

## Summary of the Results of Evaluation Study

<b>1 Outline of the Project</b>	
<b>Country:</b> Kingdom of Cambodia	<b>Project Title:</b> Project for Improvement of Transmission System Operation and Maintenance
<b>Thematic Area:</b> Electricity	<b>Cooperation Scheme:</b> Technical Cooperation Project
<b>Division in Charge:</b> Industrial Development and Public Policy Department	<b>Total Cost:</b> 337 million Yen
	<b>Counterpart Agency:</b> Electricite du Cambodge (EDC)
<b>Project Period:</b> January 2013 ~ September 2015	
<b>Supporting Organization in Japan:</b>	
<p><b>1.1 Background of the Project</b></p> <p>Reflecting the rapid economic growth that the Kingdom of Cambodia has achieved, over the period 2003 – 2010 Cambodia’s maximum power and electrical energy both grew by an average of over 20% per year. This rapid growth has drawn attention to the need for Cambodia to put in place the systems that are required in order to ensure a stable electric power supply. The electricity generation in Cambodia is mainly undertaken by independent power producers (IPPs), while Electricité du Cambodge (EDC), the most important electric-power-related organization in Cambodia, which is responsible for transmission and distribution (including system operation) .</p> <p>EDC has a plan to establish a nationwide high-voltage transmission network ; currently, the company is already in the process of putting in place a transmission network to supply Southern Cambodia (in particular the area around the capital, Phnom Penh) using electric power imported from Vietnam, while also installing transmission line to supply the same region with power generated by newly established power stations owned by IPPs. In January 2012, a national Control and Center (NCC) was established in EDC, a Supervisory Control and Data Analysis (SCADA) system was installed, with the aim of ensuring effective control over the electric power system to as to be able to carry out system operation in such a way as to provide low-cost, high-quality electric power supply.</p> <p>Japan began providing support for the establishment of a transmission line between Kampot and Sihanoukville through the Greater Mekong Power Network Development Project (Cambodia Growth Corridor) in 2006, a loan assistance project. In addition, JICA implemented the Data Collection Survey on Electric Power Sector in Cambodia (March, 2012), it was reported that there was a clear need to undertake further measures to strengthen the capabilities and experiences of EDC employees necessary to operate, maintain and manage the new transmission and substation equipment that has been installed while EDC has been focusing heavily on human resource development such as upgrading its training facility to Institute of Electrical Science (IES) .</p> <p>Under such a circumstance, Royal Government of Cambodia requested the Government of Japan (GoJ) for technical cooperation project with a view to strengthening operation and maintenance of transmission system. In response to this request, JICA has conducted Detailed Planning Survey for “the Project for Improvement of Transmission System Operation and Maintenance” (hereinafter referred to as “the Project”) in June 2012. Following the survey, the Project was launched in January 2013 for the period of two years and nine months.</p>	

## 1.2 Project Overview

### (1) Overall Goal

Electrical power is stably supplied in Phnom Penh power grid.

### (2) Project Purpose

Electrical power is stably supplied in Phnom Penh bulk power system.

### (3) Outputs

1. Capacity of operation and maintenance of transmission line (TL) and substation facilities (SS) in Phnom Penh bulk power system is enhanced.
2. Basic capacity of enhanced power system operation such as planning, scheduling and actual execution is strengthened.

### (4) Inputs (As of April 2015)

#### (Japanese Side)

- Experts: 15 short-term experts in 14 fields of expertise (55 Man/Month)
- 1 long-term expert (24 Man/Month)
- Training in Third Country: 36 persons (including 24 Counterparts)
- Provision of Equipment: Approximately 26.7 million JPY (226,994 USD)
- Local Cost: 100,414 USD (approximately 11,458,450 JPY)

#### (Cambodian Side)

- Counterpart: 36 persons (including Project Director, Project Manager, and Working Group members)
- Provision of Land and Facilities: Project office spaces, and installation place for training tower
- Local Cost: 66,110 USD (approximately 7,909,400 JPY)
- Terminal Evaluation Team

