Kingdom of Cambodia

Data Collection Survey on Electric Power Sector in Cambodia

Final Report

March 2012

Japan International Cooperation Agency (JICA)

The Chugoku Electric Power Co., Inc.

SAP
JR
12-021

Contents

Abbreviations

Abbreviation	Description
ADB	Asia Development Bank
BCS	Battery Charge Stations
BOO	Build-Operate-Own
BOT	Build-Operate-Transfer
CBHV	Capacity Building for HV transmission system
Census	General Population Census of Cambodia 2008
CDC	Cambodia Development Council
CDM	Clean Development Mechanism
CESS	Cambodia Energy Sector Strategy
CPSS	Cambodia Power Sector Strategy
DAS	Distribution Automation System
DIME	Department of Industry, Mines and Energy
EAC	Electricity Authority of Cambodia
EDC	Electricité du Cambodge
EDL	Electricité du Laos
EGAT	Electricity Generating Authority of Thailand
EIA	Environmental Impact Assessment
EVN	Electricity of Vietnam
FS	Feasibility Study
GDP	Gross Domestic Product
GIS	Gas Insulated Switchgear
GMS	Great Mekong Sub-region
GREPTS	General Requirements of Electric Power Technical Standards of the Kingdom of Cambodia
GS	Grid Substation
GWh	Giga Watt hour (1GWh = 1,000,000 kilo Watt hour)
HV	High Voltage
IA	Implementation Agreement
IAEA	International Atomic Energy Agency
IEIA	Initial Environmental Impact Assessment
IPP	Independent Power Producer
IRC	Inter-ministerial Resettlement Committee
ITC	Institute of Technology of Cambodia
JETRO	Japan External Trade Organization
JICA	Japan International Cooperation Agency

KfW	Kreditanstalt für Wiederaufbau
KOICA	Korea International Cooperation Agency
kV	Kilo Volt (1kV = 1,000 Volt)
kW	Kilo Watt (1kW = 1,000 Watt)
kWh	Kilo Watt hour (1kWh = 1,000 Watt hour)
LV	Low Voltage
MEA	Metropolitan Electricity Authority, Thailand
MEF	Ministry of Economy and Finance
MIME	Ministry of Industry, Mines and Energy
MOE	Ministry of Envirnment
MOWRAM	Ministry of Water Resources and Meteorology
M/P	Master Plan
MP2006	The Master Plan Study on Rural Electrification by Renewable Energy in the Kingdom of Cambodia 2006
MPWT	Ministry of Public Works and Transportation
MV	Medium Voltage
MW	Mega Watt (1MW = 1,000 kilo Watt)
NCC	National Control Center
NEDO	New Energy and Industrial Technology Development Organization
NGD	National Grid
NSDP	National Stategic Development Plan Update 2009 to 2013
OJT	On the Job Training
PCB	Polychlorinated Biphenyl
PEA	Provincial Electricity Authority, Thailand
PEC	Private Electricity Company
PEU	Public Electricity Utility
PPA	Power Purchase Agreement
RD	Resettlement Department
REE	Rural Electricity Enterprise
REF	Rural Electrification Fund
RGC	Royal Government of Cambodia
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SCADA	Supervisory Control And Data Acquisition
SHS	Solar Home System
SPC	Special Purpose Company

SPDRE	Strategy and Plan for Development of Rural Electrification in the Kingdom of Cambodia
SREPTS	Specific Requirements of Electric Power Technical Standards of the Kingdom of Cambodia
SS	Substation
SSC	System Stabilizing Controller
UNIDO	UN Industrial Development Organization
WB	World Bank

Executive Summary

1. Background, Objectives and Scope of Study

Cambodia's rapid economic growth has been accompanied by a steady increase in power demand, with peak demand rising by average of over 20% a year during the period 2003 - 2008. There is thus a clear need for the formulation and effective implementation of power development plan and power supply planning to cope with this growing demand.

Regarding the power system, the inadequacy of the domestic transmission lines covering the whole Cambodia is exacerbated by the unreliability of the power supply; together, this factor is one of the main reasons for the low rural electrification rate. Improvements in the reliability of the electricity supply by reducing the frequency and duration of power outages can help to stimulate investment activities such as the construction of factories, etc.; in addition to the development of new power sources, expansion and improvement of the power systems are thus both very important issues for Cambodia.

The electricity tariff is relatively high in Cambodia compared to neighboring countries such as Thailand, Laos and Vietnam. In order to bring the electricity tariff down, besides working to achieve a mid- to long-term review of shifting the power configurations away from excessive reliance on diesel fired power towards greater use of hydropower, coal and gas, another key task is to promote the connection with grids by extending transmission and distribution lines to Rural Electricity Enterprises (REE) that supply power to independent power systems at high tariff.

As the issues outlined above - including power development planning, power system extension, rural electrification, stable supply of electricity, and low electricity tariff – are all interrelated, an appropriate balance needs to be maintained among them when undertaking development in this area.

Unfortunately, Electricité du Cambodge (EDC), which is the organization mainly responsible for tackling these issues, suffers from a shortage of personnel with the necessary capabilities and experience, and needs to undertake capability enhancement with respect not only to the construction, maintenance and management of power facilities, but also a wide range of other capabilities, including power system operations.

The purpose of the Study is to grasp the latest trend in the power sector in Cambodia in view of the above background, and to collect and collate the data needed to examine specific areas where cooperation is required in this sector.

2. Current Status of the Power Sector in Cambodia

(1) Electricity policies

The NATIONAL STRATEGIC DEVELOPMENT PLAN UPDATE 2009-2013 that has been established in 2010 based on the rectangular strategy includes the national strategy related to electricity.

The RGC focuses on ① ensuring supply capacity, ② inexpensive electricity tariff, and ③ reinforcement and capacity development of electricity-related organizations.

(2) Current status of electricity supply

Importation of electricity from Thailand (115kV transmission lines), Vietnam (230kV transmission lines), and Laos (22kV distribution lines) started at the end of 2007, in 2009, and 2010, respectively. In 2010, imported electricity was 61.5% of all generated electric power. In 2010, Independent Power Producer (IPP) generated 91% of the total electric power.

(3) Electricity development plan

In order to solve the lack of supply capacity, large scale hydropower plant development projects are developing. Total amount of 1,816MW power plants (Hydro power: 96MW, Thermal power: 900MW) will start to operate by 2017.

(4) Support from other donors and private enterprises

Cambodia has been supported by foreign donors in various ways. At present, most organizations support rural electrification by extending grids

(5) Rural electrification

On November 30, 2011, the government of Cambodia issued the "Strategy and Plan for Development of Rural Electrification in the Kingdom of Cambodia: SPDRE", a specific strategy and plan to

achieve essential targets for rural electrification as PRAKAS (ministry ordinance). This plan was discussed by MIME, EAC, REF, and EDC based on the result obtained by the cooperation of international organizations, and set up as the national goal according to SPRDRE. Under this plan, each organization is supposed to make an action for the targets below:

① For village area, achievement of rural electrification rate of 100% including battery illumination by 2020

② For household electrification, achievement of electrification rate of at least 70% by the grid quality electricity by 2030

The electrification rates of Cambodia were surveyed by the Census 2008 and electrification rates in the metropolitan area, rural area, and the entire Cambodia are 87%, 13%, and 26.4%, respectively.

Regarding the grid extension which is the best method to be electrified, 80% of all Villages will receive electricity supply from the national grid or from neighboring countries by 2020 and 95% of all Villages will receive electricity supply from the national grid or from neighboring countries by 2030 if RGC gets the necessary fund to follow the investment plan for the grid extension. At that time, 46% of households will connect to National Grid (NGD) by 2020 and 70% of households will connect to NGD by 2030.

(6) Electricity tariff

The electricity tariff is relatively high in Cambodia (compared to neighboring countries such as Thailand, Laos and Vietnam), mainly due to Cambodia's high level of dependence on small diesel generators with high fuel costs. As the resilt, average electricity tariffs of the EDC Phnom Penh systems, the EDC local offices and REEs are 17.7USCent/kWh, 21.4USCent/kWh and 51.6USCent/kWh respectively.

(7) System stabilization and quality of electricity

SAIFI and SAIDI in the EDC Phnom Penh system in 2010 are 42 times and 2,515 minutes respectively. Fore a reference, power failure incidences and durations of power failure per household in Japan in 2007 were 0.14 and 16 min, respectively, which were <1/100 of those in Cambodia. Records show that 1/3 of power failure incidences and 1/2 of the duration of power failure were due to supply capacity shortage.

(8) Opinions of Japanese companies

The objective of this survey was to obtain basic information that would help in creating contributive cases for Japanese companies launched or plan to launch in Cambodia. Answers were collected from 11 companies. Results showed;

- Quality improvement can promote Japanese companies such as manufacturers to launch in Cambodia;
- Many companies think high tariff and low quality;
- Consolidation of other infrastructure, human resources of RGC, good quality emplyees and maintenance of emplyees are the highest barriers;
- Power stations such as relatively cheap thermal power plant should be constructed as soon as possible.

3. Problems Facing the Electric Power Sector, and Proposed Solutions

(1) Verification of Electric Power Development Plan

The slope of the actual demand line most closely resembles the "High Case" scenario of World Bank (WB) report. However, there is a disparity of approximately 70 MW between the demand forecast for 2011 under the High Case scenario and the actual level of demand in that year, so the High Case forecasts cannot be used without modification. The most suitable approach would be to implement demand forecasting based on actual demand in 2010 and the High Case demand growth rate scenario for 2011 onwards. The results of forecast are;

① Peak demand and annual electrical energy generation of each province;

② Peak demand and annual electrical energy gereration of main grid.

And supply capacities of existing power stations as well as those of stations under construction and at the planning stage such as hydropower plants were estimated in the rainy season and dry season. In the dry season, supply capacity will be short until 2015.

(2) Transmission and distribution facilities in Phnom Penh

Phnom Penh system has the following issues;

① Due to inadequate transformer capacity, even if the supply capability of the 115kV system is adequate, rolling power outages are still needed for the 22kV system;

② An outage on a single transmission line can cause a power outage affecting half of the Phnom Penh urban area;

③ The breakdown of a single transformer can prevent the supply of power from being maintained.

In order to solve the above issues, the following the transmission and distribution expansion plans are proposed considered to demand forecast and growth in Phnom Penh.

a. Establishment of new grid substations (GS)
b. Establishment of 115kV underground transmission line
c. Improvement of the 115kV relay system
d. Adoption of a Distribution Automation System (DAS)
e. Adoption of a System Stabilizing Controller (SSC)

(3) Human Resources Development

This report proposes Human Resource Development described below for ①National Control Center (NCC), ②Transmission and substation engineer and ③Hydropower Engineer.

① To formulate rules for load dispatching and implement NCC operater training, so as to ensure the smooth running of the NCC once it begins operation; by achieving safe, precise operation, this will help to enhance the overall reliability of the electric power supply.

② To ensure that members of staff are fully familiar with the rules relating to transmission and transformation facilities maintenance and inspection and machinery operation, thereby facilitating the stable, reliable supply of power with as few accidents as possible.

③ To enhance the management capabilities of Ministry of Industry, Mines and Energy (MIME) and Electricity Authority of Cambodia (EAC) with respect to IPP power stations, and to enhance EDC's ability to plan, design, management and maintain hydropower stations.

(4) Rural Electrification and Micro-Hydro

Bay Srock Micoro Hydropower Project in Ratanak Kiri Province was selected as the most suitable site for rural electrification using renewable energy (micro hydro). In addition, integration development with the rehabilitation of existing O'Chum II hydropower Plant located in the same Province is estimated to reveal a synergistic effect.

(5) Electricity tariff

Power generating costs fluctuate greatly as the composition of power sources (power suppliers) changes. The future electricity cost was estimated considering the power development plan in Cambodia. The cost was13.4USCent/kWh in 2011 and will be 14.0USCent/kWh in 2012 due to a 30% or so price hike for power from Vietnam (however, the amount of inflation is compressed due to the commissioning of Kamchay Hydropower Station and Kirirom III Hydropower Station). With the successive commissioning of large-scale hydropower stations from 2013 onwards, it is forecast that purchase prices will fall up to 2014, after which they will steadily rise again. This is because the ratio of coal-fired thermal power, for which fuel costs are increasing, will become larger, and hydropower plants in the planning stage are not taken into consideration. Meanwhile, in order to reduce power purchasing costs, it is important to advance the phased development of cheap power sources including imported power.

(6) Grid Stability and Power Quality

In order for Cambodia to promote the attraction of factories and so on, it requires power supply with good quality (frequency and voltage, etc.), however, it currently has to rely on Vietnam, which has large grid capacity, in order to conduct frequency adjustment. Concerning adjustment of generator output, NCC will continue to issue all output commands by telephone and wireless. When the system and load fluctuations become larger in the future, since telephone-based generator commands may become a problem from the viewpoint of maintaining frequency due to the lack of speed. Since it is not realistic for the NCC to directly conduct output operations for all IPP, which account for the large majority of power sources in Cambodia, it will become necessary for the EDC to possess its own power sources for adjustment purposes. For reference, Figure 3 28 shows the image of frequency adjustment techniques in Japan.

(7) Issues concerning International Interconnection

Concerning problems in terms of international interconnection system stability, there is currently a

risk that the Phnom Penh system could blackout if supply from Vietnam was suspended. A possible solution is load shedding based on a power system stabilizer. As transmission lines continue to be built and the systems in become interconnected in the future, supply reliability will be enhanced, Even though realizing wide area interconnection with Thailand, Cambodia and Vietnam has advantages in terms of stabilizing the power supply and frequency and securing economic merits, there is a possibility that failure in one country will spread to the entire system and cause large-scale power interruption. Therefore, it is necessary to take measures to prevent failures from spreading. Additionally, in order to further utilize the merits of wide area interconnection, it is also important to prepare a mechanism for mutually advancing power between countries to counter tight supply and demand conditions caused by power supply troubles, etc.

(8) Verification of Optimum Generating Equipment Operation considering Stable Supply and Economy

Numerous large-scale hydropower plants are scheduled to successively go into operation from now on, and the ratio of hydropower in the power source composition will expand. Moreover, as it is difficult to secure 100% supply capacity from hydropower plants during the dry season, the key to securing supply capacity at this time will be to conduct the planned operation of reservoirs upon conducting accurate flow rate forecasting and compiling annual plans based on statistical data. During the dry season, since conditions will become harsh in terms of supply till 2015, important points in reservoir operation will be (1) to maintain as high a water level as possible before entering the dry season while considering the dam discharge risk based on appropriate inflow forecast, and (2) to give priority to power generation during the times when demand is high and to limit generation when this won't hinder supply. Meanwhile, during the rainy season, since there will be times when the hydropower plant utilization rate is 100% and situations of excess power arise, it will be necessary to bind a contract for selling power to Vietnam via interconnected line.

Chapter 1 Background, Objectives and Scope of Study

1.1 Background of the Study

During the period 2000 - 2007, Cambodia maintained an average annual Gross Domestic Product (GDP) growth rate of 9%. Although Cambodia experienced negative growth in 2009 due to the impact of the global financial crisis, there was a recovery in 2010, with the GDP growth rate rising to 6.0%, and it was generally felt that Cambodia was getting back on the path towards continued growth. Cambodia's rapid economic growth has been accompanied by a steady increase in power demand, with peak demand rising by average of over 20% a year during the period 2003 - 2008. There is thus a clear need for the formulation and effective implementation of power development plan and power supply planning to cope with this growing demand.

Cambodia has two separate power systems - one is Phnom Penh system and the other is Northwestern system - which are not interconnected. The inadequacy of the domestic transmission lines covering the whole Cambodia is exacerbated by the unreliability of the power supply; together, this factor is one of the main reasons for the low rural electrification rate. Improvements in the reliability of the electricity supply by reducing the frequency and duration of power outages can help to stimulate investment activities such as the construction of factories, etc.; in addition to the development of new power sources, expansion and improvement of the power systems are thus both very important issues for Cambodia.

The electricity tariff is relatively high in Cambodia (compared to neighboring countries such as Thailand, Laos and Vietnam), mainly due to Cambodia's high level of dependence on small diesel generators with high fuel costs. In order to bring the electricity tariff down, besides working to achieve a mid- to long-term review of shifting the power configurations away from excessive reliance on diesel fired power towards greater use of hydropower, coal and gas, another key task is to promote the connection with grids by extending transmission and distribution lines to Rural Electricity Enterprises (REE) that supply power to independent power systems at high tariff.

Regarding the promotion of electrification in off-grid areas, the emphasis here needs to be placed on extending the transmission and distribution lines and on making effective use of renewable domestic energy sources. While the Rural Electrification Fund (REF) has been examining the possibilities for developing micro hydroelectric energy projects not in use in rural areas, the number of locations where such projects have been placed on the table for discussion so far is quite limited, and the scope of the study work has been somewhat restricted.

As the issues outlined above - including power development planning, power system extension, rural electrification, stable supply of electricity, and low electricity tariff – are all interrelated, an appropriate balance needs to be maintained among them when undertaking development in this area.

Unfortunately, Electricité du Cambodge (EDC), which is the organization mainly responsible for tackling these issues, suffers from a shortage of personnel with the necessary capabilities and experience, and needs to undertake capability enhancement with respect not only to the construction, maintenance and management of power facilities, but also a wide range of other capabilities, including power system operations.

1.2 Objectives of the Study

The purpose of the Study is to grasp the latest trend in the power sector in Cambodia in view of the above background, and to collect and collate the data needed to examine specific areas where cooperation is required in this sector. The key objectives of the Study are outlined below:

① To collect a wide range of basic data needed to analyze future direction for the power sector in Cambodia, taking into account the background information noted above.
② To formulate feasible power development scenarios and power system development scenarios, using realistic electricity demand projection based on the latest data.
③ To review electricity tariff in Cambodia.
④ To verify the suitability of the transmission and distribution network enhancement plan aimed at stabilizing the supply of power in Phnom Penh, which besides being Cambodia's capital city is also the main center of economic activity in the country.

⑤ To collect information regarding potential sites for rural electrification projects using renewable energy (micro hydropower).
⑥ To identify the needs of EDC's human resources development in relation to power facilities construction, maintenance and management, and power system operation technology.
⑦ To identify, based on the Study work outlined above, the key issues affecting the power sector in Cambodia, and to examine solutions to these issues.

1.3 Supported agencies of the study

This study was supported by the Ministry of Industry, Mines and Energy (MIME), the Electricity Authority of Cambodia, and the Electricité du Cambodge (EDC).

1.4 Road map of study

The road map covering the study is shown in Fig. 1-1. The study team performed the field trip twice. The first trip was given from November 20, 2011 to December 10, 2011, and the second trip was given from January 12, 2012 to January 28, 2012. The schedule of each field trip is shown in Table 1-1 andTable 1-2 respectively. The structure of the team member is shown in Table 1-3.
The list of references collected by the study team is shown in Table 1-4.

