Market research of the photovoltaic power (the following item (3))
- Local small hydro power investigation
- Small hydro power project development investigation (as mentioned earlier in Section "Development Plan for Generation Facilities")

MIME made "Market Study and Project Pipeline Development for Solar Photovoltaics" (by BURGEAP in partnership with branch office of KOSAN Engineering Ltd.) from October 2000 to March 2001 as a part of "Rural Electrification and Transmission Project" supported by the World Bank fund.

The purposes of this investigation are as follows.

- To analyze and map the feature of the dispersed energy market in rural areas.
- To analyze and evaluate the scale of the photovoltaics market for rural households and the small business creation.
- To propose at least new three photovoltaics development projects.
- To propose a preliminary design, pre-requisites for investments, and operating organizations for these three projects.