## 2 Terminal Evaluation Team

<b>Member of the Evaluation Team</b>	<b><u>Japanese side</u></b>		
	Name	Title	Occupation
	Mr. Suzuki Kaoru	Leader	Senior Advisor to the Director General (Energy), Industrial Development and Public Policy Dept., JICA
	Mr. Naito Shingo	Cooperation Planning	
	Ms. Nakamura Mitsuko	Evaluation Analysis	Assistant Director, Team1, Energy and Mining Group, Industrial Development and Public Policy Dept., JICA Consultant, Overseas Dept. Kokusai Kogyo Co., Ltd.
<b><u>Cambodian side</u></b>			
Name	Title	Occupation	
Dr. Praing Chulasa	Leader	Deputy Managing Director, EDC	
Mr. Nou Sokhon	Member	Director, Transmission Department, EDC	
Mr. Oum Piseth	Member	Director of Institute of Electrical Science (IES), EDC	
<b>Period of Evaluation</b>	24 May 2015~13 June 2015	Type of Evaluation: Terminal Evaluation	

### **3 Project Performance**

#### **3.1 Achievements of Outputs**

##### **(1) Output 1: Almost achieved**

Rules and standards of patrol, inspection, repair, and work safety of Transmission line (TL) which specify patrol and inspection items, frequency, and acceptance standards and so forth, were formulated and approved. In accordance with new inspection items, 326 transmission towers (20% of the whole towers) and 505 concrete poles (43 % of the whole poles) were already inspected. As a result, a cumulative total 1,031 problems were detected. However, EDC was taking necessary counter-measures according to a status of emergency and based on the repair plan ; therefore preventing troubles from occurring. Rules and guidelines of inspection of Substation facilities (SS) were also formulated and approved. Based on the new guideline, all 20 transformers EDC owned in Phnom Penh bulk power system were diagnosed. 25 pieces of equipment out of 1,104 were inspected, and a cumulative total of 43 problems were detected. However, EDC was taking necessary counter-measures according to a status of emergency and formulating the repair plan ; therefore no troubles have been occurred. In addition, based on the certification and evaluation standards formulated by the Project, total 6 trainers on maintenance of TL and SS were certified at IES, and they prepared training materials and have been already conducting training courses.

##### **(2) Output 2: Almost Achieved**

Rules and standards for operation and planning of power system operation such as load dispatching operation, coordination of planned outage, demand & supply plans, and voltage control were formulated and approved. In addition, Power System Operation Plan, including indication of issues of power system configuration, was formulated at the first time in EDC, and information sharing and its conveyance through reciprocal coordination among relevant departments has been performed smoothly. As for the relay protection, the rules and standards for protection relay type selection, setting and work procedures were formulated and approved. The Project calculated impedance and fault current to formulate impedance list and fault current map at the first time in EDC. By reviewing relay setting of facilities and revising inappropriate settings in accordance with the situation of power system operation, troubles have been prevented from occurring. Whereas totally 4 trainers on protection relay were certified at IES, based on the certification and evaluation standards formulated by the Project, C/P also certified a new trainer additionally.

#### **3.2 Achievement of the Project Purpose**

There were actual reports such as removal of an iron roof to avoid cutting conductors, repair of broken insulators to prevent from ground fault and eventual power outage, and inconsistency and revising of relay setting in protected zone. These problems could lead to the serious accidents and troubles if any counter-measure were not taken ; however, any serious accidents and trouble such as fire on transformer or cut of conductors did not occurred during the period of cooperation. As a result of the power outage and fault data analyzed by the Project, it was reported that both frequency and duration of power outage could have been reduced if accidents and troubles were detected by patrol/inspection and review of relay setting, which are now mainstreamed by the Project. Therefore the Project purpose would satisfactorily be attained by the end of the cooperation period.

## **4 Review Based on the 5 Criteria**

### **4.1 Relevance: High**

There has not been any drastic change in the development plans (Rectangular Strategy for Growth, Employment, Equity and Efficiency Phase III) of Royal Government of Cambodia after launching of the Project, and the Project is also well in line with Japan's ODA policy for the Kingdom of Cambodia. Taking account of power development plan, expansion of power system network with new high voltage transmission lines and substations construction plans in the future, "strengthening preventive maintenance by improvement of patrol and inspection techniques" and "improving power supply reliability by power system operation plan," addresses the needs of beneficiaries appropriately.