Road map

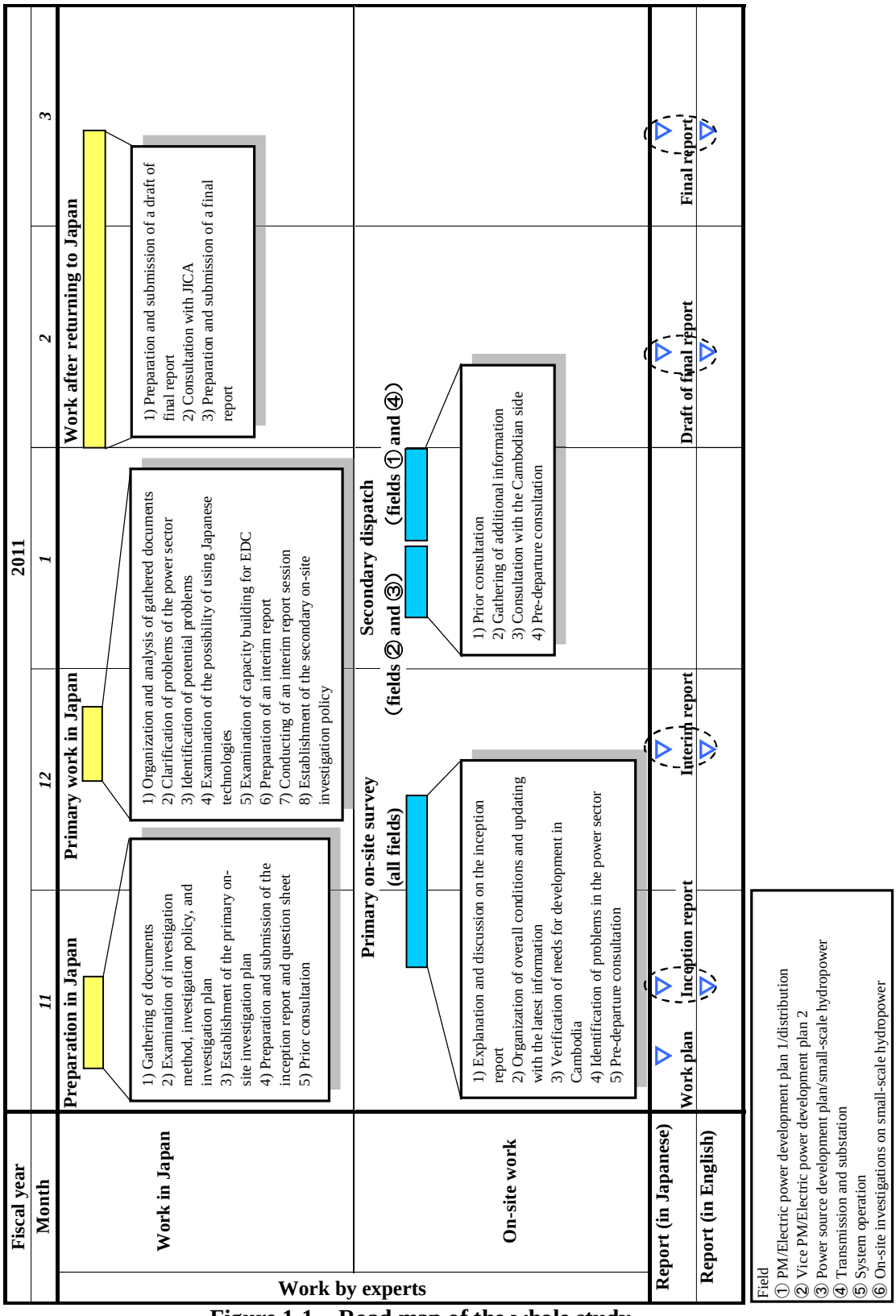


Figure 1-1 Road map of the whole study

Table 1-1 Schedule of the first field trip

Date		Schedule	
		SHINOHARA, IRIE, HAMADA	HIROSE, FUKUGAICHI, YAMAMOTO
Nov. 20	Sun	Move to Cambodia	
Nov. 21	Mon	AM: Courtesy Call JICA, EAC PM: Courtesy Call Embassy	
Nov. 22	Tue	AM: Courtesy Call MIME, REF PM: Courtesy Call EDC	
Nov. 23	Wed	AM: NIS, MIME PM: MOWRAM(Nihon Koei)	AM: Interview EDC Training Center, NCC PM: JICA
Nov. 24	Thu	AM: EDC GIS Office PM: Interview MOWRM, MIME, NIS, EDC GN	AM: EDC Dispatching Control Center PM: EDC NCC, Transmission Unit, Relay Protection Office
Nov. 25	Fri	AM: MOP, REF Interview PM: EDC Generation Dep.	AM: EDC Transmission Unit PM: Nihon Koei, EDC Transmission Unit
Nov. 26	Sat	Field Trip to Kamchay HP, Takeo GS, Kampot GS	
Nov. 27	Sun	Holiday	
Nov. 28	Mon	AM: EAC, MOWRAM PM: ADB, EDC Distribution Dep.	AM: Nihon Koei, EDC CP&P Dep. PM: ADB, UNIDO
Nov. 29	Tue	AM: Field Trip for Irrigation Survey PM: Field Trip for Irrigation Survey	AM: Report Writing PM: KOICA, EAC
Nov. 30	Wed	AM: Field Trip for Irrigation Survey PM: Field Trip for Irrigation Survey	AM: EAC PM: EDC, Survey(Transmission Line)
Dec. 1	Thu	AM: EAC PM: Report Writing	AM: GS Survey(GS1, GS2, GS3), EDC Training Center PM: Report Writing
Dec. 2	Fri	AM: EAC, EDC Generation Dep. PM: EDC CP&P Dep.	AM: EDC Transmission Unit PM: Marubeni, EDC Transmission Dep.
Dec. 3	Sat	Holiday	
Dec. 4	Sun	Holiday	
Dec. 5	Mon	AM: EAC, EDC PM: MIME, EDC CP&P	
Dec. 6	Tue	AM: MOP EDC Transmission Dep. PM: EAC, EDC Generation, Report Writing	
Dec. 7	Wed	AM: EDC CP&P Dep., Transmission Dep. PM: Report Writing	
Dec. 8	Thu	AM: Phnom Penh SEZ, MOE, Report to EDC PM: Report Writing	
Dec. 9	Fri	AM: Report to JICA, EDC PM: MPWT, Move to Japan	
Dec. 10	Sat	Arrival in Japan	

Table 1-2 Schedule of the second field trip

Date		Schedule	
		HIROSE, IRIE	SHINOHARA, FUKUGAICHI
Jan. 12	Thu	Move to Cambodia	-
Jan. 13	Fri	AM: MIME,EDC PM: WB	-
Jan. 14	Sat	Holiday	-
Jan. 15	Sun	Field Trip for Irrigation Survey	-
Jan. 16	Mon	AM: EDC,MIME,EAC PM: WB	-
Jan. 17	Tue	AM: REF,EAC,MIME PM: EDC	-
Jan. 18	Wed	AM: EAC PM: Report Writing	-
Jan. 19	Thu	AM: Field Trip for Irrigation Survey PM: Field Trip for Irrigation Survey	Move to Cambodia
Jan. 20	Fri	AM: JICA PM: EDC, Move to Japan	AM: JICA PM: EDC
Jan. 21	Sat	Arrival in Japan	AM: Report Writing PM: Report Writing
Jan. 22	Sun	-	Holiday
Jan. 23	Mon	-	AM: EDC PM: Embassy
Jan. 24	Tue	-	AM: EDC PM: Report Writing
Jan. 25	Wed	-	AM: EDC PM: ODA Task force
Jan. 26	Thu	-	AM: Report Writing PM: Report Writing
Jan. 27	Fri	-	AM: Report to JICA PM: Move to Japan
Jan. 28	Sat	-	Arrival in Japan

Table 1-3 List of team members

Name of member	Assigned field	Company
1. Junya Shinohara	Project Manager/Electric power development plan 1/Distribution	Chugoku EPCO
2. Masakazu Hirose	Vice Project Manager/Electric power development plan 2	Chugoku EPCO
3. Akira Irie	Power development plan/small-scale hydropower	Chugoku EPCO
4. Atsushi Fukugaichi	Transmission and Substation	Chugoku EPCO
5. Eiji Yamamoto	System operation	Chugoku EPCO
6. Takayuki Hamada	On-site small-scale hydropower investigation	Chuden Engineering Consultants

Table 1-4 List of collected references

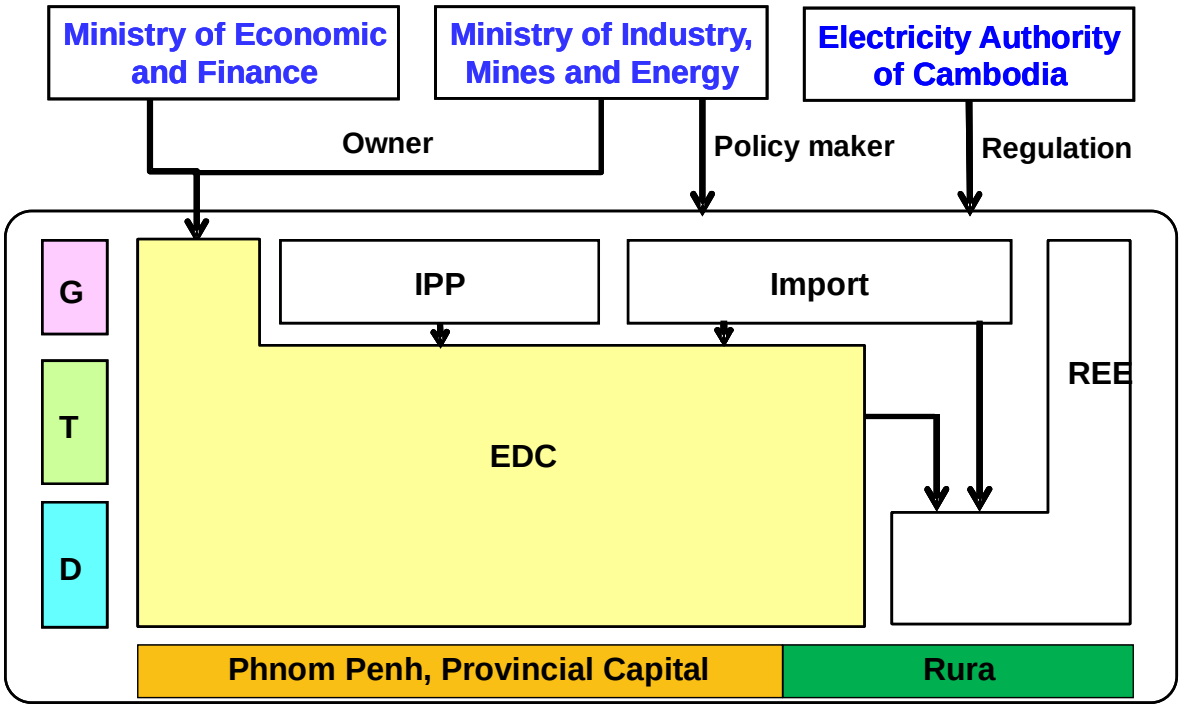
		Category									
		Policy and organization	Power development plan	Power transmission, distribution, and substation facility plan in the city of Phnom Penh	Capacity building for EDC	Rural electrification using renewable energies (small-scale hydropower)	Electricity tariffs	Environmental problem	Organization, human resources, capacity, and financial conditions of relevant agencies	Support by other donors and private enterprises	Quality of electricity
Documents Received from EDC											
1-1	EDC Annual Report(2008,2009,2010)	○	○								
1-2	EDC Operation Budget for the Year 2012						○				
1-3	Cooperation Procedure Between NCC and Distribution Licensees Operating Distribution system Medium Voltage										○
1-4	Cooperation Procedure Between NCC and Power Plants										○
1-5	Cooperation Procedure Between NCC and Special Purpose Transmission Licensees Operating High Voltage										○
1-6	Data Management of Power Outage and Distribution System Reliability Evaluation										○
1-7	Job Description of NCC			○							
1-8	EDC Financial Statements for the Year Ended 31 December 2010						○				
1-9	EDC Organization Chart(2011.8)	○									
1-10	Plan for Power supply to Big customers in Phnom Penh System(2009.7)			○							
1-11	Estimated Electric Power for CAMKO CITY Project			○							
1-12	Estimated Electric Power for SUNWAY CITY Project			○							
1-13	List of Transformers in Phnom Penh system (2011)			○							
1-14	Brochure for Safety of Transmission Line										
1-15	One Pillar Substation			○							
1-16	Map of Pursat Power Plant				○						
1-17	Distribution network in Phnom Penh			○							
1-18	Energy Purchase Plan(2010-2012)						○				
1-19	Grid Generation and Cost(2009-2016)						○				
1-20	Hydro Project Under Prefeasibility Study					○					
1-21	Method of Implementing Procedure of System Restoration										○
1-22	Power Development Plan		○								
1-23	Procedure For Correction Power Factor										○
1-24	SAIFI-SAIDI(2009-2011)										○
1-25	Demand Data		○	○							○
1-26	Patrol Sheet				○						
1-27	Organization of Transmission Unit				○						
1-28	Report on Training in Vietnam				○						
1-29	Detail of Transmission Line and Grid Substation				○						
1-30	List of Equipment of Transmission Line				○						
1-31	Safety Work Procedures for TL Work				○						
1-32	Strategy and Plan for Development of Rural Electrification in the Kingdom of Cambodia	○				○	○				
1-33	Royal Government Decision on the Responsibility of Land Acquisition and Resettlement	○								○	
Documents Received from EAC											
2-1	EAC Annual Report 2010	○	○				○				
2-2	List of EAC staff for background 2011	○							○		
Documents Received from JICA											
3-1	Review of Japanese Business Opportunities for Public Private Partnerships Program in Cambodia										
3-2	Proposal to Develop Infrastructure for Economic Growth in Cambodia(Mitsubishi Research Institute)		○								
3-3	Electricity Tariffs of EDC for Users in Phnom Penh, Kandal and Kampong Speu(EDC)						○				
3-4	Warmly Welcome the Esteemed Delegation from Japan's Lower House(EDC)		○								
3-5	Workshop on Plan for Sustained Operation of REF(2011.11.17)	○									
Documents Received from Other Organization											
4-1	Document about PCB Project(UNIDO)							○		○	
4-2	ADB_Country Partnership Strategy for Cambodia(Excerpt)(ADB)									○	
4-3	NATIONAL STRATEGIC DEVELOPMENT PLAN(NSDP)2009-2013	○	○	○		○	○			○	
4-4	Overview on Transport Infrastructure Sectors in the Kingdom of Cambodia(MPWT, 2010)		○								

Chapter 2 Current Status of the Power Sector in Cambodia

2.1 Organizations of the Power Sector

2.1.1 Structure of the power sector

The Electricity Law issued on February 2, 2001 covers the totality of electricity business from electricity supply services to use of electricity. It provides the fundamental concept of electricity business operation, consolidation of requirements for private investment and commercial operation, promotion of electricity supply facility operation by the private sector, and rule of principle for competitive environment. To actualize stable nationwide electricity supply services, the Electricity Law established EAC as an independent regulatory agency that executes duties provided in the Electricity Law and authorizes MIME to manage, create policies, take necessary measures, and create plans for the power sector. EDC is the largest electricity business organization in Cambodia and is involved in generation and transmission of bulk electric power as well as supply and distribution of electricity. EDC is jointly owned by MIME and the Ministry of Economy and Finance (MEF). Major electricity enterprises, MIME, and EAC are interrelated as shown in Figure 2-1.



Source: Survey Team

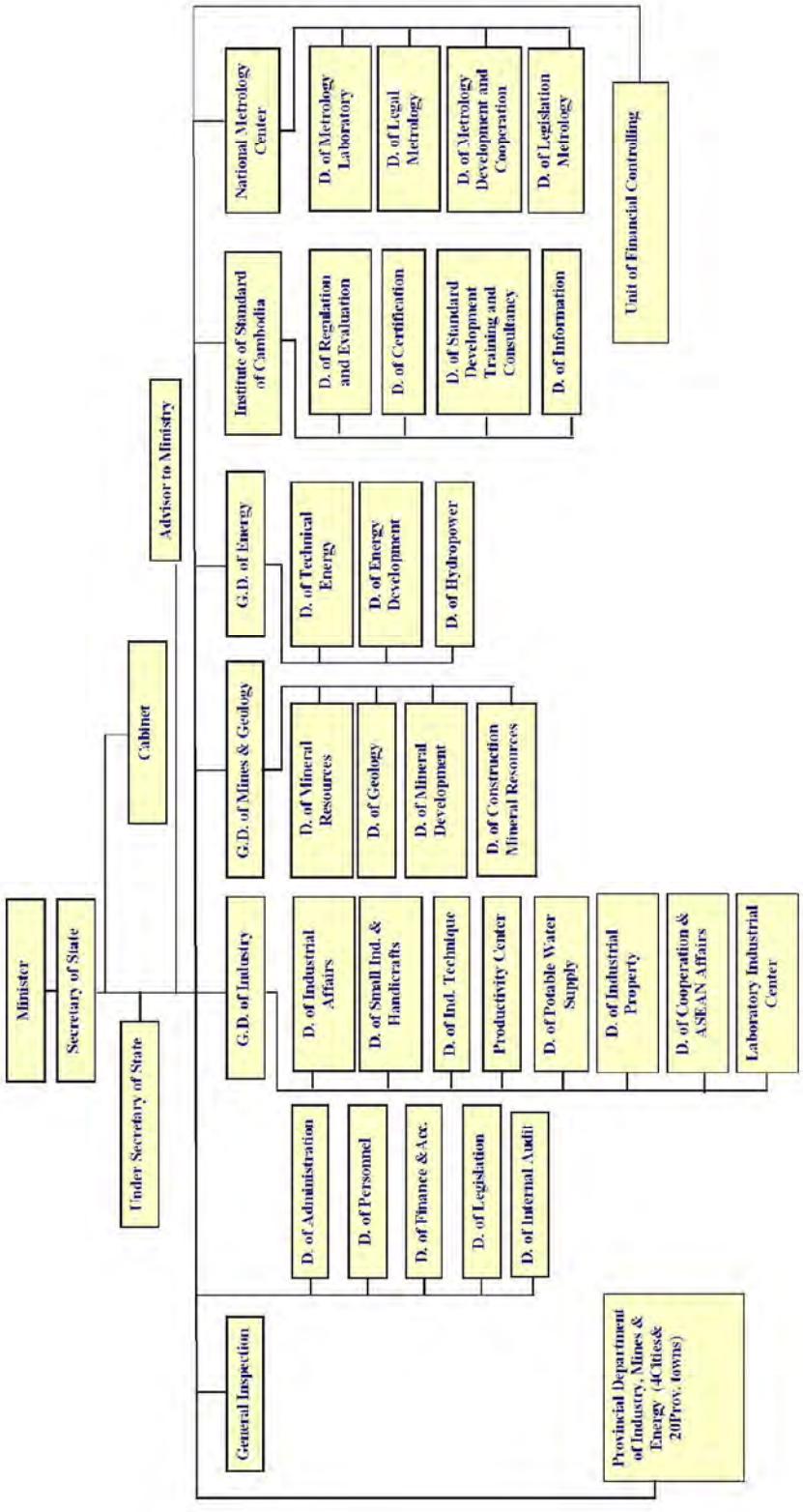
Figure 2-1 Organizations of the Power Sector

2.1.2 MIME

MIME was established in 1993 by reorganizing Ministry of Industries. MIME shares electricity administration with EAC, which was established following the issue of the Electricity Law in February 2001. Main affairs of MIME are as follows:

- Planning energy policies and principles
- Planning strategies for the power sector
- Planning the electricity development project
- Enacting electricity technology, safety, and environmental standard

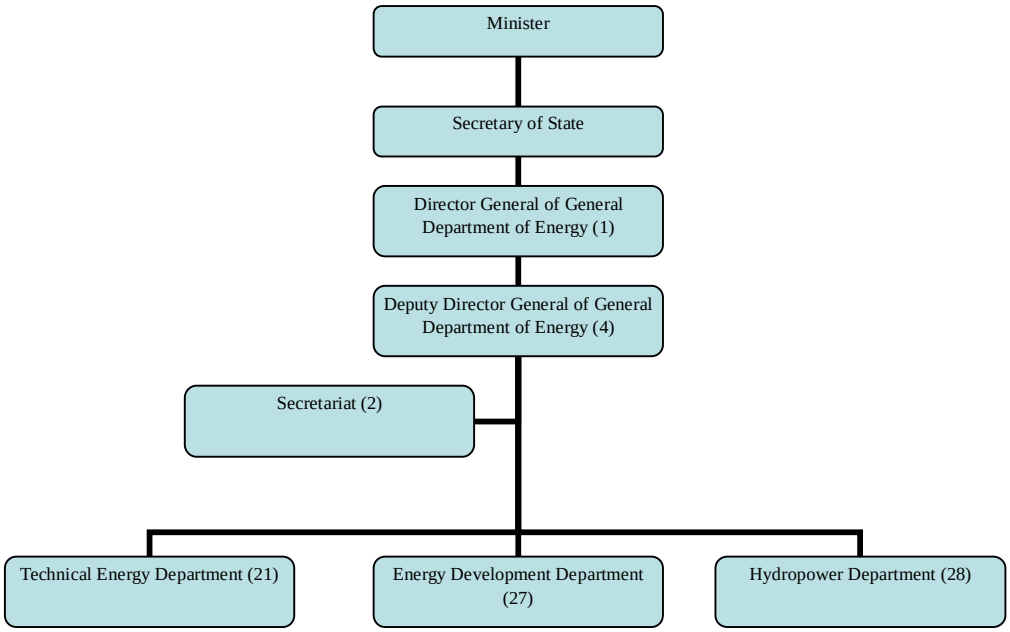
Organization of MIME is schematized in Figure 2-2. MIME consists of the National Metrology Center, the Institute of Standard of Cambodia, the General Department of Industry, the General Department of Mines & Geology, the General Department of Energy, and the Provincial Department of Industry, Mines and Energy, which is in charge of district towns.



Source: Survey Team

Figure 2-2 Organization of MIME (2011)

The General Department of Energy of MIME that administers the electric power discipline consists of three bodies, i.e., the Department of Energy Development, the Department of Technical Energy, and the Department of Hydro Power, as shown in Figure 2-3. As of December 2011, the total number of staffs is 83 and 15 more staffs are expected to join in 2012.



Source: Survey Team

Figure 2-3 General Department of Energy organization chart (2011)

On October 17, 2011, MIME signed a cooperative agreement with General Electric of the U.S. on the development of industrial infrastructure and use of alternative energy. Studies on the development of industrial infrastructure and use of alternative energy have been examined. More specifically, examination is on use of gas turbine technology, promotion and prevalence of smart grid, and studies and development of biomass energy generation using agricultural waste for electrifying farm villages.

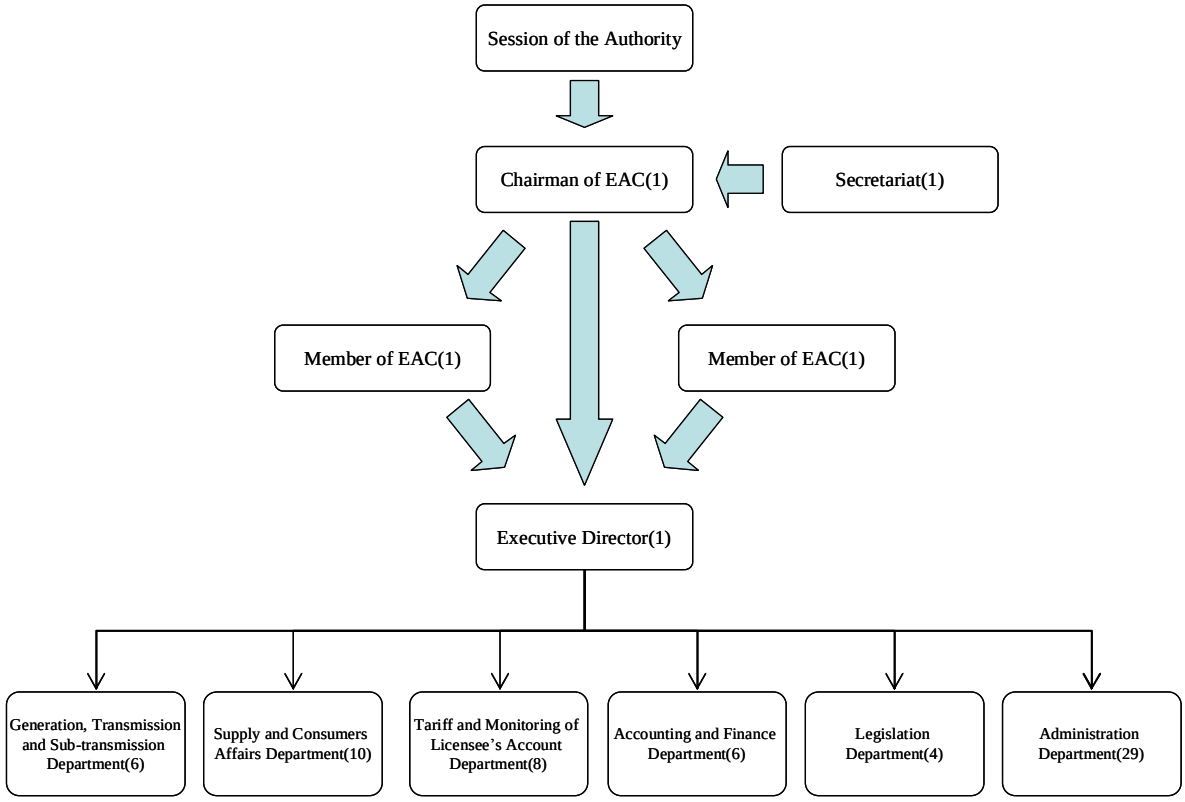
2.1.3 EAC

The EAC organization chart is shown in Figures 2-4. EAC became independent of MIME with the aim to ensure effective, high-quality, continuous, and transparent conduct of electricity business and use of electricity in accordance with the Electricity Law issued in February 2001. EAC has the Board of Directors that acts as the executive decision maker and it consists of the Chairman and two Vice Chairmans (3 members in total). Those reporting to the Executive Director are the Generation, the Transmission and Sub-transmission Department, the Supply and Consumers Affairs Department, the Tariff and Monitoring of Licensee's Account Department, the Accounting and Finance Department, the Legislation Department, and the Administration Department. As of December 2011, 67 staffs work with EAC.

EAC is responsible for regulation and guidance of electricity business and operates on a stand-alone basis supported by licensing fees from electricity enterprises.

Main affairs of EAC are as follows:

- Issue and suspend business license for electricity enterprises
- Approve electricity tariffs
- Plan electricity supply regulations
- Audit electricity enterprises
- Guide electricity enterprises on accounting standardization
- Collect electricity business-related information and produce periodicals



Source: Survey Team

Figure 2-4 EAC organization chart

Sixteen engineers report to the Secretary Ty Norin but there is no civil engineer at the moment. Since a series of medium- to large-size hydropower and thermal power stations are expected to open in the next few years and EAC has no experience with auditing, EAC hopes to receive assistance from experts abroad. Terms of Reference (TOR) for experts are

a) capacity building for inspecting hydropower stations in Kamchay through OJT, and
b) periodical OJT in a country(s) with multiple hydropower stations.

Average monthly salary of EAC staffs is over US$400, which is higher compared to those of MIME and EDC.

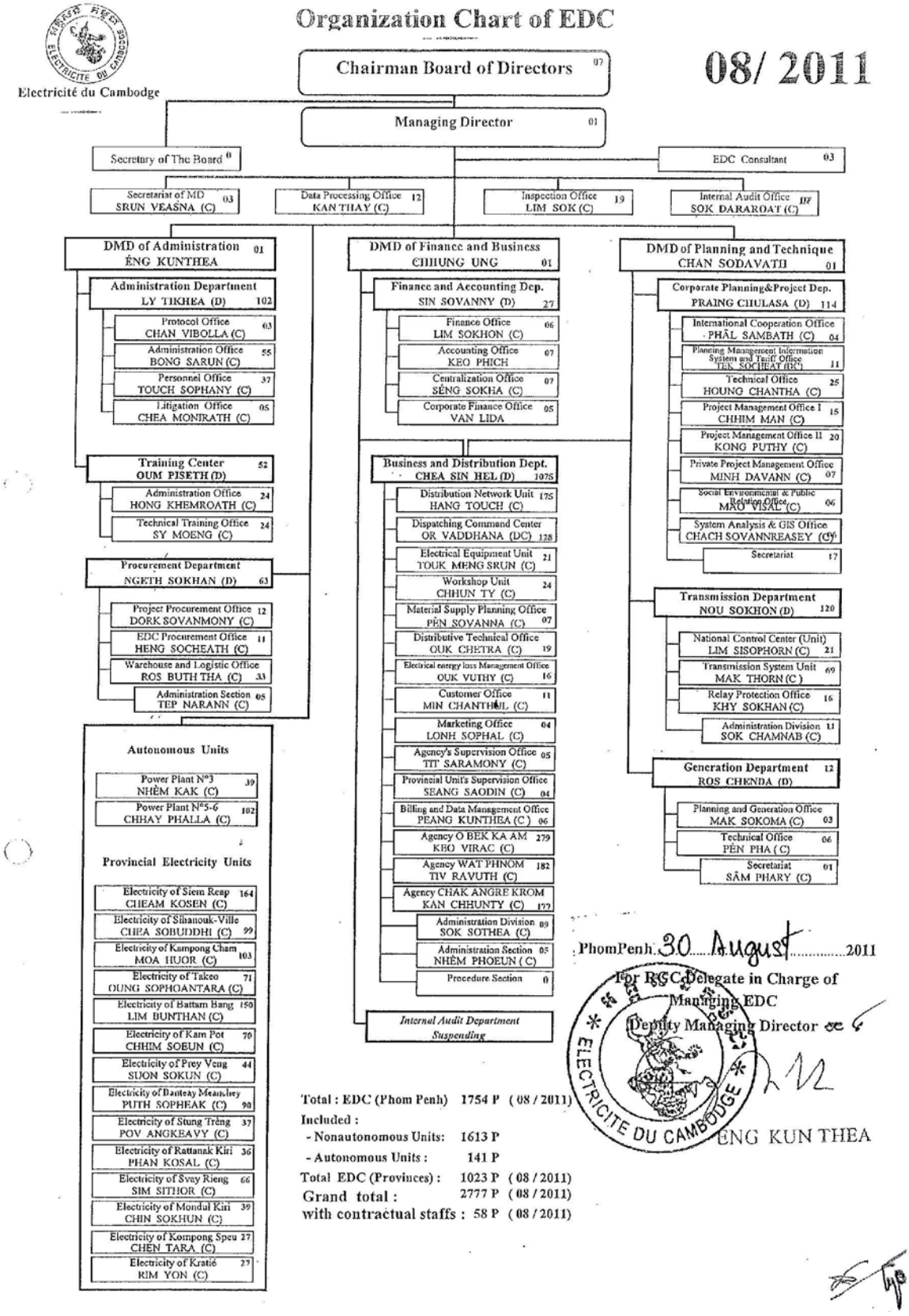
2.1.4 EDC

EDC was established in October 1958 as a public corporation when the Royal Government of Cambodia (RGC) purchased Compagnie des Eaux et Electricité (CEE), which used to supply electricity to Phnom Penh, and Union d' Electricité d' Indochine (UNEDI), which supplied to areas other than Batdambang. However, since most of the facilities were destroyed during the civil war, it was reconstructed as Electricité de Phnom Penh (EDP) in 1979 under the Ministry of Industry with the aim to supply electricity in Phnom Penh. In 1992, the name changed to EDC and became under the jurisdiction of the Ministry of Energy. Following the 1993 nationwide election, it became under the jurisdiction of MIME and by the ministerial ordinance of March 1996, it turned to a public corporation that generates, transmits, and distributes power throughout Cambodia.

At present, EDC is under the jurisdiction of the decision making agency that consists of 7 people and the head of EDC, Managing Director, operates EDC with his subordinates, i.e., 3 Deputy Managing Directors, 7 Departments, 1 Training Center, and 14 local offices. As of the end of August 2011, a total of 2,777 staffs (1,754 from Phnom Penh and 1,023 from local offices) work with EDC. Detailed organization chart is presented in Figure 2-5.

Electricity is supplied in the metropolitan area (Phnom Penh and part of Kandal province) and provincial capitals of Siemreap, Sihanouk, Kampong Cham, Takeo, Battambang, Kampot, Preyveng,

Banteay Meanchay, Stung Treng, Rattanak Kiri, Svay Rieng, Mondul Kiri, Kampong Speu, and Kratie as well as some area near the Cambodia-Vietnam border.



Source: EDC

Figure 2-5 Organization chart of EDC

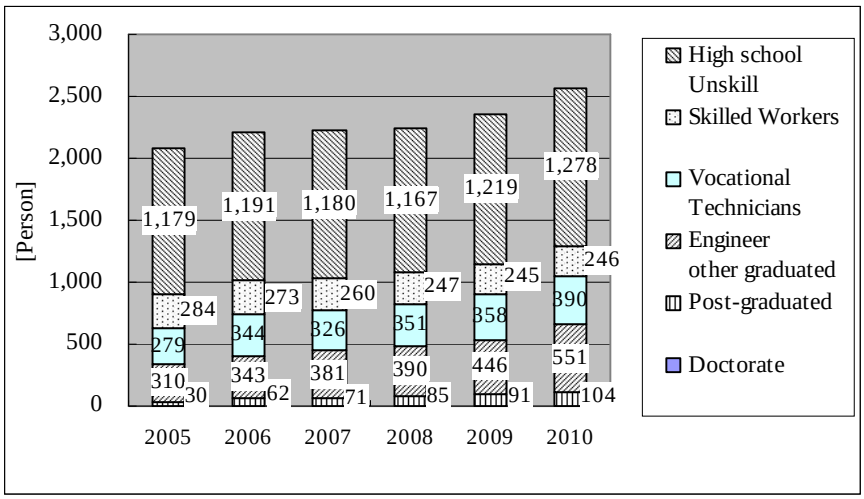
Changes in the number of EDC staffs are presented in Table 2-1 and Figure 2-6. Gradual but steady increases in the numbers of engineers and staffs with higher technical capabilities are shown.

Table 2-1 Number of EDC staffs

[person]

	2005	2006	2007	2008	2009	2010
Doctorate	2	1	1	1	1	1
Post-graduated	30	62	71	85	91	104
Engineer other graduated	310	343	381	390	446	551
Vocational Technicians	279	344	326	351	358	390
Skilled Workers	284	273	260	247	245	246
High school Unskill	1,179	1,191	1,180	1,167	1,219	1,278
Total	2,084	2,214	2,219	2,241	2,360	2,570

Source: EDC



Source: EDC

Figure 2-6 Number of EDC staffs

Recently, average monthly salary increased to be over US$300 and salaries were raised twice in 2011.

(1) Current status of the Transmission Department

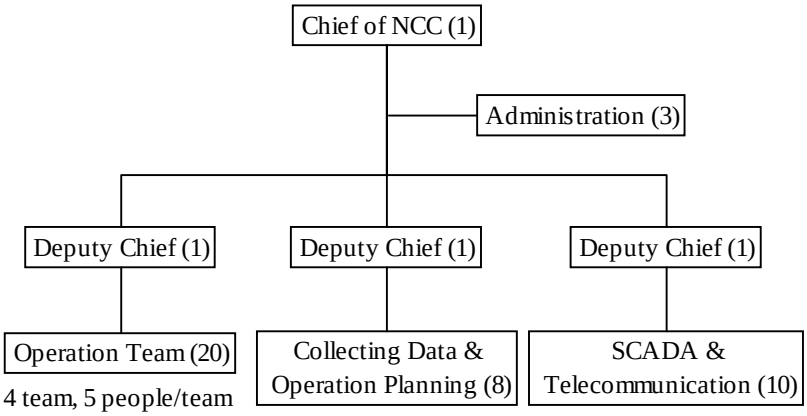
The Transmission Department was established in 2007 when the Transmission and Distribution Department split into the Distribution Department and the Transmission Department. The Transmission Department is responsible for maintenance and operation of the EDC-owned transmission and transformation facilities and consists of three Offices: the Transmission Unit that maintains and operates transmission lines and substations; National Control Center (NCC) that orders electricity supply; and the Relay Protection Office that maintains and settles protection relays. At substations, the demarcation point between the Transmission Department and the Business and Distribution Department is the Circuit Breaker (CB) of distribution line. The Business and Distribution Department is in charge of the CB and later.

a. NCC

The Dispatching Control Center (DCC) of the Business and Distribution Department used to centrally manage demand and supply operation (i.e., to balance demand and supply and to provide good-quality and affordable electricity by adjusting output from thermalpower and hydropower stations); monitor and control transmission lines and substations; and monitor and control distribution lines. Of these responsibilities, NCC will separate demand and supply operation and monitoring and controling of transmission lines and substations from DCC and take over the responsibilities. Since NCC will control the bulk electric power, it will be a highly important agency responsible for stable electricity supply throughout Cambodia while the development of power sources and the consolidation of transmission and transformation facilities evolve.

NCC is being built as part of a WB project called "Rural Electrification and Transmission Project," and the construction is underway as of January 2012. It is expected to be complete at the end of January 2012. At completion, the construction vendor General Electric of the U.S. will hand it over to EDC and NCC will be operated by EDC.

NCC plans to have a system including a Chief, 3 Deputy Chiefs, as well as three divisions for (1) staffs in charge of short-term electricity supply plans, (2) staffs in charge of SCADA and communication equipment, and (3) staffs in charge of operation. The operation division will have four groups of 5 staffs, but the numbers of staffs to be allocated to other divisions are being discussed at this moment. DCC staffs who have experience with operation will be assigned to NCC. Figure 2-7 shows the organization chart.



Source: Survey Team

Figure 2-7 Organization Chart of NCC

Eight EDC engineers received a four-month training provided in Canada by General Electric of the U.S., which delivered the equipment. However, 3 have not returned as of January 2012 and only 5 are trained and available at EDC. The training was OJT and was for the following four sections: hardware, Software, Generator Management System, and Network Analysis System.

Current status of policy making and staffs for operating NCC is summarized below:

① No policies exist for NCC operation at present and need to be developed. The Transmission Department is aware of the need and is in preparation of policies for power generation-related services, procedures for working with companies such as IPP companies, and tasks associated with accident statistics.

② SCADA: Staffs in charge are familiar with use of the system but are not about the type of data to use. Since the training in Canada did not provide texts and was not systematic, knowledge they obtained from the previous training is not sufficient.

③ Communication equipment: EDC will need to perform maintenance after the 1-year warranty period of the communication device manufacturer. However, EDC does not have communications engineers and maintenance may not be possible.

④ Most of the operators do not have experience. Some staffs have worked with DCC, but power distribution has been the main responsibility at DCC and experiences with operation

of transmission and transformation systems are insufficient.

Source: Survey Team

Figure 2-8 NCC under construction

Source: Survey Team

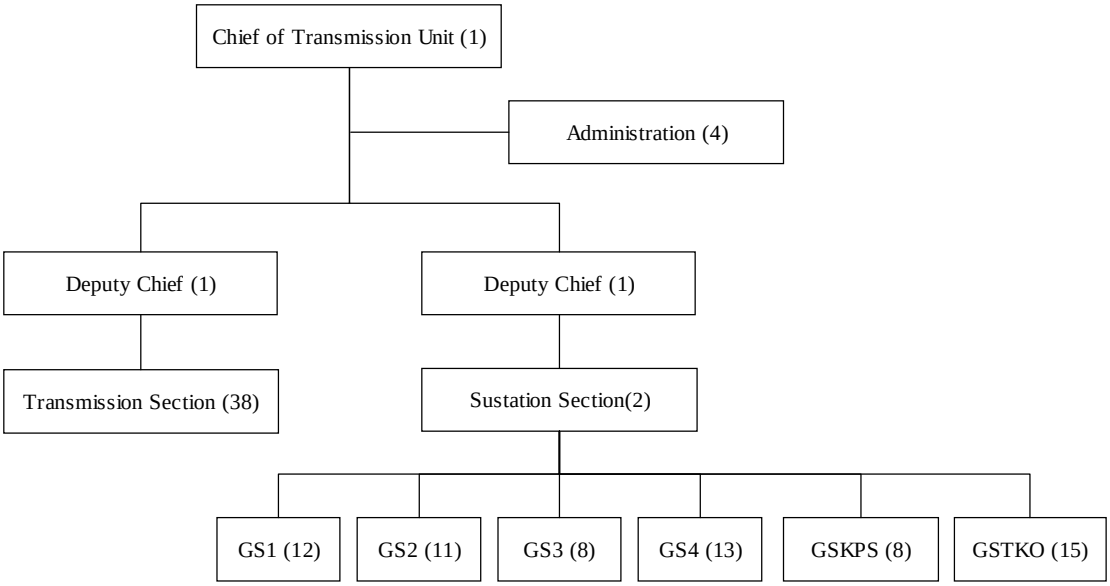
Figure 2-9 Control room of NCC

Thus, EDC hopes to have technical aids in the areas of ① policy development, ② SCADA maintenance, ③ maintenance of communication equipment, and ④ operator training. NCC operation will start in a short while and the needs have to be met urgently.

b. Current status of maintenance and management of transmission and transformation facilities

Transmission and transformation facilities (transmission lines and substations of 115kV and 230kV) are maintained by the Transmission Unit that has a total of 122 staffs at present. Figure 2-10 and Table 2-2 show the constitution of the Transmission Unit. The Transmission Unit maintains 6 substations, 300 km of transmission lines, and 1,161 steel towers and poles. Table 2-3 and Table 2-4 and Figure 2-11 show parameters for transmission lines and substations maintained by the Transmission Unit.

Maintenance-related work for GS1, GS2, GS3, and GS Kampong Speu substations has been transferred from the Business and Distribution Department to the Transmission Department in September 2011.