### **4.2 Effectiveness: High**

Through formulation of rules and standards of O&M of transmission line and substation facilities ; strengthening the abilities of patrol/inspection and relay protection, and formulation of power system operation plan including relay protection, it has been reported that EDC's capacity of stable electric power supply was enhanced. Towards the stable electric power supply, "technologies related to preventive maintenance (Output 1) ", and "technologies related to power system operation to ensure supply reliability (Output 2) ", were transferred by the Project. The logical sequence between the outputs and Project purpose was appropriate, and these outputs have been mostly achieved. In addition to these two outputs, the Project formulated a plan for early restoration, which is also essential for stable power supply. These outputs and supplementary activity contributed to achieve the Project purpose. It has been reported that there were no serious accidents or troubles of transmission and substation facilities during the cooperation of the Project, and it has been estimated power outage time and number would be reduced by the activities installed by the Project. Therefore the Project purpose would satisfactorily be achieved by the end of the cooperation period.

### **4.3 Efficiency: High**

The inputs necessary for implanting activities were provided almost as planned, by both Japanese and Cambodian sides. Although a part of the Project activities was started late due to unexpected delayed procurement of equipment, the outputs of the Project have been produced as planned without extension of cooperation period. The Project re-designed the contents and level of the OJT training to a certain extent, because SCADA system has not been fully utilized for power system operation due to telecommunication issues. However, it resulted to improve essential basic capacity before starting power system operation, and eventually contributed to achieve the Project purpose.

### **4.4 Impact: High positive impact**

Average number (SAIFI) and time of power outage (SAIDI) has been decreased in Phnom Pehn city for three years. It is expected that by continuing their activities and by enhancing their activities to the other regional areas in the countries for further scale up of achievements of the Project ("Electrical power is stably supplied in Phnom Penh power grid."), positive impacts of the Project are anticipated on the attainment of the overall goal.

### **4.5 Sustainability: High**

It is generally assumed that the policy supports would continuously be secured. Transmission Department

of EDC is strengthening human resources necessary for new transmission and substation facilities. Since EDC's turnover rate is about 1 % and low, organizational sustainability is generally assumed high. There would be no financial resource constraints as an implementing agency. However, since Transmission Department was established in 2007, roles and responsibilities of staff and sections have not been yet clear and it has been yet immature as organization. It may still need further organizational restructuring and reinforcement by taking account of new roles, responsibilities and working procedure defined within officially approved rules and manuals in the Project. As for technical sustainability, dissemination of transferred technologies would be continuously expected by certified trainers in IES as well as C/P of Transmission Department.

#### **4.6 Factors that have promoted or hindered the implementation of Project**

##### **Promoting factors**

(1) Factors Concerning the Planning: N/A

(2) Factors Concerning the Implementation Process

The Project has conducted a baseline survey prior to determine the basic policy and plan of respective fields, then implement the activities according to the schedule, which was strictly followed by both the JET and C/Ps. Timing and length of dispatch were carefully determined according to the progress of the Project and schedules and assignments of the Project were well informed in advance, and progress of the activities during absent period of JET was also followed up and supported by the long-term expert who stationed at EDC. EDC provided necessary input timely to promote efficient technical transfer. In addition to these efforts, in case which required urgent technical transferring during absence of JET, the Project held a technical meeting via TV conference system with full support of JICA Cambodia and Headquarter office. These efforts and support dedicated by all the stakeholders of the Project should be regarded as a promoting factor to the Project.

##### **Hindering factors**

(1) Factors Concerning the Planning

(2) Factors Concerning the Implementation Process: N/A

Initially, the Project was planning to transfer the technique of power system operation with SCADA system to NCC, aiming to operate power system and control the facilities. However, it was found as a result of detailed study by Japanese expert on telecommunication that there was complicated telecommunication issue, limiting full operation of SCADA system. EDC is still making efforts to solve the problem with external support. Although this did not critically "hamper" the Project, it should be noted that the change of the technologies had required the Project to re-design the contents of the OJT training to a certain extent.