Source: EDC

Figure 2-10 Organization Chart of Transmission Unit

Table 2-2 Staff number of Transmission Unit (Oct. 2011)

Transmission Unit	Number
Chief, Deputy Chief	3
Administration	4
Substation Section	2
GS1	12
GS2	11
GS3	8
GS4	13
GS Kampong Speu	8
GS Takeo	15
Transmission Section	38
Temporary	8
Total	122

Source: EDC

Table 2-3 Details for Transmission Lines under EDC (Dec. 2010)

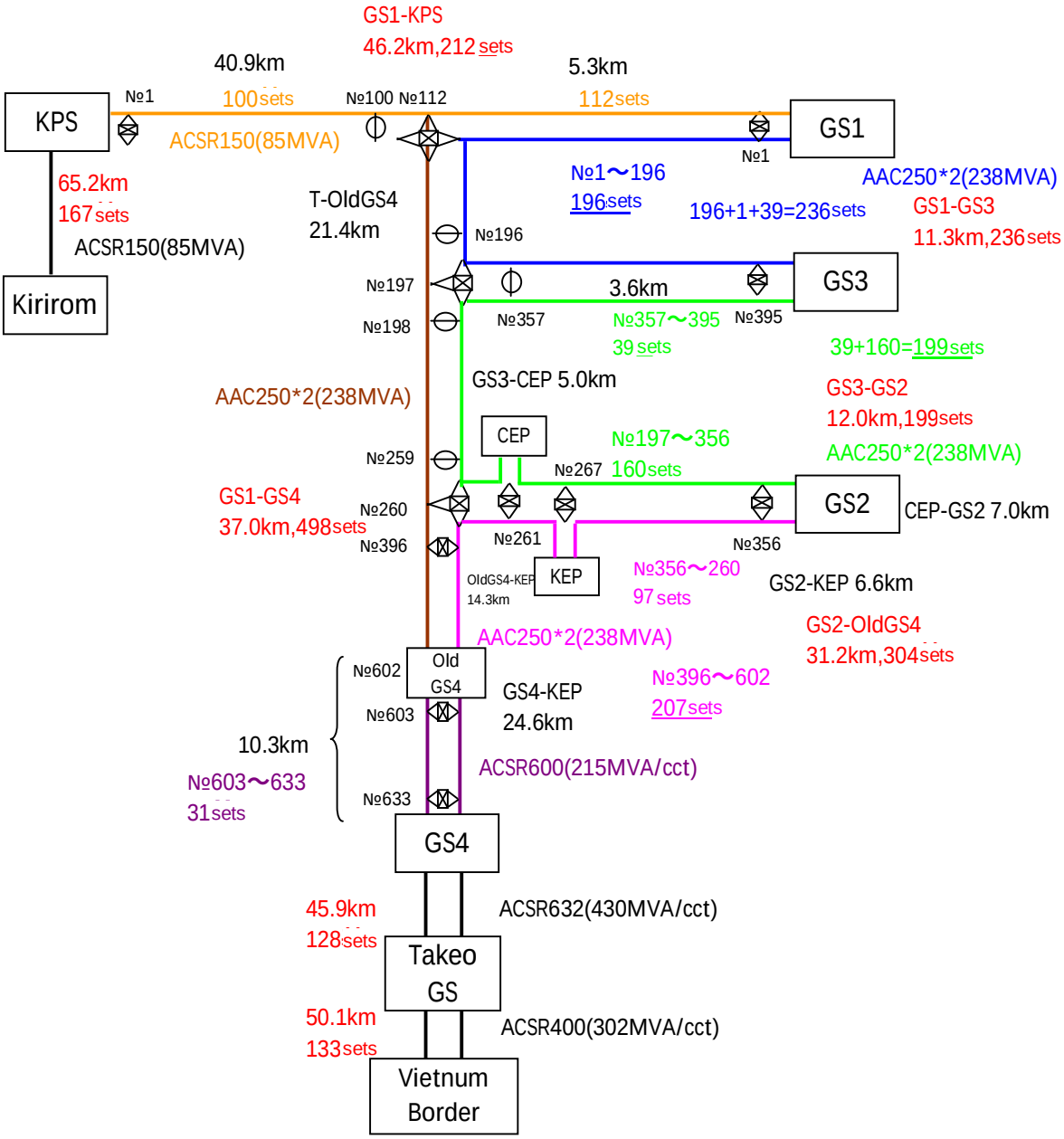
Voltage	Transmission Line	Cross Section (mm^2)	Conductor Type	Capacity (MVA/cct)	Number of Circuit	Number of poles/towers	Length[km]
115kV	GS1-GS3	250×2	AAC	238	1	602	11.3
	GS3-CEP	250×2	AAC	238	1		5.0
	CEP-GS2	250×2	AAC	238	1		7.0
	GS2-KEP	250×2	AAC	238	1		6.6
	KEP-Old GS4	250×2	AAC	238	1		14.3
	Old GS4-T Connection	250×2	AAC	238	1		21.4
	T Connection-GS1	150	ACSR	85	1		5.3
	Old GS4-GS4	600	ACSR	215	2	31	10.3
	T Connection-GSkps	150	ACSR	85	1	100	40.9
	GSkps-KIRIROM	150	ACSR	85	1	167	65.2
230kV	GS4 - GS TAKEO	632	ACSR	430	2	128	45.9
	GS TAKEO - VN Border	400	ACSR	302	2	133	50.1
Total						1161	283.3

Source: EDC

Table 2-4 Details for Grid Substations under EDC (Dec. 2010)

Substation	Transformer			Total Capacity[MVA]
	Voltage ratio	Capacity[MVA]	Number	
GS4	230kV/115kV	200	2	400
	115kV/22kV	50	2	100
GSTakeo	230kV/22kV	16	1	16
GS1	115kV/22kV	50	2	100
GS2	115kV/22kV	50	2	100
GS3	115kV/22kV	50	2	100
GSKPS	115kV/22kV	6.3	1	6.3
Total				822.3

Source: EDC



Source: EDC

Figure 2-11 Transmission diagram

The Transmission Unit has been performing monthly or bimonthly rounds, but has not inspected transmission or transformation facilities. In the "Capacity Building for HV transmission System" (CBHV) performed by Chugoku Electric Power in 2009, EDC suggested to perform inspections as necessary but has not decided the frequency of inspections.
In case of equipment failure, EDC inquires a manufacturer in Vietnam or Thailand and repairs by themselves for substations-related equipment. For transmission line-related equipment, EDC requests a transmission construction company in Cambodia to repair. Simple repair is done by Internal policy for maintenance of transmission and transformation facilities is provided in "Safety Work Procedures for Transmission Line Work (English, Khmer)." This guideline was created based on "Rules for Transmission Work**,** Safety Work Procedures for Substation / Transmission Line Work (English, Khmer)" that Chugoku Electric Power prepared for CBHV. The guideline provides minimum safety rules necessary to maintain equipment. No other policies have been developed for maintenance of transmission and transformation facilities.

As for tools necessary for maintenance, CBHV has procured some, but more tools are needed. Table 2-5 indicates tools and equipment procured by CBHV.

Table 2-5 Tools and Equipment procured by CBHV

Description	Specifications	Unit	Qty
ABS helmet	-	Set	20
Safety belt	R1378-1	Set	11
Anti-fall grip	R1380, 1009383(10.5mm, 15m)	Set	11
Tether rope with energy absorber	KB01	Set	11
Double tether rope with energy absorber	KB02	Set	7
Tether rope equipped with a tension device	R1351(1009175)	Set	11
Safety boundary post	R1360	Set	10
Chain delineators	R6185	Set	3
Stopwatch	-	Set	4
Thermo-hygrometer	-	Set	3
Others (Tools, cables for testing, etc.)	-	LS	1
HV and EHV clamps	LIAT M-MT3735	Pieces	6
Insulating stick	LIAT SM-30AB-H, SM-30AP-U	Pieces	3
Earth clamp	LIAT M-MT43.M	Pieces	6
Earth cable	LIAT CE-CU-P-150	Phase	6
Short-circuiting and earthing systems carrying bags		Set	2
GPS Receiver with Radio Communication	Garmin Rino530HCx, Cambodia Map	Set	4
Laptop Computer	TOSHIBA Satelite M200, mouse, carry case	Set	1
CF adaptor with Compact Flash Memory	1GB, for CW240	Set	4
Voltage Withstanding Test Equipment	HIOKI 3173	Set	1
Shoes with conductivity	-	Set	10
Digital Multi-meter	HIOKI 3286-20	Set	2
Insulation Resistance Meter	HIOKI 3454	Set	3
Circuit Tester (Digital)	HIOKI 3805	Set	4
Circuit Tester (Analog)	HIOKI 3008	Set	2
Clamp Tester	HIOKI 3283	Set	2
Analog Voltage Meter	YOKOGAWA 201319	Set	2
Analog Current Meter	YOKOGAWA 201314	Set	2
Self-checker for Voltage Detector	HASEGAWA CL-1-06	Set	4
Electromagnetic Coating Thickness Tester	LE-370	Set	1
Hotline stick for 230kV	-	Set	1
Hotline stick for 115kV	TN-2, L=2.5m	Set	1
Noise Meter	HIOKI 3431	Set	1
Voltage detector for (115kV,230kV)	WM-275	Set	4
Short-circuiting and earthing systems for 230kVTransmission line	HASEGAWA Z1	Set	2
Short-circuiting and earthing systems for 115kVTransmission line	HASEGAWA Z2	Set	2

Short-circuiting and earthing systems for 230kV,115kVSubstation	HASEGAWA 60	Set	2
Binocular	EA757AD-49A	Set	5
Bottles for tapped Insulating Oil	2045	Set	30
Walkie Talkie	EA790AF-1	Set	4
Rope	EA638TH-10C	Set	1
Hook for rope	FS-90	Set	1
Sling	EA981CH-1	Set	3
Pulley block for rope	SH1001	Set	1
Pulley block for wire (type1)	SH1502	Set	2
Pulley block for wire (type2)	SH1501	Set	4
Pulley block for conductor	300 mm x 65 mm	Set	3
Wire sling (type1)	12mm x 1.5m	Set	4
Wire sling (type2)	12mm x 5.0m	Set	2
Shackle	SC18 (Load:2t)	Set	7
Insulated step ladder	KM-3 (length:2.6m)	Set	1
Rope	10mm x 20m	Set	1
Tool bag	P-276	Set	9
Short rope	5mm x 12m	LS	1
B.V. Winch and attachment	-	Set	1
B.V. Winch	S601	Set	1
Attachment for B. V. Winch	S620-12MM, L90-L175	Set	1
Wire rope	12mm x 100m	Set	1
Hydraulic wire cutter	S-40B	Set	1
Double-acting, engine-driven pump	SEP-5A	Set	1
Compression head	SR-100C-2	Set	1
Compression dice for AAC 250	-	Set	1
Flat rasp	EA521V-1	Set	2
Blackboard, chalk	EA581E-11	Set	1
Compression full tension joint for AAC 250	-	Ps	20
3t Hippaler	TAIYO LA-3W	Set	2
Wire grip	3 ton	Set	2
Bindwire	N.G.K.	Set	1
Scale	Bamboo scale	Set	3
Rag	5kg	Set	1
Vinyl tape (10pieces)	19mm x 20m, 10packs	Set	1
Clamp-on Power Meter with Clamp prove 50A x 4	YOKOGAWA CW240-M/C8	Set	4
Carry Case for CW240	YOKOGAWA 93020	Set	4
Clamp Prove 3000A range	YOKOGAWA 96034	Ps	4
Analysis Software	YOKOGAWA AP240	Ps	1

Source: Survey Team

These tools and equipment are well maintained. However, tools for hot lines (e.g., voltage detectors) are not inspected periodically, since the frequency of inspection has not been determined and EDC does not have a pressure resistance tester.

Some but not all tools and equipment are labeled at substations. Many tools and equipment in the substations that of maintenance has been transferred from the Business and Distribution Department in September 2011 do not have labels. EDC is aware of this issue and plans to label the tools and equipment that do not yet have labels, whenever identified.

(2) Current status of the Training Center

The Training Center has been training electrical engineers using the thermal power and power distribution curriculum prepared by France. CBHV training texts have been added for transmission and transformation curriculum but it is not yet insufficient.
Other than training EDC staffs, the Training Center is open to general audience as a 2-year vocational school. In October 2012, it is expected to become an institute called Institute of Electrical Science, which will be able to grant bachelor's degrees. About 200 students are expected to engage in a bachelor's degree course annually. The training curriculum for EDC staffs for the year 2012 is shown in Table 2-6.
Based on the suggestion Chugoku Electric Power provided at CBHV in 2009, EDC constructed three training towers in 2011for use by transmission line engineers. However, since the towers were not designed for training, tension force cannot be applied to electric wires and training other than going up and down the towers cannot be performed. Thus, remodeling of the existing towers or installation of towers dedicated for training is needed for proper training. As for transformer equipment, there are one breaker and one disconnector only. Obsolete equipment in substations should be moved to the Training Center so that training with other tools and equipment (e.g., transformers and arresters) can be performed. Further, not much progress has been made in human resource training, since training curriculum and materials, equipment, and trainers required for the curriculum are scarce.

Table 2-6 Short Course Program in Training Center

Name of Program	Contents
Distribution	- Unwinding, Pulling along and Adjustment of the Low voltage XLPE Cables - Operation and Consignments on Aerial MV and LV Networks - MV Aerial networks repairing - Calculation of Overhead and Underground Cables - Study control implementation of LV/MV overhead line - LV underground cable preparation - Customer Communications of information - Electrical Phenomena in Underground Cables and Respect of cables - Application of capacitor banks to distribution system LV/MV - Protection system medium voltage - Repair and maintenance switchgear system - Voltage drop calculation - Substation operation and maintenance - Principle of transformer operation and maintenance - Operation and maintenance for LV/MV Network - Power lose calculation - Overhead line Equipment installation - Distribution transformer installation - Voltage Regulation - Improving Line Losses and Voltage Drops by Power Capacitors - Fault on Distribution System - Searching Default of Cable Insulation - Pole Mounted Transformer Installation - Distribution Planning (MV/LV)
Metering	- Mechanical and electronic meter reader (Indigo+) - Training on sm3050 with INDIGO+ meter three phase 4 wire - Installation of Connected meter - Installation of LV meter indirect with CT - Calibration of single phase meter - Installation of MV meter indirect with VT and CT - Loss power on meter calculation

	- Electronic meter reader (Landys) - Control Power Loss on Meter
Safety	- Knowledge of electrical risks - Earthing System on Distribution Network - Safety Work for Manual Handling Equipments - First aid work - External heart massage - The prevention of electrical risks during intervention on the MV overhead network and electric current breaking - Earthing System on distribution network MV/LV and lightning protection - Devices of protection and control fault - Installation of System Protection for Voltage Surges - Calculation and Implementation on Earthing System
Power Plant Protection	- Basic Electricity for operating staffs in power plants - Transformers, AC motor and cutting devices - Alternator - Circuit protection of the generator (Demonstration panel experience) - Automatism-Protection and circuits devices - Generator and Transformer Protection Setting Relay Protection of Generator
Transmission Line	- Switchgear 24kv - Relay testing over current (MCGG82) - Testing relay KCGG142 - Network Configuration - Basic Knowledge on Transmission Line - Operation and Maintenance Substation (HV) - Current and Voltage Transformers - Relay Technology - Unit Protection of Feeders - Safety Work on Transmission Line - Operation and Maintenance of Transmission Line
Diesel Engine	- Basic technical drawing for mechanical - Basic Metrology for Diesel for mechanical - General principle of Diesel Engine - Injection - Endoscope - Fuel oil system - Cooling water system - Lubricating oil system - Starting air system - Turbo repairing - Maintenance and Repairing of Diesel Engine - Maintenance and Installation of Separators - Repair and Maintenance the motor bloc - Repair and Maintenance the feeding system - Repair the Cooling water system and Lubricating system - Starter system, loading system and maintenance characteristic of engine - General Basic of Hydro-Electric Power - Selection of Hydro Turbine - Power Capacity of Hydroelectric

Source: EDC

(3) Current status of the Generation Department

The Generation Department, which is owned by EDC and consists of the Planning and Generation Office and the Technical Office, is responsible for providing management and technical support for thermal power stations operated and maintained by local offices and the Autonomous Unit as well as three micro hydropower stations.

All of the existing small and medium size hydropower stations in Cambodia (O'Chum II, O'Moleng, and O'Romis stations owned by EDC and Kirirom I station owned by IPP) were developed by foreign organizations or private enterprises. Likewise, medium and large hydropower and thermalpower stations that of construction is in progress and expected to commence operation in the next few years are also being developed by foreigners. This means that no power generator will be developed by Cambodian engineers for a while. Further, enterpreneurs working at large-scale hydropower stations at present do not seem to disclose information on the power generation equipment or maintenance and operation of them to Cambodia.

Current status of the Generation Department is, thus:

- short of engineers associated with hydropower and thermal power generation,
- short of means to train engineers on hydropower generation and coal fired power generation, and
- short of OJT experience for development, operation skills, and operation knowledge.

For instance, the O'Chum hydropower station in the Ratana Kiri province is improperly maintained due to the reasons above. This hydropower station was constructed in 1993 with the aid of Vietnam and has been operated and maintained by DIME in the Ratana Kiri province. Thereafter, in 2006, operation and maintenance have been transferred from DIME to EDC. At the time of transfer,

- the water reservoir was not systematically used,
- there was no engineering drawing for power generation equipment, and
- there were no checklists for inspection or records for equipment operation.

Thus, the capacity of the water reservoir has not been effectively used up to the present.

For these reasons, EDC wishes to obtain the following:

a) Power generation technology professionals (obtaining advice for power generation-related responsibilities, such as planning, construction, operation, and maintenance and capacity building through OJT in Cambodia); and
b) Capacity building through OJT in a country with much experience.

(4) Resettlument and social environment

According to the government document No. 1518 dated on Decmber 28, 2010, EDC is in charge of demining, resettlement and land expropriation about all EDC projects. Social, Environment and Public relation Office in Corporate Planning & Projects Department has responsibility to do this work and consists of 7 staff members.

2.1.5 REF

On December 4, 2004, establishment of Rural Electrification Fund (REF) was approved as a support organization for electrification of rural areas and it has been engaged in full activities since April 2007. Funded by WB, main activities include:

① providing subsidy for connecting new consumers with micro hydropower generation or renewable energy sources,
② providing subsidy for introducing the solar home system (SHS);
③ providing subsidy for introducing power system using renewable energy sources (including micro hydropower); and
④ performing a pilot project.

The amount of subsidy is:

a) $150 per new consumer
b) $100 per 40W panel
c) $300-$400 per 1kW ($400 for micro hydropower)

The maximum amount of subsidy is 1/4 of the operating expense.
As for ② subsidy for introducing SHS above, the system has been changed to where REF purchases SHS and applicants repay via a 4-year loan. Methods of payment are single payment, every 6 months for 4 years, or every month for 4 years. The RGC supplements $100 per site. The number of households to be installed is 12,000 in 7 provinces. SHS is expected to be installed by Sunlabob Renewable Energy Co., Ltd. of Laos following bidding before January 31, 2012. Table 2-7 shows the number of SHS installation by the solar panel output.

Table 2-7 Location and number of SHS

No.	Province	Number of Households	Capacity 30Wp	Capacity 50Wp
1	Kampong Thom	4,131	686	3,445
2	kampong Speu	2,477	550	1,927
3	Pursat	1,267	38	1,229
4	Preah Vihear	805	144	661
5	Siem Reap	964	31	933
6	Mondul Kiri	1,062	194	868
7	Ratana Kiri	1,294	467	827
Total		12,000	2,110	9,890

Source: REF

Regarding subsidy for ③ introduction of power system using renewable energy sources (including micro hydropower), the plan has been changed to performing Feasibility Study (FS) at 5 candidate sites for micro hydropower generation. FS was surveyed by SMEC International Pty Ltd. Candidate sites are summarized in Table 2-8.

Table 2-8 Details of selected sites

Site	Design Flow, Q_d (CMS)	Firm Flow, Q_f (CMS)	Net Head (m)	Installed Capacity (MW)	Firm Capacity (MW)	Estimated Annual Generation (MWHr)	Plant Factor %
O'Katieng 1 (Ratana Kiri)	0.90	0.31	44.00	0.34	0.09	1,640	55
O'Sinler 1 (Ratana Kiri)	1.80	0.63	28.50	0.30	0.114	2,830	50
O'Phlai 2 (Mondul Kiri)	2.34	0.15	46.83	0.80	0.29	4,883	60
Bu Sra (Mondul Kiri)	3.20	0.1	50.56	1.30	0.20	7,445	65
Upper Pailin (Paillin)	1.20	0.31	48.00	0.45	0.09	2,696	45

Source: REF

Results of the survey revealed that it is impossible to introduce SHS in the 5 sites due to economic reasons.
Since WB capital is scheduled to be provided until January 31, 2012, The RGC tries to determine whether to make REF as an independent organization within EDC

2.1.6 REE

REE used to have private electricity companies (PEC) and public electricity utilities (PEU). Since

the only PEU, Electricity of Kratie Province, has been absorbed to EDC in 2011, it consists of PEC only at the moment. One group of REE distributes self-generated electricity and the other group purchases electricity from EDC and IPP and distributes it amongst residents of the area.

2.1.7 Summary of electricity enterprises

EAC issues the following 8 types of electricity enterprise licenses:

① Generation License
License for power generation.

② Transmission License
License for transmission of electricity. Two types of Transmission License are available: the National Transmission License is for nationwide use and the Special Purpose Transmission License permits partial construction, ownership, and operation. The National Transmission License is issued only to EDC.

③ Distribution License
License for distribution of electricity.

④ Consolidate License
License that combined generation, transmission, and distribution of electricity. It is issued to EDC and isolated systems of REE.

⑤ Dispatch License
License for supplying electricity that improves transmission and receipt of electricity.

⑥ Bulk Sale License
License for selling electricity purchased from power generation enterprises or neighboring countries to electricity distributors and bulk consumers.

⑦ Retail License
License for electricity retailing.

⑧ Subcontract License
License for providing services based on the Operating Agreement of the current licensee.

As of the end of 2010, 278 licenses are effective and 266 electricity enterprises are engaged in business. Table 2-9 shows the numbers of electricity enterprises at the end of years 2002-2010

Table 2-9 Number of different types of Licenses

Type of License	2002	2003	2004	2005	2006	2007	2008	2009	2010
EDC	1	1	1	1	1	1	1	1	1
Generation	6	7	8	11	14	14	20	19	19
Distribution	4	7	8	9	13	16	21	25	27
Consolidate (Generation + Distribution)	10	69	87	98	114	147	172	197	221
Retail					1	1	1	1	1
Special Purpose Transmission						1	1	3	3
Consolidate (Special Purpose Transmission + Distribution)							2	3	6
Total	21	84	104	119	143	180	218	249	278

Source: EAC Annual Report 2011

Table 2-10 shows the licensees involving electricity supply per province in 2010:

Table 2-10 Province wise Area of supply served by Distribution, Retail and Consolidated Licensees at the end of Year 2010

Province/city	Area of supply	License Number	Name of Licensee	Hours of Supply per Day
1-Banteay Meanchey	Provincial Town of Banteay Meanchey and Mongkul Borei District Town	001L	EDC	24 hours
	Some areas of O Chrov District	011L	Anco Brothers Co., Ltd	24 hours
	Khum O-Prasat and Khum Banteay Neang, Mongkul borei District	077L	Mrs Chao Nuy	24 hours
	Phsar Kotsat Town, Khum Nimit, Khum Kob and Khum Samrong, O-chrov District	078L	Mr.Pak Sun Heng	24 hours
	Khum Phnom Toch, Mongkul borei District	079L	Mr.Thon Thoeurn	24 hours
	Khum Banteay Neang and Khum Talam, Mongkulborei District	080L	Mr. Sok Vitith	24 hours
	Phsar Phnom Srok Town, Khum Sras Chik, Phnom Srok District	081L	Mr. Muon Han	8 hours: From 11:00 to 13:00 and from 17:00 to 23:00
	Phsar Phnom Thom Tbong Town, Khum O-Prasat, Mongkul Borei District	105L	Mr. Soeung Sovanna	24 hours
	Preahnet Preah District Town	108L	Mrs. Sin Savuon	20 hours
	Malay District Town	149L	Sinn Khim Import Export Co., Ltd	24 hours
	Some parts of Khum Teuk Chor, Preah Net Preah District	164L	Vathanak N.T. Angkor Co., Ltd,	24 hours
	Along Road No. 56 from Serey So Porn Town to Boeng Trakuon Town, Khum Kokromeat, Thmar Puok District	189L	Phum Nimit Co, Ltd	24 hours
	Svay Chek District Town	190L	Mr. Mak Van	12 hours
	Khum Changha, O-Chrov District	257L	Mr. Koung Leangheng	5 hours: 18:00 to 23:00
	Khum O-Beychorn, O-Chrov District	276L	Mr. Chun Rithy	10 hours: from 11:00 to 16:00 and from 18:00 to 23:00
	Some parts of Khum Poycha and Khum Srahcheak, Phnom Srok District	289L	Mrs. Duong Sambin	24 hours
2-Battambang	Provincial Town of Battambang	001L	EDC	24 hours
	District Center of Kamrieng	008L	Franasie Import Export Co., Ltd	24 hours
	District Center of Phnom Proeuk	008L	Franasie Import Export Co., Ltd	24 hours
	District Center of Sampeou Loun	008L	Franasie Import Export Co., Ltd	24 hours
	Khum Tapoung, Khum Tamoeun, Thmor Kol District Town, Thmor Kol District	043L	Mr. Som Visal	24 hours
	Khum Phnom Sampov, Banoan District	068L	Mrs. Tuoch Mantha	24 hours
	Rattanak Mondol District Town	069L	Mr. Nop Bin	24 hours
	Khum Boeung Pring, Thmarkol District	079L	Mr. Thon Thoeurn	24 hours
	Khum Prek Khpob, Khum Prek Luong and Khum Prek Norin, Ek Phnom District	091L	Mr. Sun Pov	24 hours

Province/city	Area of supply	License Number	Name of Licensee	Hours of Supply per Day
	District Town of Mongrussey (Left Hand Side of National Road No. 5, Direction from Phnom Penh to Battambang)	109L	Mrs. Tieng Chenda	24 hours
	District Town of Mongrussey (Right Hand Side of National Road No. 5, Direction from Phnom Penh to Battambang)	110L	Mrs. Sea Kech	24 hours
	Phum Ang Long Tamey, Khum Chheuteal, Banorn District	117L	Mr. Dung Ly	24 hours
	Bovil District Town	182L	Mr. Khun Sarun	24 hours
	Khum Tamoeun and Khum Chrouy Sdov, Thmarkol District	201L	Mr. Ou Chanrat	24 hours
	Khum Chrey, Thmarkol District	202L	Mrs. Kung Samon	24 hours
	Khum Lvea and Khum Prey Khpous, Bovil District	242L	Miss San Chhan	9 hours: From 11:00 to 16:00 and from 18:00 to 22:00
	Khum Kantoeu II, Khum Chheurteal and Khum Baydamram, Banan District	244L	Mr. Lun Rith	24 hours
	Some parts of Khum Kampong Preang, Khum Kampong Preah and Khum Raing Kesey, Sangke District and Khum Prey Touch, Khum Kokoh and Khum Mong russey, Mong Russey District	246L	Mr. Sam Nang Sathia	5 hours: From 17:30 to 22:30
	Khum Wat Tameum, Khum Raing Kesey, Sangke District and Khum Baydamram and Khum Cheuteal, Banan District	248L	Mrs. Oun Neang	24 hours
	Khum Takream and Khum Phnom Sampov, Banan Distric	251L	Mrs. Ouch Sophalla	24 hours
	Khum Tapon and Khum Roka, Sangke District	262L	Mr. Tin Savet	20 hours: From 04:00 to 24:00
	Khum O_Taki, Thmarkol District	270L	Mrs. Tech Yeatra	24 hours
	Khum Sneung, Banan District	275L	Mr. Koy Mach	24 hours
	Some parts of Khum Khnach Romeas, Khum Lvea, Khum Bovil, Bovil District and Khum Roung Chrey, Thmar Kol District	282L	Mrs. Soeurn Sophornnara	10 hours: 05:00 to 09:00 and 18:00 to 23:00
	Some parts of Khum Bansay Treng and Khum Roung Chrey, Thmar Kol District	283L	Mrs. Srey Aun	10 hours: 05:00 to 09:00 and 18:00 to 23:00
	Khum Tipakdei, Koas Krala District	302L	Mr. Sem Vuthy	**Not Operated in 2010**
	Khum Prey Svay and Khum Reussey Kraing, Mong Reussey District	303L	Mrs Lim Vanna	11 hours: From 11:00 to 22:00
3-Kampong Cham	Provincial Town of Kampong Cham	001L	EDC	24 hours
	Ponhea Krek District	001L	EDC	24 hours
	Memut District	001L	EDC	24 hours
	Phsar Prey Toteung Town, Prey Chhor District	023L	Electricity Preychhor Enterprise	24 hours
	Some part of Khum Mepring and Khum Phaav, Batheay District	026L	Mr. Chang Bunnaret	24 hours
	Phsar Suong Town, Tbongkhmum District	027L	Electricity Suong Enterprise	24 hours

Province/city	Area of supply	License Number	Name of Licensee	Hours of Supply per Day
	Some parts of Khum SvayTeab, Khum Chmka andoung, Khum Tabrok and Khum Lvea Leu, Chamkaleu District	038L	Mrs. Houng Thanbopha	24 hours
	Khum Sotep, Khum Sramor, Khum pdovchum and Khum Prey Char, Cheung Prey District	047L	Mrs. Sar Malis	24 hours
	Phsaar Bos Knor Town, Chamkar Leu District, and Traeung Town, Prey Chhor District	056L	Mrs. Nhek Theary	24 hours
	Some parts of Khum Prek Kok area, Steung Trang District	057L	Mr. Chin Sohin	24 hours
	Khum Mesorchrey, Steung Trang District	060L	Mrs. Eam Sreng	24 hours
	Phsar Svay Teab Town, Khum Svay Teab, Chamkar Leu District	074L	Mr. Mean Vanna	24 hours
	Phsar Speu Town, Khum Speu and Chayo, Chamkar Leu District	075L	Mr. Chhay Kim Huor	24 hours
	Phsar Tnaltoteung Town, Khum Chob, Tbongkmom District	085L	Electricity Tbong Khmum Enterprise	24 hours
	Some parts of Khum Ampil Tapork, Khum Korng Chey, Khum Tuol Sophy and Khum Mien, O Raing Ov District	088L	Mr. Khun Sophal	24 hours
	Some parts of Khum Tuol Snoul, Khum Chhouk, Krouch Chmer District, Khum Roka Porpram, Khum Kor, Khum Lngeang, Khum Vihearluong, Khum Thmorpech, Khum Sralop, Khum Suong, Khum Anhcheum, Tbong Khmum District, Khum KandoukChrum, Khum Propel, Khum Vealmlo, Khum Korngkang, Khum Krek, Khum Kork, Khum Dauntey, Pohneakrek District	122L	Electricity Development and Construction Company	24 hours
	Thnal Keng Town, Khum Taingkrang and Khum Chea Lea, Bathay District	130L	Mr. Try Leng	24 hours
	Phum Taong, Khum Taong, Chamkar Leu District	140L	Mr Chea Chan Naroeun	24 hours
	Some parts of Khum Mepring and Khum Batheay, Bathey District	159L	Mr. Khun Sopheap	24 hours
	Khum Ptas Kandal, Khum Prekpo and Khum Meanchey, Srey Santhor District	160L	Mr. Seng Chinleang	24 hours
	Kang Meas and Kampong Siem District towns	165L	Electricity Kang Meas Enterprise	24 hours
	Dambe District Town	181L	Mr. Kim Meng	4 hours: From 18:00 to 22:00
	Khum Chinik, Krouch Chhmar District	191L	Mrs. Phin Vipheavy	24 hours
	Some parts of Khum Krouch Chhmar, Khum Svaykhlaing and Khum Poeus II, Krouch Chhamar District	192L	Mr. Path Seang Hun	24 hours

Province/city	Area of supply	License Number	Name of Licensee	Hours of Supply per Day
	Khum Krek, Ponhea Krek District	200L	Electricity Chi Paing Enterprise	24 hours
	Some parts of Khum Prekdombouk, Khum Ptas Kandal, Khum Svaysachpnom and Khum Baray, Srey Sonthor District	207L	Mr. Lay Veng Kheang	24 hours
	Khum Sam Bor, Batheay District	216L	Mrs. Tek Nimol	24 hours
	Khum Krala, Kampong Siem District	220L	Electricity Skun - Chamkar Leu Enterprise	24 hours
	Khum Thmar Poun, Prey Chhor District	241L	Mr. Ung Kimsean	12 hours: From 04:30 to 07:00, from 11:00 to 15:00 and from 17:30 to 23:00
	Khum Tomnoub, Khum Cheung Prey and some parts of Khum Pha-av, Batheay District and some parts of Khum Kouk Roveang, Khum Khnol Dambang and Khum Pdav Chun, Chheung Prey District	254L	Mrs. Pheng Sophat	24 hours
	Khum Chealea, Batheay District	255L	Mrs.Som Sokhalin	13 hours: From 6:00 to 09:00, from 10:00 to 14:00 and from 17:00 to 23:00
	Khum Chamkar Andoung, Chamkar Leu District	256L	Mr. Toek Hong	18 hours: From 03:00 to14:00 and 16:00 to 23:00
	Khum Tonloung, Memot District	277L	Mr. Sean Siphan	19 hours: From 04:00 to 23:00
	Some parts of Khum Roung, Khum Treak, Khum Chanmoul, Khum Tramoung, Memot District	280L	Electricity Daun Roth Enterprise	24 hours
	Some parts of Khum Reussey Srok, Khum Preak Romdeng, Khum Koh Andet, Srey Santhor District, Khum Prek Tanong, Khum Maha Khunhoung, Khum Kampong Reap, Koh Soten District and Khum Peam Chikrong, Kong Meas District	285L	Mrs. Yeab Mey	**Not Operated in 2010**
	Khum Sdeung Chey, Cheung Prey District	286L	Mrs. Sou Rong	**Not Operated in 2010**
	Some parts of Khum Sandek and Khum Taing Krasaing, Batheay District	288L	Mr. Yin Kimly	8 hours: From 04:00 to 08:00 and from 18:00 to 22:00
	Some parts of Khum Araktnout and Khum Prek Kak, Steung Reang District	292L	Mr. Seng Kry	19 hours; from 04:00 to 23:00
	Khum Peam Bra Tnous, Khum Pongro, Khum Mahaleap and some parts of Khum Lve and Khum Kampong Reap, Koh Soten District	297L	Mr. Hout Sothy	**Not Operated in 2010**
	Khum Koh Samroung, Kampong Siem District	301L	Mr. Hak Siekveng	6 hours: from 17:30 to 23:30
4-Kampong Chhnang	Boribo District Town with Zones of Khum Punley, Khum Popel and Khum Khunrong	040L	Mr. Mak Heat	24 hours
	Kampong Tralach District Town and Khum Chres, Kampong Tralach District	041L	Mr. Ty Sokorn	24 hours

Province/city	Area of supply	License Number	Name of Licensee	Hours of Supply per Day
	Provincial Town of Kampong Chhnang	051L	Sovanny Electricity Development Co.Ltd	24 hours
	Some parts of Khum Andong Snay, Khum Rolea Phear and Khum Kouk Banteay, Rolea Phear District	095L	Mrs. Chan Simoly	24 hours
	Phsar Pong Ro Town, Khum Pong Ro and Svay Chrum, Rolea Phear District	096L	Mr. Un Sophal	24 hours
	Teuk Phos District Town	119L	Mr. Un Sothea	24 hours
	Khum Longvek and Khum Svay, Kampong Tralach District	166L	Mr. Or Ratana	24 hours
	Rolear Phear, Teuk Phos and Kampong Tralach District area	167L	Electricity Rolear Phear Enterprise	24 hours
	Khum Prey Kry, Chulkiri District	298L	Mr. Ke Saroeun	18hours 30 minutes: From 04:30 to 23:00
	Khum Phsar, Khum Trapang Chan, Khum Melom, Khum Pechangva, Khum Anchanah Roung and some parts of Khum Brasneb, Khum Popel and Khum Khunrong, Baribo District	300L	OSVR Trading Co., Ltd	24 hours
5-Kampong Speu	Provincial town of Kampong Speu	001L	EDC	24 hours
	Khum Trapaing Kong, Samrong Tong District	053L	Mr. Nget Hong	24 hours
	Khum Chung Rouk, Khum Shnom Kropeu, Khum Maharesey and Khum Preah Vihear, Korng Pisey District and Khum Tuol Ampil, Borseth District	064L	Electricity Tramkhnar	24 hours
	Phsar Trapaing Kraloeung Town, Some parts of Khum Kirivoan, Khum Taing Sya and Khum Mohasaing, Phnom Srouch District	067L	Mr. Sok Hoy	24 hours
	Khum Viang Chas, O'dong District	076L	Mr. Quach Edward	24 hour
	Khum Treng Trayeng, Phnom Srouch District	082L	Mr. Ly Sok Kry	24 hours
	Phsar Bat Doeung, Khum Khsem Khsan, Odong District	099L	Mr. Leng Mov	24 hours
	Khum Por Ankrang and Netan, Bor Seth District	101L	Mr. Chhin Song	24 hours
	Talat Town, Khum O, Phnom Sruoch District	136L	Mr. Men Kunthae	24 hours
	Area along RN 4 (north) from Khum Vorsar and along RN 51 to the end border of Khum Mkak, Samarongtong District, Oddong District	137L	Mr. Meng Sokleng	24 hours

Province/city	Area of supply	License Number	Name of Licensee	Hours of Supply per Day
	Khum Roleang Kreul, Samraong Tong District and Khum Roka Koh, Kongpisei District	154L	Mr. Uy Sopath	24 hours
	Phsar Krangchek Town, Khum Krangchek and some areas of Khum Chheungras, Udong District	155L	Mr. Samret Kiri	24 hours
	Khum Trapeang Kong, Samraong Tong District	156L	Mr. Men Sambath	24 hours
	Khum Preahnipean, Kongpisey District	219L	Mr. Phoeurn Saroeurn	24 hours
	all the Khum in Korng Pisey District, Khum Svay Rompea, Khum Pheary Meanchey, Khum Svay Chorchep, Khum Tuol Sala, Borset District, Khum Kirivirn, Khum Mohasaing, Khum Preykorng, Phnom Sruoch District, Khum Thormta-Or, Khum Skus, Khum Kraing Ampil, Khum Rolaing Chork, Khum Rolaing Kreul and Khum Sendey, Samrong Tong District	224L	Sokha Electricity Co., Ltd	24 hours
	Khum Preyromduol, Khum O and Khum Kirivoan, Phnom Sruoch District	237L	Mr. Ly Chinlong	24 hours
	some areas of Khum Kasemkasam, Khum Prehsre, Uddong District	278L	Mr. Sot Sarin	6 hours: From 17:00 to 23:00
6-Kampong Thom	Kampong Thmar town consisitng of Khum Balang and Khum Chong Daung Baray District and Khum Kampong Thmar, Sontuk District	006L	Mr. Huor Pheng	24 hours
	Provincial Town of Kampong Thom	012L	Sung Jin & Chilbo Industrial Co., Ltd	24 hours
	Khum Treal, Khum Sralov, Khum Chralorng, Khum Andoung Pur and Khum Chraneang, Baray District	019L	Mr. Te Kok Eng	24 hours
	Khum Chraneang, Khum Svayphleung, Khum Soyong, Khum Pongro and Khum Chralorng, Baray Distric	032L	Mr. Nhen Kong	24 hours
	Phsar Baray Town, Khum Baray, Baray District	039L	Mr. Kim Chantara	24 hours
	Stong District Town	063L	Mr. Ong Hok Sin	24 hours
	Santuk District	073L	Mr. Treung San	24 hours
	Sandann District Town	199L	Mr. Some Lai Y	24 hours.
	Khum Sankor, Kampong Svay District	228L	Mr. Saeu Tiengkok	24 hours
	Khum Treal and Khum Chhouk Khsach, Baray District	245L	Mr. Chhea Sokhom	24 hours
7-Kampot	Kampot provincial town	001L	EDC	24 hours.

Province/city	Area of supply	License Number	Name of Licensee	Hours of Supply per Day
	Kompong Trach district Town, Khum Oeuseysrok Khanglech and Khum Kompong Trach Khangkeut, and Khum Kanthor Khanglech, Kompong Trach District	001L	EDC	24 hours
	Khum Prekthnot, Khum Kohtoch and Khum Beungtouk, Kampot District	042L	Mr. Kong Sophal	24 hours
	Phsar Chhouk Town, Chhouk District, Chumkiri District Town, Dong Tong District areaand Kampot District area	044L	Mr. Kong Puthy	24 hours
	Some areas of Khum Tropaing Sala Khangket, Khum Tnaut Chongsrol, Khum Prey Tonle, Banteay Meas District, Khum Mroum, Khum Deum Dong, Angkor Chey District, Khum Kanthor Khangcheung, Khum Kanthor Khangket, Khum Prekres, Kampong Trach District	093L	Banteay Meas Electricity	24 hours
	Angkor Chey District Town	097L	Mr. Yin Ech	24 hours
	Some areas along 22 kV line from Lork Town, Khum Svaytong Khangtboung, Kampongtrach District to Authorised Distribution area of EDC at Kampot	180L	Kep Power Supply Co. Ltd	24 hours
	some parts of Khum Srae Cheang, choum Kiri District	197L	Mr. Chith Ponnara	24 hours
	Dorng Tong District Town	225L	Mrs. Chann Sokim	24 hours
8-Kandal	Area around Phnom Penh	001L	EDC	24 hours
	Some area of Koh Thom District and Sa-Ang District	011L	Anco Brothers Co., Ltd	24 hours
	Phsar Neak Loeung Town (West of Mekong River), Khum Prek Tonlap and Khum Kampong Phnom, Leukdek District	021L	Mrs. Nov SreyPich	24 hours
	Phsar Rokakong Town, Mukkampoul District	037L	Mr. Eang Seng Hy	24 hours
	Khum Kampong Chamlorng, Khum Sithor and Khum cheythom, Khsach Kandal District	045L	Mrs. Choup Neang	24 hours
	Khum Troeuysla, Khum Talun, Khum Khpob, Saang District, Khum Pouthiban, Khum Kampongkong, Khum Chrouytakhaev, Khum Chheu Khmau, Khum Prek Chrey and Khum Leudek, Koh Thom District	049L	Eastern Power Supply Enterprise	24 hours
	Khum Prekthmey and Khum Chheu Teal, Kean Svay District	050L	Reeco Company	24 hours
	Phsar Thnal Toteung Town, Khum Damnak-Ampil, Ang Snoul Distict	053L	Mr. Nget Hong	24 hours

Province/city	Area of supply	License Number	Name of Licensee	Hours of Supply per Day
	Phsar Kampong Kantuot Town, some parts of Khum Bakou and Khum Anlong Romeat, Kandal Stung District	058L	Mr. Chay Neng	24 hours
	Phsar Ang Snoul Town, Khum Peuk, Ang Snoul District	061L	Mr. Khoeun Sambath	24 hours
	Estern Phsar Prek Kdam Town, Khum Kohchen, Ponhealeu District	062L	Mr. Er Long	24 hours
	Phsar Prek Anh Chagn, some areas of Khum Prek Anh chagn, Muk Kampoul District	066L	Mr. Pean Sokhalay	24 hours
	Southern Phsar Saang Town, Khum Prek Koy and Khum Saang Phnom, Saang District	071L	Mr. Heng Tray	24 hours
	Khum Ponnhealeu, Khum Vihealuong, Khum Phsar Dek, Khum Phnom Bath, Khum Tomnobthom, and Khum Kampongluong, Punnhea leu District	076L	Mr. Quach Edward	24 hours
	Phsar Northern Saang Town, Saang District	086L	Mr. Koeung Rithy	24 hours
	Muk Kampoul District and Pongealeu District	090L	Veasna New Land Power Co., Ltd	24 hours
	Khum Tomnob Thom, Ponhea Leu District and Khum Mkak, Ang Snoul District	099L	Mr. Leng Mov	24 hours
	Khum Bak Kheng, Mukkompul District	103L	Mr. Nhem Phany	24 hours
	Area along RN 4 (north) from Khum Vorsar and along RN 51 to the end border of Khum Mkak, Angsnoul District	137L	Mr. Meng Sokleng	24 hours
	Khum Kohdach, Muk Kampoul District	143L	Mrs. Leang Chhunny	5:30 hours: From 17:30 to 23:00
	Phsar Siem Reap town, Khum Siem Reap, Khum Kouk Trab, Khum Preah Putth and Khum Ampov Prey, Kandal Stung District	144L	Mr Ouk Sopheap	24 hours
	Khum Korky, Khum Dey-Et, Khum Banteay Dek, Khum Chheur Teal, Khum Khalkoh, Khum Kampong Svay and Khum Phum Thom, Keansvay District and Khum Svay Brateal, Sa-ang District	150L	Akkisni Kien Svay Co., Ltd	24 hours
	Khum Svayrolum and Khum Setbo, Sa-Ang District	151L	Khmer Electricity Service Co., Ltd	24 hours
	Khum Beng Kyang, Khum Prek Sleng, Khum Prek Roka and Khum Trea, Kandal Steung District	153L	Mrs Nguon Socheatey	24 hours
	Khum Svayproteal and Khum Troeysla, Saang District	168L	Mrs. Ou Kimheng	24 hours
	Khum Banteaydek, Kien Svay District	169L	Mr. Bun Huy	24 hours
	Phum Raing Dek, Khum Kokythom, Kien Svay District	170L	Mr. Chhun Ly	24 hours
	Khum Prek Takov and Phum Leu, Khum Svay Chrum, Khsach Kandal District	171L	Mrs Nhem Sotheary	24 hours