### **5 Results of the Terminal Evaluation**

#### **5.1 Conclusion**

The Team has confirmed that the expected outputs have largely been achieved without any critical problem or notable delay in the implementation of the Project. It was also assumed that the Project would successfully achieve its expected purpose within the cooperation period.

## **5.2 Recommendations**

### **Recommendation for Remaining Period of the Project**

#### (1) Dissemination of the New Standards, Rules and Working Procedure

It is more effective to disseminate the outcome of the Project within responsible sections of Transmission Department, and other departments from the perspective of Sustainability and Impact of the Project.

It is recommended for C/Ps to continue lecturing and instructing the rules and working procedures to all the relevant staff, including field and regional staff of the Project, in a systematic manner and in cooperation with IES. In addition, it is also recommended to notify the standards and rules to IPPs, continuously.

#### (2) Periodical Review of the Standards, Rules and Working Procedure

As it is regulated in the rules and manuals, it is essential to review the standards, rules or working procedures periodically to fit into the actual situation, and continue the improvement in the future, using practical knowhow and experiences of formulation and implementation within the Project.

It is recommended to conduct the periodical review of all the standards, rules and working procedure regulated by the rule.

### **Recommendation for Future**

#### (1) Towards Stable Power Supply in Low Price

It is generally appreciated by the target groups that the Project has been successful in improving technical capacities of the staff in terms of “establishment of preventive maintenance” and “securing of power network and supply reliability”. However, it is recommended for EDC to set the “Stable Power Supply in Low Price” to the corporate goal, and take necessary actions at cooperate management level. For example, in terms of organizational perspective, it is recommended to strengthen the core organization for planning, construction, operation and maintenance, and power network system, considering N-1 standard, early restoration of power outage, and least cost development and operation. In terms of human resource development perspective ; it is recommended to formulate establishment of corporate human resource development section and its policy to enable collaboration between technical departments and training center more closely.

#### (2) Improvement of Power Statistics More Reliably

As key performance indicator to monitor the actual situation of Stable Power Supply in Low Price, it is recommended to improve power statistics more reliably including SAIDI and SAIFI.

#### (3) Accelerating Full Operation of NCC with SCADA system

Towards automation of power system, EDC has already been making great efforts to solve the telecommunication issue related to SCADA system. In terms of Effectiveness of the Project, it is recommended to accelerate the process and allocate appropriate personnel to manage the telecommunication system.

## **5.3 Lessons learned**

#### (1) Effectiveness of Counterpart Training in Third Counties

As for training of power system operation, C/Ps reported that training in Thailand provided eye-opening experience about international standards of power system operation, which actually the Project was

introducing to EDC. After the training, it was reported that C/Ps reconsidered the importance of formulated standards and their activities became more active and accelerated. This indicates that training in Third country was very effective to enable EDC to recognize its own technical standard and level in the future as an electrical power company, through the training and experiences in other electric power companies in surrounding Southeast Asian countries (i.e. ASEAN) .

#### (2) Establishment of Power Outage and Fault Statistics

The Project instructed to compile fault and power outage data in detail to analyze the effect of preventive maintenance, and power outage and fault statistic was established in EDC. By analyzing faults and estimating the results of preventing power outage, it was able to assume the effect of the Project in terms of power outage number and time quantitatively, and could convince the executives of electric power company the significance of preventive maintenance. In cases of projects related to preventive maintenance, although it is difficult to show the prevented troubles, it should be noted that quantitative estimation (comparison between the actual troubles and troubles which could be prevented) is very effective and persuasive to show the effect of the Project.

#### (3) Selection of Appropriate Technology

As for SCADA system, it was found that there have been complicated telecommunication problems between EDC and IPPs, and it has been limiting full operation of SCADA system for almost three years. Although the SCADA system was not introduced by the Project, it is important to carefully examine the technical level of counterpart organization, and provide the appropriate operation system in accordance with the local situation.