Province/city	Area of supply	License Number	Name of Licensee	Hours of Supply per Day
	Khum Beung Kyang and Khum Prekroka, Kandal Steung District	174L	Mr. Moeun Sokhan	24 hours
	Khum Samrong and Prektateng, Ponhnealeu District	176L	Mr. Moul Tit	24 hours
	Khum Kraing Youv, Saang District	179L	Mr. Nhoek My	24 hours
	Khum Vihearsuor, Khsach Kandal District	186L	Mr. Heng Kosal	24 hours
	Khum Preah Prosob, Khum Svay Romeat, Khum Prek Tameak, Khum Koh Choram and Khum Taek, Ksach Kandal District	204L	Mr. Chhay Chansophea	24 hours
	Khum Prek ampil and Khum Pukrussey, Khsach Kandal District	209L	Mr. Sok Pin	24 hours
	Khum Koh Anlongchen, Saang District	211L	Mrs. Iv Mala	24 hours
	Special Economic Zone, Khum Boeng Thom and Khum Kantauk, Ang Snoul District	215L	Colben Energy (Cambodia) PPSEZ Limited	24 hours
	Phsar Prey Toteung Town, Khum Trapaing Veng, Kandal Steung District	219L	Mr. Phoeurn Saroeurn	24 hours
	Khum Prek Kompoeus, Khum Cheung Keub, Khum speanthmor, Khum Kongroy, Khum Tean, Khum Rotous, Khum Prehput, Khum Kandouk and Khum Siem Reap, Kandal Stoeung District and Sangkat Prek Ho, Krong Takmao	223L	L.M.K.Co., Ltd	24 hours
	Khum Rolaing Ken, Khum Roka, Khum Doeum Reus, Khum Trapaing Veng, Khum Trea, Kandal Steung District	224L	Sokha Electricity Co., Ltd	24 hours
	Khum Samroangthom, Kiensvay District	226L	Mrs. Hen Bonith	24 hours
	Khasach Kandal District Town	230L	Mrs. Thauy Vorun	24 hours
	Khum Ruessey Chrouy, Muk Kampoul District	234L	Mrs. Kak Srey On	24 hours
	Khum Prekluong and Khum Prektakov, Khasach Kandal District	235L	Mr. Cheng Sophal	24 hours
	Khum Ponhea Pon and Khum Chhvaing, Pohnea Leu District, Khum Ponsaing and Toulpreich, Angsnoul District	243L	SVC Power Development Co., Ltd	24 hours
	Some parts of Khum Areyksat and Khum Sarikakeo, Lvea Em District and some parts of Khum Svaychrom, Ksach Kandal District	249L	Mr. Vann Ramon	24 hours
	Khum Koh Oknhatey, Kasach Kandal District	250L	Mrs. Suy Chamnan	24 hours
	Khum Snao, Khum Chauk Cher Neang, Khum Ovloak and Khum Ponsgsaing, Angsnoul District	261L	Sahakreas Aphivath Akisni Chunabort	**Not Operated in 2010**
	Khum Prektaten, Ponhealeu District	264L	Mr. El Henghuot	24 hours

Province/city	Area of supply	License Number	Name of Licensee	Hours of Supply per Day
	Khum Ampov Prey, Kandal Stueng District	266L	Mr. Lors Toeur	24 hours
	Khum Kampongchamlong, Khum Bakdav and Khum Sithor, Kasach Kandal District	272L	Mr. San Soeun	20 hours: from 04:00 to 24:00
	Khum Chreylas, some parts of Khum Tomnobothom, Pohnealeu District	278L	Mr. Sot Sarin	6 hours: From 17:00 to 23:00
9-Koh Kong	Provincial Town of Koh Kong	014L	L.Y.P Group Co., Ltd	24 hours
	Sre Ambel District Town, Some areas of Khum Beongprev and Khum Donpen, Sre Ambel District	028L	Mr. Samreth Sothy	24 hours
	Phum Koh Sdech, Khum Koh Sdech, Kirisakor District	106L	Mrs. Ann Samlan	24 hours
	Some parts of Khum Boeyng Preav, Sre Ambel District	279L	Mr. Try Chhunheng	**Not Operated in 2010**
10-Kratie	Provincial Town of Kratie	059L	Electricity of Kratie Province	24 hours
	Part of Snuol District	059L	Electricity of Kratie Province	24 hours
	Chhloung and Chitburey District	191L	Mrs. Phin Vipheavy	24 hours
	Khum Cham Bork and Khum Rossey Keo, Prek Brasorb District	217L	Mr. Heang Pov	10 hours: From 04:00 to 06:00, from 11:00 to 13:00 and from 17:00 to 23:00
	Prek Prasob District Town	227L	Mr. Phin Ham	24 hours
	Sambo District Town	263L	Mrs. Sam Bun Kich	24 hours
11-Kep	Kep City and some areas along 22 kV line from Lork Town, Khum Svaytong Khangtboung, Kampongtrach District, Kampot Province to Authorised Distribution area of EDC at Kampot	180L	Kep Power Supply Co. Ltd	24 hours
12-Mondulkiri	Keoseyma District Town	001L	EDC	24 hours
	Provincial Town of Mondul Kiri	001L	EDC	24 hours
13-Oddor Meanchey	Osmach Town, Khum Osmach, Samrong District	014L	L.Y.P Group Co., Ltd	24 hours
	Provincial Town of Oddor Meanchey and area along Road 68 from Osmach to Oddor Meanchey	014L	L.Y.P Group Co., Ltd	24 hours
	Trapaing Prasat District Town	163L	Mr. Phom Phal	16 hours: From 05:00 to 11:00, and from 13:00 to 23:00
	Anlong Veng District Town and along road no.67 from Anlong Veng District Town to Thai Border	214L	All Stars Entertainment Co., Ltd	24 hours
14-Pailin	Salakrao District	009L	MSP Development co., Ltd	24 hours
	Pailin City	089L	Vannak Pheap Devlopment Co., Ltd	24 hours
15-Phnom Penh	Phnom Penh & surrounding area	001L	EDC	24 hours
	Khan Rusey Keo	090L	Veasna New Land Power Co., Ltd	24 hours

Province/city	Area of supply	License Number	Name of Licensee	Hours of Supply per Day
	Sangkat Prek Lep,Khan Rusey Keo	103L	Mr. Nhem Phany	24 hours
	O-Rusey Market, Phnom Penh	138L	Lim Heng Group Co, Ltd	24 hours
	Sangkat Pleung Ches Rotes, Khan Dangkoa	215L	Colben Energy (Cambodia) PPSEZ Limited	24 hours
	Along National Road No. 3 located in Khan Dangkor	222L	Akisni Dangkor Co., Ltd	24 hours
16-Preah Vihear	Provincial Town of Preah Vihear	031L	Mr. Chan Thun	24 hours
	Rovieng District town	128L	Mr Eang Khun	24 hours
	Chum Ksan District Town	162L	Mr. Hay Tina	21 hours: From 04:00 to 01:00
	Khum Srayang, Koulen District	172L	Mr. Mor Malen	24 hours
17-Prey Veng	Provincial Town of Prey Veng	001L	EDC	24 hours
	Neak Loeung Town (East of Mekong River), Peamro District	017L	Mrs. Bun Liv	24 hours
	Khum Roka and Khum Prey Sneat, Pearang District	018L	Mr. Ky Sophear	24 hours
	Kar-Andoek Town, Khum Prasat, Kampong Trabek District	036L	Mrs. Pauch Kim	24 hours
	Some parts of Khum Kampong Popel, Khum Kampong Praing, Khum Mesor Brachan and Khum Reap, Pearang District	045L	Mrs. ChoupNeang	24 hours
	Kampong Leav, Svay Antor and Pearaing District Area	046L	Mr. Seng Sokun	24 hours
	Khum Ampil Krao, Sithor Kandal District	088L	Mr. Khun Sophal	24 hours
	Khum Krabao, Kamchay Mea District	122L	Electricity Development and Construction Company	24 hours
	Khum Kampong Trabek and Khum Peam Montear, Kampong Trabek District	187L	Mr. Khem Rany	24 hours
	Khum Prek Ksay "A", Khum Peamro and Khum Bapong, Peamro District	198L	Mrs. Nov Sophea	24 hours
	Prahsdach District Town and along the road from Prah Sdach District Town to Distribution area of Neak Loeung Town, Peam Ro District	206L	Bun Liv Co., Ltd Development Import Export	24 hours
	Khum Kanh Chreach, Khum Tnout, Khum Thmar Poun and Khum Koukkonglech, Kanh Chreach District	208L	Mr. Keo Cham Reun	24 hours
	Mesang District Town	239L	Mr. Chan Sothea	16 hours: from 07:00 to 23:00
	Khum Chea Klang, Svay Antor District, Khum Chrey, Khum Daun Keung, Khum Smaung Cheung and Khum Kranhoung, Kamchay Mea District	259L	Geniinstall Co., Ltd	24 hours
	Some parts of Khum Chheurech and Khum Cheung Phnom, Baphnom District	267L	Mr. But Bunchea	24 hours

Province/city	Area of supply	License Number	Name of Licensee	Hours of Supply per Day
	Khum Chres, Mesang District	269L	Mr. Kong Yorn	15 hours: from 07:30 to 22:30
	Khum Prey Kandang and Khum Theay, Peamro District and some parts of Khum Roung Damrey, Khum Rakchey, Baphnom District	284L	Mr. Long Hay	24 hours
	Khum Roka, Khum Prey Sralet, Khum Prey Pneuv and Khum Prey Sneat, Pearang District	294L	Mrs. Chheng Kimheak	12 hours
	Khum Prey Deum Thneng, Khum Romlech, Khum Lve, Khum Prek Changkram, Khum Roseysanh and Khum Prey Teung, Sithor Kandal District	295L	Mr. Khun Visal	5 hours: From 17:00 to 22:00 hrs
	Khum Prey Phnouv, Pearang District	299L	Mr. Lim Pros	24 hours
18-Pursat	Phsar Beung Khna Town, Khum Beung Khna, Bakan District	033L	Mr. Chhuor Nguon	24 hours
	Some parts of Khum Trapaing Chong, Khum Beng Botkandal and Khum Snam Preah, Bakan District	034L	Mr. Toem Touch	24 hours
	Provincial Town of Pursat and parts of Kandeang District	052L	Nareth Co. Ltd Electricity Development	24 hours
	Phsar Svay Daun Keo Town, Khum Svay Doun Keo, Bakan District	072L	Mr. Ya Sambat	24 hours
	Khum O-Tapong, Bakan District	102L	Mr. Preap Vannaret	5 hours: From 18:00 to 23:00
	Phnom Kravanh District Town	124L	Mrs. Ear Lay Sien	18 hours: From 5:00 to 23:00
	Krakor District town	125L	Mr. York Savong	24 hours
	Khum Chheutom, Krakor District	233L	Mr. Srun Sokun	24 hours
	Khum Pramouy, Veal Veng District	281L	Mr. Vong Sombo	15 hours: From 07:00 to 22:00
19-Ratanakiri	Provincial Town of Ratanakiri	001L	EDC	24 hours
	Some parts of Khum Laminh, Khum Kak and Khum Seng, Borkeo District	291L	Mr. Sarit Ly	24 hours
20-Siem Reap	Provincial Town of Siem Reap	001L	EDC	24 hours
	Pouk District Town	035L	Vonn Virek Service Co, Ltd	24 hours
	Khum Domdek, Phsar Domdek Town, Sotnikum District	048L	Mr. Chhom Sophay	24 hours
	Phsar Thnal Chek Town, Khum Kien Sangke and Khum Dam Dek, Sotnikum District	083L	Mr. Tun Yoeun	24 hours
	Chikreng District Town	111L	Mr. Kong Vun	24 hours
	Chikreng District Town	112L	Mr. Ly Kang	24 hours
	Phum Phsar Kleang, Khum Kampong Kleang, Sotnikum District	127L	Mr Te Hong Cheng	9 hours: From 12:00 to 17:00 and 18:00 to 22:00
	Phum Chork, Khum Sangveuy, Chikreng District	129L	Mr.Chan Sok	24 hours
	Angkor Chum District Town	139L	Mr Duong Narin	16 hours: From 07:00 to 23:00
	Khum Anlong Samnor and Khum Chikreng, Chikreng District	161L	Mr. Kea Kimseng	5 hours: From 17:30 to 22:30

Province/city	Area of supply	License Number	Name of Licensee	Hours of Supply per Day
	Khum Kampong Thkov, Khum Kralanh and Khum Sranal, Kralanh District, and Khum Prey Chrouk, Pouk District	164L	Vathanak N.T. Angkor Co., Ltd,	24 hours
	Khum Samrong, Sotnikum District	183L	Mrs. Meas Keav	5 hours: From 18:00 to 23:00
	Khum Kantraing, Prasatbakong District	185L	Mr. Phlok Vannak	24 hours
	Khum Roluos, Khum Meanchey and Khum Trapiangthom, Prasat Bakong District	203L	Mr. Tan Kang	24 hours
	Svay Lue District Town	229L	Mr. Khean Kev	4 hours: From 18:00 to 22:00
	Khum Srey Noy, Varin District	240L	Mrs. Long Kimheng	24 hours
	Some parts of Khum Sasarsdom and Khum Mokben, Puork District	287L	Mr. Sam Toek	15 hours: From 04:30 to 11:00 and from 16:30 to 23:00
21-Sihanouk	Sihanoukville	001L	EDC	24 hours
	Phsar Veal Reinh Town and Phum Chheng Kor, Preynob District	029L	Mr. Sok Thy	24 hours
	Khum Tumnob Rolok and Khum Kampenh, Stoeung Hav District	030L	Mr. Ly Bunthy	24 hours
	Khum Teuk Thla, Khum Teuk Leak and some areas of Khum Veal Reang, Preynob District	042L	Mr. Kong Sophal	24 hours
	Phsar Smachdeng Town, Khum Ream, Preynob District	098L	Mr. San Ke	24 hours
	Khum Otresh, Steung Hav District	120L	Mr. Chan Keat	24 hours
	Khum Prey Nob, Khum Toul Toetueng, Khum Angdong Thmor and Khum O Oknha Heng, Prey Nob District	184L	Mrs. Chea Kimthat	24 hours
	Khum Ochrov and Khum Taprum, Preynob District	271L	Mr. Hung Huy	24 hours
	Kampong Sela District Area	279L	Mr. Try Chhunheng	**Not Operated in 2010**
22-Steung Treng	Provincial Town of Steung Treng	001L	EDC	24 hours
	Khum Koh sampeay, Seambouk District	218L	Mr. Seang Savot	**Not Operated in 2010**
	Some parts of Khum Sekong and Khum Thmarkeo, Siem Pang District	296L	Mrs. Kong Lymey	6 hours: From 11:00 to 13:00 and 18:00 to 22:00
23- Svay Rieng	Svay Rieng Area including Bavit Area	001L	EDC	24 hours
	Khum Krolko, Svaychrum District	247L	Mr. Sean Narith	24 hours
	Khum Kseatr, Kampong Ror District	268L	Mr. Tak Bora	24 hours
24-Takeo	Takeo provincial town and Ang Tasom District town	001L	EDC	24 hours
	Areas along the National Road No. 2 from Vietnam border to the border of Preak Bat Cheun Chum, Kirivong District	013L	Mr. Mak Thorn	24 hours
	Phsar Samrongyorng town, Some areas of Khum Trapaingsab, Khum Chompey, Khum Kandeung and Khum Peaream, Baty District	015L	Electricity Samrong Yorng Enterprise	24 hours

Province/city	Area of supply	License Number	Name of Licensee	Hours of Supply per Day
	Phsar Kampong Chrey Town, Districts of Trang and Koh Andet	016L	Mr. Ke Kuyhuoy	24 hours
	Some parts of Khum Snor, Khum Char, Khum Preylvea, Khum Bankam and Khum Porromchak, Preykabas District and Khum Thnot, Baty District	020L	Mr. Chhou Lay	24 hours
	Some areas of Khum Korkpor, Khum Dongkpos, Khum Angkagh and Khum Borey Cholsar, Boreycholsar District	022L	Mr. Kong Phat	24 hours
	Phsar Sayva Town, Some areas of Khum Tang Yap, Khum Champa and Khum Prey Phdao, Prey Kabas District	054L	Mrs. Ouch Por	24 hours
	Along NR 2 fr EDC Takeo border of Sangkat Rokarkrav, Krong Daun Keo to the border of LD 13 in Khum Preah Bat Cheun Chum, Kirivong District	055L	Mr. Mak Khom	24 hours
	Khum Tangdong, Khum Lompong, Khum Sophy, Khum Komarachea and Khum Krangleuv, Baty District and Khum Khvav, Samrong district	064L	Electricity Tramkhnar	24 hours
	Khum Kampeng, Khum Kauk Prech, Khum Ream Andeuk, Kirivong District	093L	Banteay Meas Electricity	24 hours
	Khum Beungtranh Northern and Khum Beungtranh Southern, Samrong District	101L	Mr. Chhin Song	24 hours.
	Khum Prek Phtol, Khum Angkorborey and District Town of Angkorborey	113L	Mr. Nou Kruy	24 hours
	Khum Chambork, some areas of Khum Trapaingkrasang, Khum Trapaing Sab and some areas of Khum Tnot, Baty District	118L	Mrs. Sok Kheng	24 hours
	Khum Nheng Nhoung and Khum Tramkork, Tramkork District	121L	Mrs. Kaing Gech Seam	24 hours
	Some areas of Khum Prey Romdeng and Khum Prey Ampork, Kirivong District	133L	Mr Hak Ly Seng	24 hours
	Khum Thleaprachom, Khum Prey Khla and Khum Romenh, Koh Andet District, and Khum Smaong, Trang District	134L	Mr Try Khlauk	24 hours
	Khum Roveang, Khum Chomrapeng and Khum Sla, Samrong District, and Khum Trapaing Krasaing, Baty District	141L	Mr Khim Sokhom	24 hours
	Some areas of Khum Poutsor and Khum Kraingthong, Baty Distric	174L	Mr. Moeun Sokhan	24 hours
	Some areas of Khum Samrong, Khum Sla, Khum Cheungkoun, Samrong District	178L	Mr. Pech Sopheap	24 hours

Province/city	Area of supply	License Number	Name of Licensee	Hours of Supply per Day
	Khum Otdam Soriya, Tram Kork District and Khum Boeng Tranh Khang Thoung, Khum Boeng Tranh Khang Cheung, Khum Samruang, Khum Chomraspen, Khum Seung and Khum Lomchong, Samraung District	188L	Mr. Lim Sisophorn	24 hours
	Khum Kompongkrosaing, Boreycholsar District	194L	Mr. Rov Trorhuot	24 hours
	Khum Angkanh, Preykabas District	195L	Mr. Ouch Kea	24 hours
	Khum Kondeung, Khum Kraing Thnong and Khum Chompey, Baty District	196L	Mr. Chaing Kim	24 hours
	Some parts of Khum Trapaing Thom Khangtbong, Khum Trapaing Thom Khangcheung, Khum Cheangtong, Khum Osaray, Khum Taphem, Khum Somroung and Khum Kous, Tramkork District	197L	Mr. Chith Ponnara	24 hours
	Khum Srange and Khum Sambour, Traing District	205L	Mr. Mao Phai	24 hours
	some areas of Khum Taing Yap, Khum Kdanh and Khum Champa, Prey Kabas District	212L	Mr. Ngeth Meng	24 hours
	Khum Daung, Baty District	231L	Mr. Mey Sina	15 hours: From 04:00 to 07:00 and from 11:00 to 23:00
	Khum Ponley, Angkorborey District	238L	Mr. Hou Veasna	24 hours
	Special Economic Zone of Duong Chhiv Phnom Den, located in Khum Phnom Den, Kirivong District	253L	Chhivtimex Group (Duong Chhiv Import Export) Co., Ltd	**Not Operated in 2010**
	Khum Som, Kirivong District	258L	Mr. Snguon Saran	24 hours
	Khum Basre and Khum Prey Pkhom , Angkorborey District	265L	Mr. Prak Sokha	13 hours: From 04:00 to 07:00, from 11:00 to 14:00 and from 16:00 to 23:00
	Khum Preyphkoam, Angkor Borey District	273L	Mr. Chea Sovannara	6 hours: From 17:00 to 23:00

Source: EAC Annual Report 2011

The Retail License has been issued to only 1 company since it became available in July 2006. The Special Purpose Transmission License has been issued to 3 companies - a private transmission company responsible for 115kV transmission lines from Thailand (Cambodia Power Transmission Line [CPTL]) and 2 companies responsible for 22kV transmission lines. The Special Purpose Transmission Licensees as of the end of year 2010 is shown in Table 2-11.

Table 2-11 Summery Information on Special Purpose Transmission Licensees in 2010

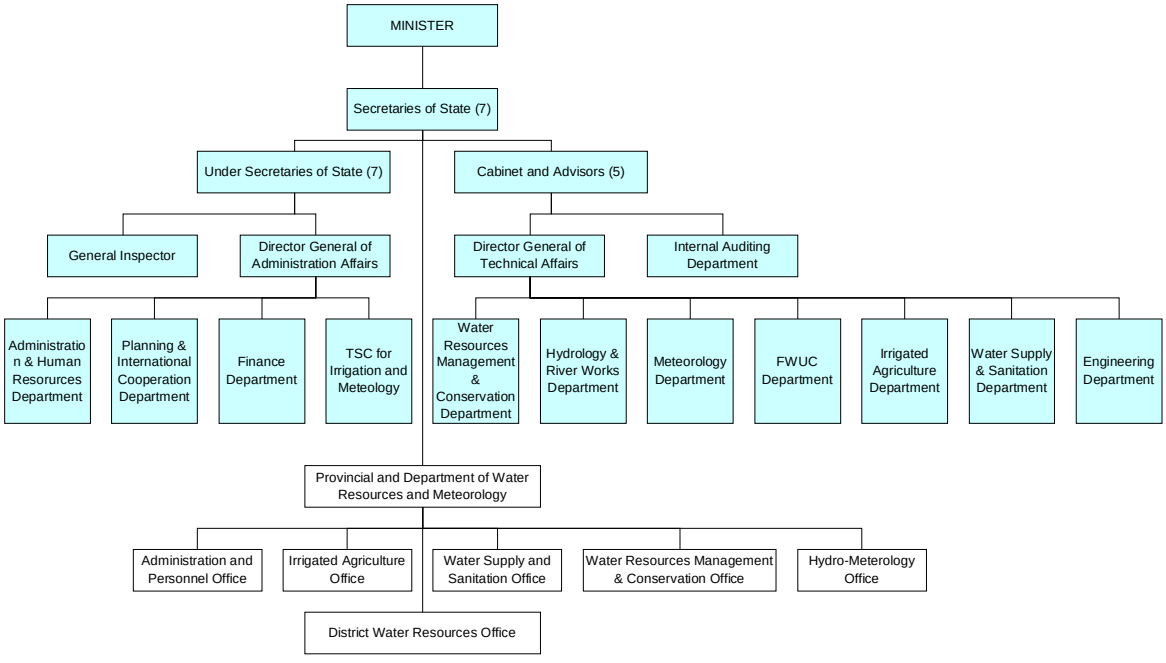
License No.	Name of Licensee	Licensed Transmission Facilities	Length of Line in kM	Energy input kWh	Energy Sent Out kWh	Loss in %
152L	(Cambodia) Power Transmission Lines Co., Ltd	115 kV line from Thai border to Banteay Meanchey, Siem Reap and Battambang	185	272,123,600	266,956,230	1.90
252L	TPLC Holdings Ltd	22 kV linealong National Road No. 6A in Batheay District, Kampong Cham Province, and along Road No. 61 in Pohnea Leu, Khsach Kandal and Lavea Em District, Kandal Province	31	1,071,408	862,992	19.45
260L	Transco Energy (Cambodia) Co., Ltd	22 kV line from GS4 to PPSEZ located along National Road No.4 in Sangkat Phleung Chhes Rotes, Khan Dang Kor, Phnom Penh City	8	7,150,800	7,150,800	0.00

Source: EAC Annual Report 2011

2.1.8 Other related organizations

(1) The Ministry of Water Resources and Meteorology: MOWRAM

The Ministry of Water Resources and Meteorology (MOWRAM) has jurisdiction over the irrigation systems in Cambodia. MOWRAM was established in 1999. MOWRAM develops and manages water resources in Cambodia. Figure 2-12 is the organization chart of MOWRAM.



Source: Ministry of Water Resources and Meteorology, Irrigation Development in Cambodia, Status as of March 2011, Supported by JICA

Figure 2-12 Organization Chart of MOWRAM

The Water Resources Management & Conservation Department that has jurisdiction over hydropower generators consists of the following 4 Offices:

- Administration Office
- River Basin Office

- Hydropower and Flood Control Office
- Legal Framework Office

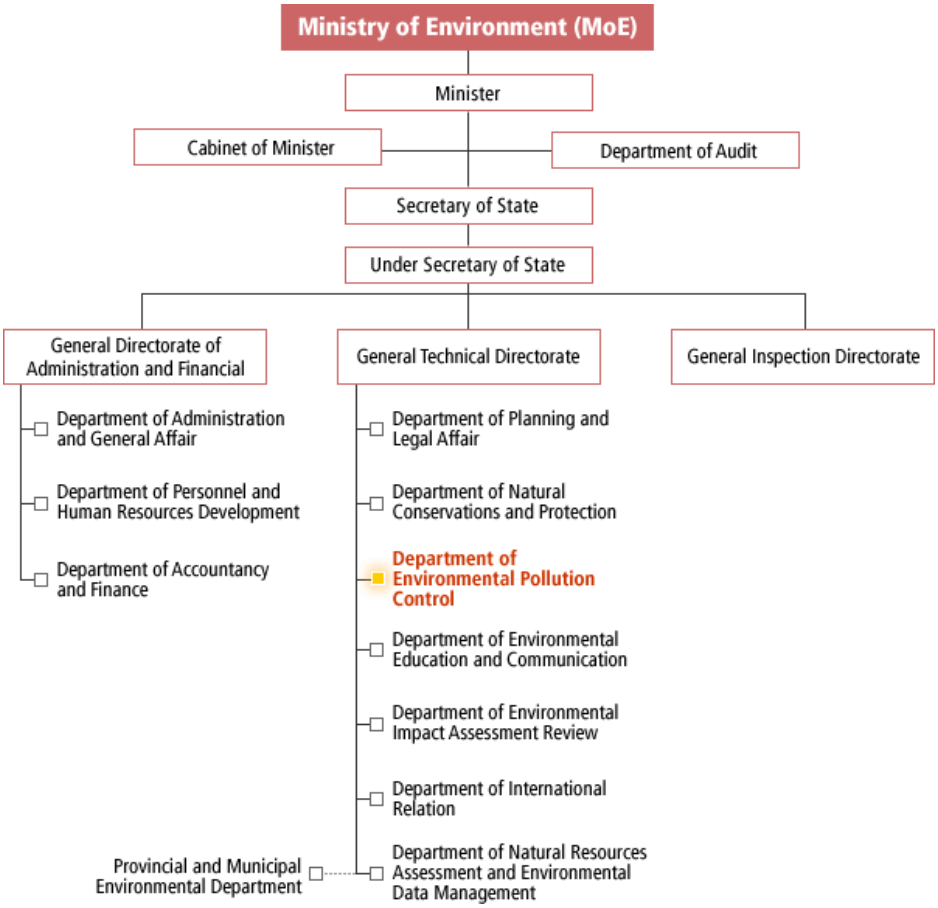
The Hydropower and Flood Control Office is in charge of hydropower development. This Office has 7 engineers and one of them is in charge of hydropower generation. However, since hydropower generation in Cambodia is initiated mainly by MIME, all 7 engineers are involved in water resource control only (i.e., flood adjustments) at the moment.

(2) The Ministry of Environment: MOE

MOE has the authority to audit and manage the environmental sector of Cambodia in accordance with Article 2, No.57 Sub-Decree. Main duties of MOE are as follows:

① Execution of environmental policies to ensure sustainable development of Cambodia
② Establishment and execution of environmental law to promote and ensure sustainable development programs in Cambodia
③ Review and advice for the results of environmental evaluation associated with development plans and activities that originate from public and private enterprises. It also stipulates review and recommendation processes.
④ Provides related Ministries with environment-related policies to ensure preservation of natural resources and reasonable and sustainable development and use.
⑤ Management of protected areas stated in the law "The Creation and Designation of Protected Areas" issued on November 1, 1993.
⑥ Identification of sources, forms, and amount of all solid and liquid wastes, contaminants, pollutants, emission matters, noise, and vibrations. Prevention, reduction and provision of environmental pollution control measures for aforementioned environmental issues in concert with related Ministries.
⑦ Execution of regulations stipulated in Paragraph 9, "Law on Environmental Protection and Natural Resource Management."
⑧ Collection, analysis, and management of environmental data and preparation of the national environmental annual report.
⑨ Creation and execution of environmental training program needed for all sectors of the society.
⑩ Proposal of joining environment-related international treaties to the central government. Provide technical assistance in fulfilling the resulting commitments and responsibilities.
⑪ Promotion of investment for protection of environment and natural resources. Establishment and management of environmental funds.
⑫ Promotion of environmental protection in Cambodia in concert with national and international organizations, NGO, local organizations, and other countries.

The organization chart of MOE is shown in Figure 2-13.



Source: http://www.wepa-db.net/policies/structure/chart/cambodia/moe.htm

Figure 2-13 Organization Chart of MOE

2.2 Legal Systems

2.2.1 The Electricity Law

The Electricity Law and other related laws are shown in Table 2-12. Electricity Law of the Kingdom of Cambodia (The Electricity Law) has been issued on February 2, 2001 and its objectives are as follows:

- Principle for activities of enterprises that operate and provide electricity business and services
- Creation of conditions favorable for power equipment investment and business activities
- Principle of electricity business regulations in Cambodia
- Protection of consumers for receiving sufficient electricity supply at a reasonable price
- Assistance for the private sector to own facilities that provide electricity supply services
- Establishment of competition amongst the power sector
- Regulation of electricity supply services by granting authority and responsibility to EAC for the foundation of such services. Penal regulation for power generation and power supply facility suppliers as well as consumers when necessary.

Table 2-12 Legal Documents for Managing and Regulating Provision of Services and Use of Electricity

No.	Name of Standard Documents	Promulgated by	Date Promulgated
1	Electricity Law of the Kingdom of Cambodia	The King	February 2, 2001
2	Sub-Decree on the Rate of the Maximum License Fees applicable to Electric Power Service Providers in the Kingdom of Cambodia	Royal Government	December 27, 2001
3	Procedures for Issuing, Revising, Suspending, Revoking, or Denying Licenses	Electricity Authority of Cambodia	September 14, 2001
	Revision 1		December 12, 2002
	Revision 2		March 16, 2004
4	Regulations on General Conditions of supply of Electricity in the Kingdom of Cambodia	Electricity Authority of Cambodia	January 17, 2003
	Revision 1		December 17, 2004
5	Regulatory Treatment of Extension of Transmission and Distribution Grid in the Kingdom of Cambodia	Electricity Authority of Cambodia	October 28, 2003
6	Regulations on Overall Performance Standards for Electricity Suppliers in the Kingdom of Cambodia	Electricity Authority of Cambodia	April 2, 2004
7	Procedure for Filing Complaint to EAC and for Resolution of Complaint by EAC	Electricity Authority of Cambodia	April 2, 2004
8	General Requirements of Electric Power Technical Standards of the Kingdom of Cambodia	Ministry of Industry, Mines and Energy	July 16, 2004
	First Amendment		August 9, 2007
9	Sub-Decree on Creation of Rural Electricity Fund of the Kingdom of Cambodia	The King	December 4, 2004
10	Sub-Decree on Principles for Determining the Reasonable Cost in Electricity Business	Royal Government	April 8, 2005
11	Prokas on Principles and Conditions for issuing Special Purpose Transmission License in the Kingdom of Cambodia	Ministry of Industry, Mines and Energy	July 21, 2006

No.	Name of Standard Documents	Promulgated by	Date Promulgated
12	Specific Requirements of Electric Power Technical Standards of the Kingdom of Cambodia	Ministry of Industry, Mines and Energy	July 17, 2007
13	Regulations on General Principles for Regulating Electricity Tariffs in the Kingdom of Cambodia	Electricity Authority of Cambodia	October 26, 2007
14	Procedures for Data Monitoring, Application, Review and Determination of Electricity Tariff	Electricity Authority of Cambodia	October 26, 2007
15	Grid Code	Electricity Authority of Cambodia	May 22, 2009

Source: EAC Annual Report, 2011

2.2.2 Technical standards for electric power

"General Requirements of Electric Power Technical Standards of the Kingdom of Cambodia (GREPTS)" has been the subject to the developmental investigation of JICA with MIME as the counterpart and it became effective as a ministerial ordinance on August 16, 2004. GREPTS consists of a total of 65 Articles, including Title 1 "General Articles" (14 Articles) and Title 2 "Basic Requirements for Power Equipment" (51 Articles). Title 1 includes definitions of terms, objectives and scope of technical standards, classification of voltage and frequencies, prevention of electric shock and fire, prevention of supply failure, and environmental protection. Title 2 has the constitution shown in Table 2-13.

Table 2-13 Constitution of Title 2 of GREPTS

Constitution of Title 2 (Articles 15-65)
Part 1: General common requirements for all power equipment (Articles 15-20)
Part 2: General requirements for thermal power station equipment (Articles 21-25)
Part 3: General requirements for hydropower station equipment (Articles 26-28)
Part 4: General requirements for other power generation equipment (Articles 29-30)
Part 5: General common requirements for transmission and distribution equipment (Articles 31-39)
Part 6: General requirements for high voltage transmission lines (Articles 40-48)
Part 7: General requirements for medium and low voltage transmission lines (Articles 49-56)
Part 8: General requirements for internal wiring (Articles 57-65)

Source: Survey Team

GREPTS are a "performance" type of standards and not a "specification" type, where detailed numerical values are specified. In developed countries such as European countries and the U.S., the foundation of the electricity business system has been well established and the fundamental concept of electricity enterprises is "voluntary security," in which electricity technology standards are shifting towards a "performance" basis. However, since the organizational structure of electricity enterprise itself is weak and not as competitive in Cambodia. Therefore, GREPTS alone have not been sufficient to operate electricity technology standards properly for MIME and EAC. From 2004 to 2007, in addition to enhancement of EAC's technology screening capacity, JICA has assisted in preparation of Specific Requirements of Electric Power Technical Standards of the Kingdom of Cambodia (SREPTS) in relation to thermal power generation, transmission, and distribution, which was enshrined to law on July 17, 2007. Thereafter, from 2008 to 2009, JICA assisted to prepare SREPTS pertaining to hydropower generation, which was enshrined to law in 2010.
EAC has issued a publication that compiled GREPTS and SREPTS and every related Office has a

copy.

2.2.3 Legal systems and processes for the environment

Major laws and regulations related to the environment in Cambodia are shown in Table 2-14.

Table 2-14 Major Environmental Laws and regulations for projects related to electricity sector

Year	Title
1993	THE CONSTITUTION OF THE KINGDOM OF CAMBODIA (Article 59)
1993	Royal Decree on the Protection of Protected Areas
1994	Royal Decree on the Establishment and Management of Tonle Sap Biosphere Reserve
1994	Declaration No. 1033 on Protected Area
1996	Law on Environmental Protection and Natural Resource Management (LEPNRM)
1997	Sub-Decree on the Organization and Functions of the Ministry of Environment
1999	Sub-Decree on Water Pollution Control
1999	Sub-Decree on Solid Waste Management
1999	Sub-Decree on Environmental Impact Assessment Process
2000	Declaration on Guidelines for Conducting Environmental Impact Assessment Report
2000	Sub-Decree on Air Pollution and Noise Disturbance
2001	Land Law
2005	Anukret on the Establishment of the Sub-Committee on Investment of the Provinces-Municipalities of the Kingdom of Cambodia
2008	Protected Area Law
2008	Law on Biosafety
2010	Law on Expropriation

Source: Survey team

When performing development activities in Cambodia, the environmental impact must be evaluated in accordance with "Sub-Decree on Environmental Impact Assessment Process" (No.72 ANRK.BK, 1999). The sub-decree describes performance of Initial Environmental Impact Assessment (IEIA) or Environmental Impact Assessment (EIA) when the development is of those specified in the Annex (Annex of ANRK.BK, 1999); review and approval of IEIA and EIA by MOE; and participation of residents during the EIA process.

When developing a power station that of the maximum output exceeds the capacity listed in Table 2-15, IEIA or EIA will be required. Since Annex has no descriptions for substations or transmission and distribution lines, we interviewed MOE about the virtual processes (Table 2-16)

Table 2-15 of the Projects Required an IEIA or EIA

Type and activities of the projects	Size / Capacity
Power plants	≥ 5 MW
Hydropower	≥ 1 MW

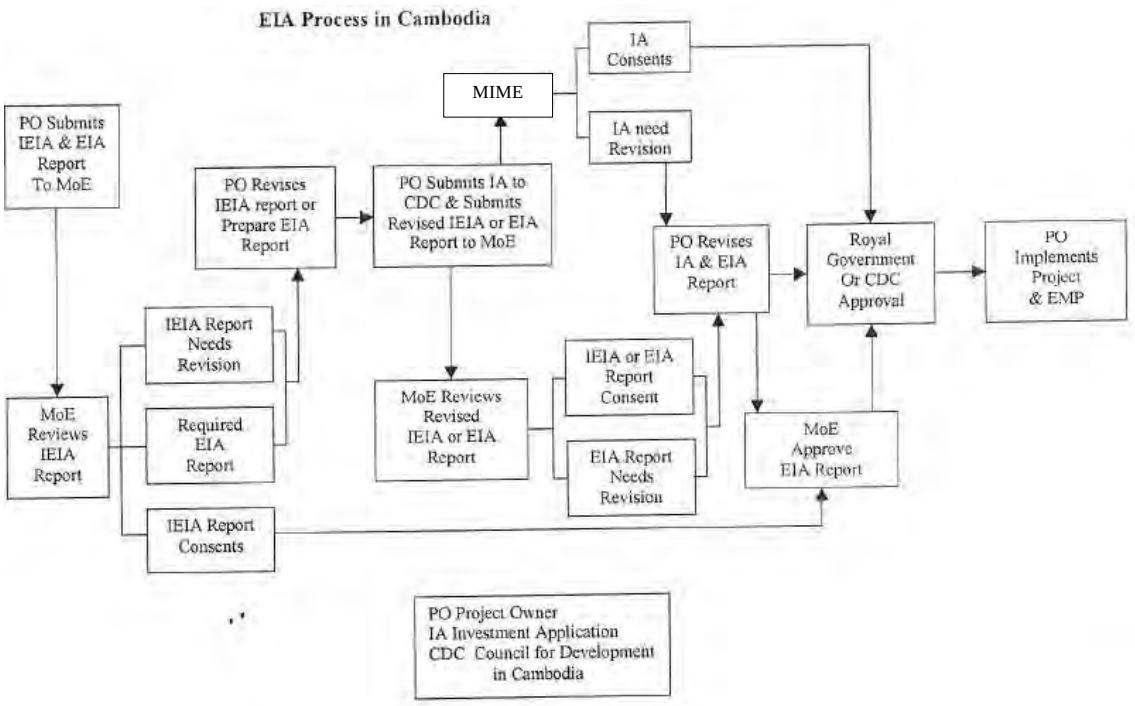
Source: SUB-DECREE on ENVIRONMENTAL IMPACT ASSESSMENT PROCESS, 1999

Table 2-16 List of the Projects Required an IEIA

Type and activities of the projects	Size / Capacity
Transmission Line / Distribution Line	≥ 115 kV
Sub Stations	---

Source: Interview with MOE

Figure 2-14 is a flow chart showing environmental impact evaluation processes in Cambodia. First, an entrepreneur performs IEIA and submits the IEIA report to MOE to receive review for the result. If MOE determined that a full-scope EIA is needed, the entrepreneur subsequently performs EIA and submits the results to MOE in order to be reviewed and approved.



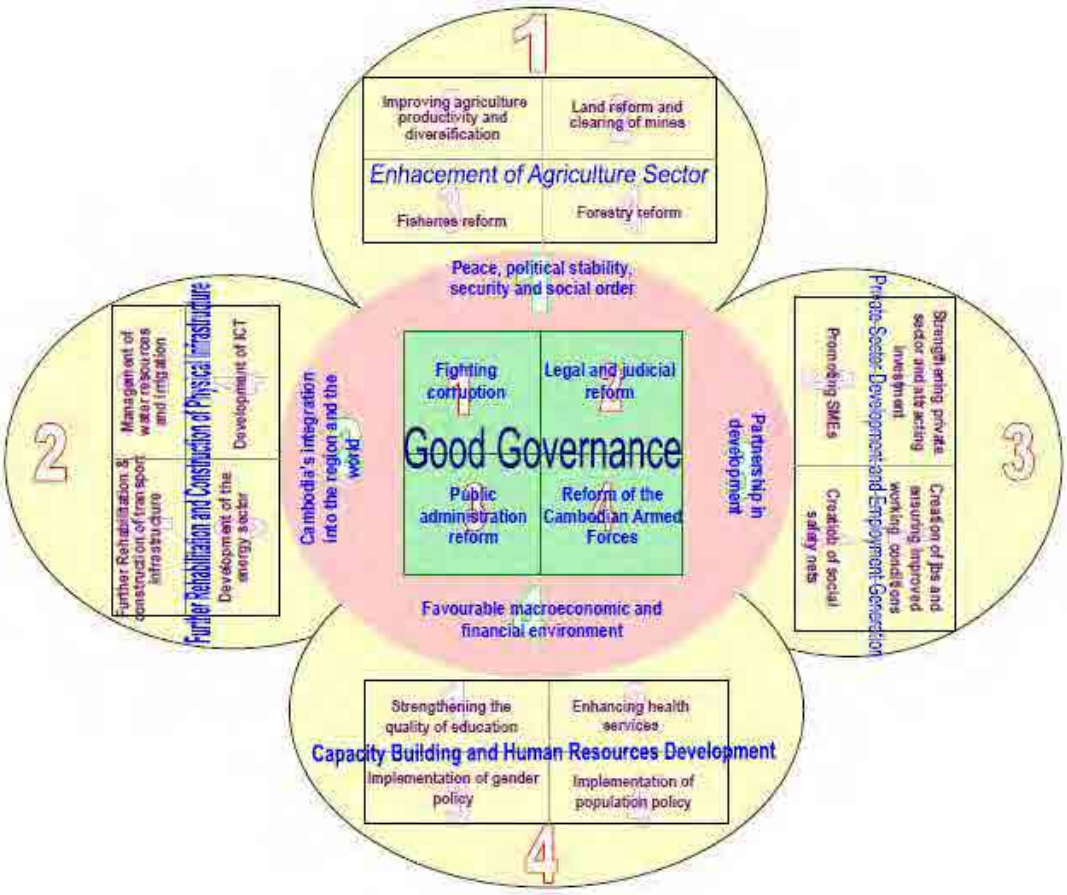
Source: DUONG SAMKEAT, Environmental Impact Assessment Process in CAMBODIA, p12

Figure 2-14 Flow Chart of Environmental Procedure for Development Activities

If the project is funded by foreigners, resident relocation resulting from the project needs to be processed in accordance with the policy practiced by the foreign organization.
For internal development, "the expropriate law" has been approved at the constituent assembly in December 2009 and went into effect in February 2010. The resident relocation associated with public works performed by Cambodia's Central Government Ministries and Agencies is centrally managed by the Resettlement Department (RD) of the Ministry of Economy and Finance (MEF). RD is in charge of the secretariat of the Inter-ministerial Resettlement Committee (IRC), which is established to discuss policies for the resident relocation associated with individual development business. However, according to the government document dated on December 28, 2010, EDC is in charge of resettlement and land expropriate about all projects related to EDC. Therefore, EDC has responsibility to play IRC role in the projects including private IPP projects.
According to MOE, approaches and processes involving the environment are under review at present in preparation of publication in 2012. This may lead to reassessment of environmental impact evaluation processes and resident relocation policies.

2.3 Electricity policies

The RGC announced the second version of the rectangular strategy at the 4th cabinet council in 2008 (Figure 2-15). The rectangular strategy is a framework plan of comprehensive national development, which emphasizes on enhancement of the agriculture sector, further rehabilitation and construction of physical infrastructure, private sector development and employment generation, and capacity building and human resources development. The NATIONAL STRATEGIC DEVELOPMENT PLAN UPDATE 2009-2013 that has been established in 2010 based on the rectangular strategy includes the national strategy related to electricity.



Source: National Strategic Development Plan Update 2009-2013

Figure 2-15 Second version of the Rectangular Strategy

The RGC focuses on ① ensuring supply capacity, ② inexpensive electricity tariff, and ③ reinforcement and capacity development of electricity-related organizations. Government policies are as follows:

① Ensuring supply capacity
- Promotion of hydropower, natural gas, and coal fire utilizing homeland resources
- Development research on nuclear power and energy with new technology
- Improvement of energy security through fuel diversification and securement of reserve margin
- Promotion of energy conservation

② Inexpensive electricity tariff
- Consolidation of national transmission network
- Amalgamation with ASEAN and Greater Mekong Subregion (GMS) network between 2 or multiple countries
- Promotion of rural electrification (including renewable energy sources)

- Promotion of investment from private enterprises
- Achieve a good balance between environmental friendliness and economic effectiveness in a project

③ Reinforcement and capacity development of electricity-related organizations

- Improvement of operational management capacity and electricity quality through human resource development in electricity-related organizations and reorganization

Further, the power sector aims to achieve the following electrification rate:

- All Villages of Cambodia shall be electrified by the year 2020
- At least 70% of households shall have grid quality electricity by the year 2030

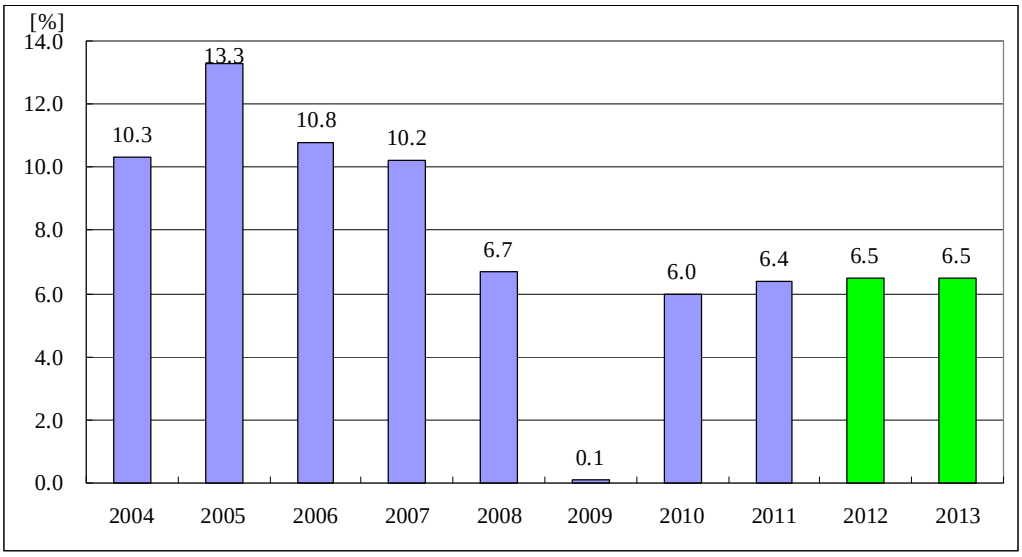
In November 2011, "Strategy and Plan for Development of Rural Electrification in the Kingdom of Cambodia" (SPDRE) has been enacted and MIME, EAC, EDC, REF, and all electricity enterprises are encouraged to achieve the above goals. (See 2.11 Rural Electrification for details.)

Regarding development research on nuclear power, Cambodia has been a member of International Atomic Energy Agency (IAEA) since 2009, which is an international organization that seeks to promote the peaceful use of nuclear energy, and to inhibit its use for any military purpose, including nuclear weapons.

2.4 Economic circumstances

2.4.1 Gross domestic product

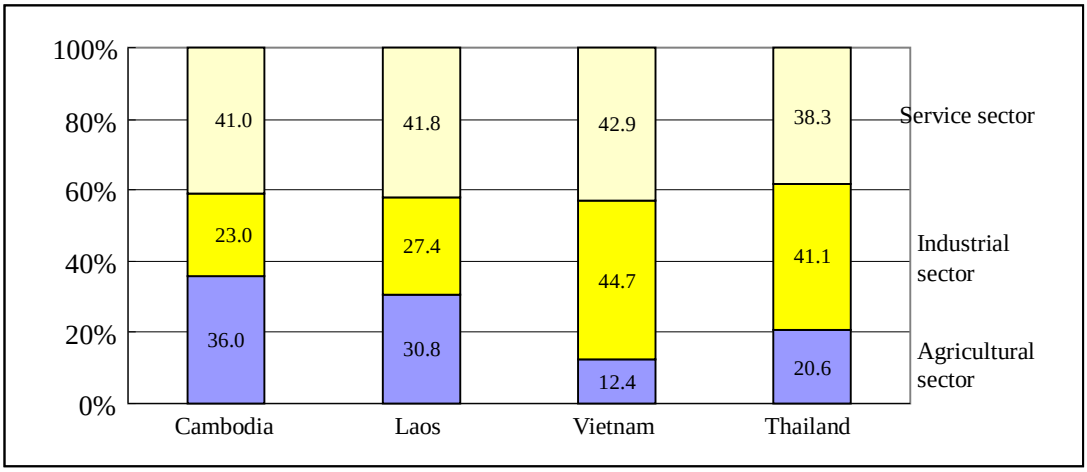
Cambodian economy maintained high economic growth of over 10% for 4 years from 2004 to 2007. Main factors were ① increase in the embroidery product export, ② steady tourist industry, ③ excellent agricultural production, ④ briskness in the construction industry (especially residences, hotels, and factories), ⑤ foreign investment, and ⑥ rapid progress in loans from commercial banks. Subsequently, the worldwide economic crisis impacted and the economic growth dropped down to 0.1%. However, the economy recovered in 2010 and MEF projects similar growth rate in 2011 and thereafter.



Source: MEF, January 2012

Figure 2-16 Changes in real GDP growth rat

2010 GDP component ratio of Cambodia and neighboring countries by industries are shown in Figure 2-17. Compared to neighboring countries, the industrial structure of Cambodia indicates that it is at the initial stage of industrialization as with Laos.

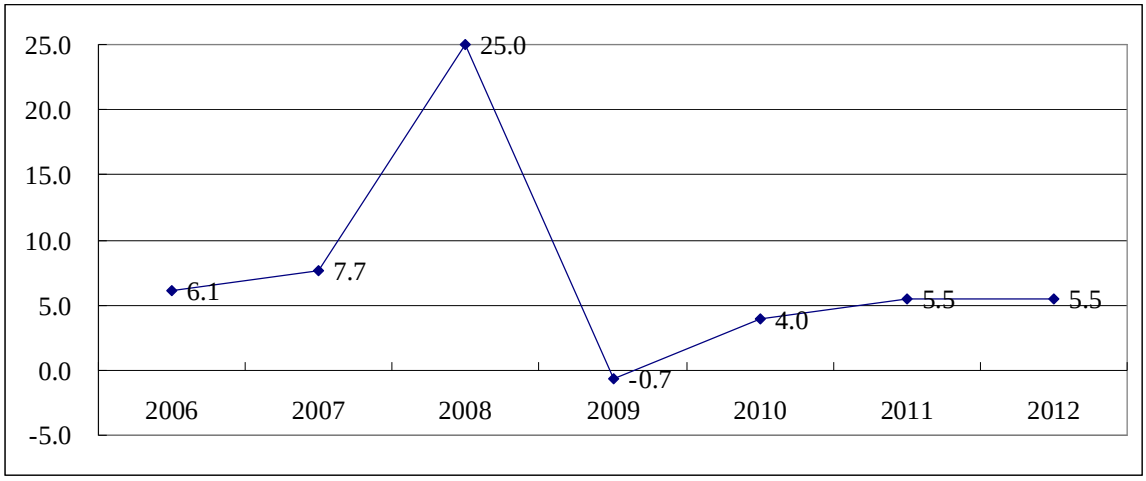


Source: ADB, Key Indicators for Asia and the Pacific 2011, August 2011

Figure 2-17 GDP component ratios of Southeast Asian countries by industries

2.4.2 Price of commodities

In the first half of the year 2008, expansion of the domestic demand caused a rapid increase in the price of consumer commodities. Furthermore, prices of imported goods rose suddenly due to rapid increases in prices of crude oil and food worldwide and effect of weak Riel and Dollar on currencies of countries Cambodia mainly trades with. As a result, the inflation rate reached 25% in 2008 as shown in Figure 2-18. Subsequently, the price of consumer commodities tranquilized and following 2011, changes have been around 5-6%. In terms of price increase, prices of food and drinks that account for a large portion of the consumer price index have increased and thus the data were impacted



Source: ADB, Asian Development Outlook 2011, 2011

Figure 2-18 Increase in price of commodities

2.4.3 Investment trend

Investment projects that are prioritized through Council for the Development of Cambodia (CDC) include Cambodian and foreign investments. This type of investments was used to be called a "investment project" by the 1994 Law on Investment, but 2003 and thereafter following amendment of the said Law, it has been changed to a "Qualified Investment Project (QIP)."

In 1995, the year after the establishment of the Law on Investment, the allowable investment on fixed assets was $2.3 billion. As opposed to the annual average of 12 years from 1994 to 2005 (approximately $0.71 billion), that of 5 years from 2006 to 2010 was $5.3 billion, approximately a 7.5-fold increase. The cumulative allowable investment from 1994 to the end of 2010 was $35,060,000,000. Table 2-17 shows trends in investment approval by countries from 1994 to 2010.

Table 2-17 Investment trends by countries

[MUS$] Country	1994-2005 Total		2006	2007	2008	2009	2010	1994-2010 Total	
	Amount	Order	Amount	Order	Amount	Order	Amount	Order	
Cambodia	2,367		1,646	1,326	4,193	3,810	447	13,789	
Cambodia	1,267	2	274	462	4,484	930	829	8,246	1
Korea	832	3	1,010	153	1,238	120	1,063	4,416	2
Malaysia	1,929	1	26	56	6	27	256	2,300	3
USA	460	5	44	3	681	1	7	1,196	4
Thailand	299	6	89	174	52	182	2	798	5
Vietnam	38	11	2	142	59	352	153	746	6
Russia	2	13	278	-	100	242	-	622	7
Singapore	260	7	12	11	30	277	31	621	8
Taiwan	539	4	41	-	-	-	-	580	9
Israel	-	14	-	2	300	-	-	302	10
France	209	9	-	-	57	2	4	272	11
Hong Kong	244	8	4	-	-	-	-	248	12
UK	104	10	4	26	67	2	11	214	13
Japan	22	12	-	82	8	5	-	117	14
Other	-	-	-	271	88	89	141	589	-
Total amount allowed	8,572	-	3,430	2,708	11,363	6,039	2,944	35,056	-

Source: CDC

The number of enterprises from Japan considerably increased since 2011. Following Minebea in 2010, automobile parts industry, such as Sumitomo Wiring Systems and Yazaki Corporation, local offices of banks, such as Mitsui Sumitomo and Mitsubishi Tokyo UFJ, transportation industry, such as Nippon Express and Yusen Logistics have launched. Japanese Business Association of Cambodia has been increased in an annual basis, as 34 members in 2007, 35 members in 2008, 45 members in 2009, 50 members in 2010, and 83 members in 2011. Now, as of November 2011, it has totally 104 members as of January, 2012: 83 regular members, including trading companies, construction companies, manufacturers, financial/servicing companies; and 21 associate and special members, including enterprises and groups.

2.4.4 Miscellaneous

Miscellaneous economic index are shown in Table 2-18. ADB's projection is shown following the year 2011.

Table 2-18 Economic index

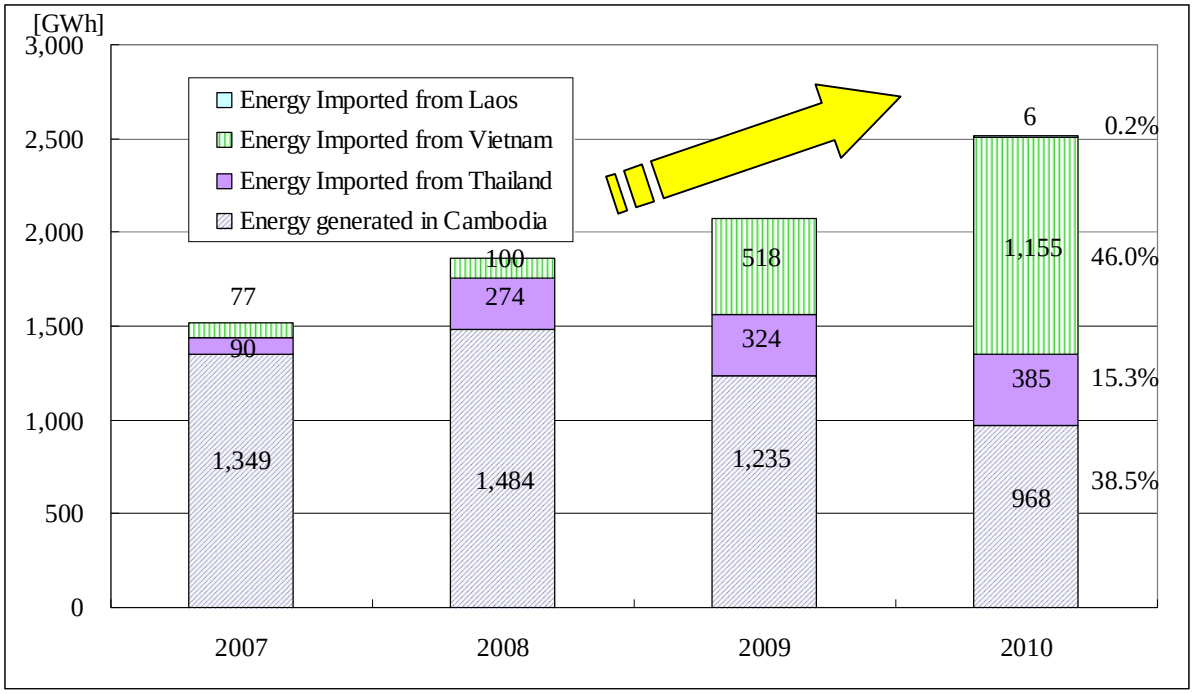
Index	2006	2007	2008	2009	2010	2011	2012
Population (million)	13.5	13.7	13.9	14.1	14.3	14.4	14.6
GDP (US$ billion, Item)	7.3	8.6	10.3	10.3	11.2	11.9	12.8
Agriculture (%)	31.7	31.9	34.9	35.7	36.0	-	-
Industry (%)	27.6	26.8	23.8	23.1	23.0	-	-
Services (%)	40.8	41.3	41.3	41.3	41.0	-	-
GDP per person ($,Item)	539	630	744	733	784	827	875
Export growth rate (%/yr)	26.9	10.7	15.1	-10.9	20.8	15.0	16.0
Import growth rate (%/yr)	21.8	13.8	19.8	-10.4	15.9	14.0	14.0
Inflation (%)	6.1	7.7	25.0	-0.7	4.0	5.5	5.5
Foreign direct investment (US$ milliion)	483	867	815	539	801	-	-
Foreign debt balance (US$ million)	2245	2555	2808	3054	3514	-	-

Source: ADB, Asian Development Outlook 2011, 2011

2.5 Current status of electricity supply

2.5.1 Generated electric power

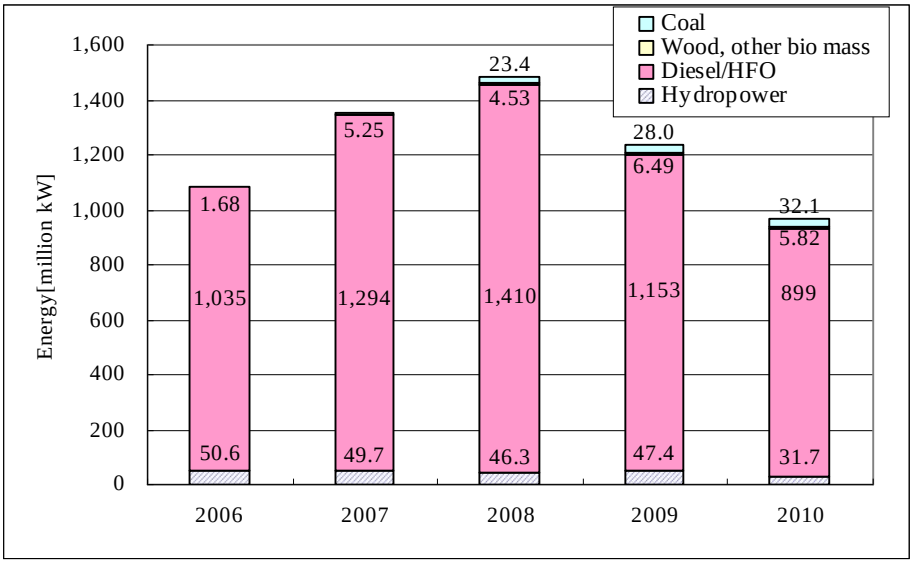
Figure 2-19 shows changes in generated and imported electric power in Cambodia. Importation of electricity from Thailand (115kV transmission lines), Vietnam (230kV transmission lines), and Laos (22kV distribution lines) started at the end of 2007, in 2009, and 2010, respectively. In 2010, imported electricity was 61.5% of all generated electric power.



Source: EAC Annual Report, 2011

Figure 2-19 Changes in generated and imported electric power

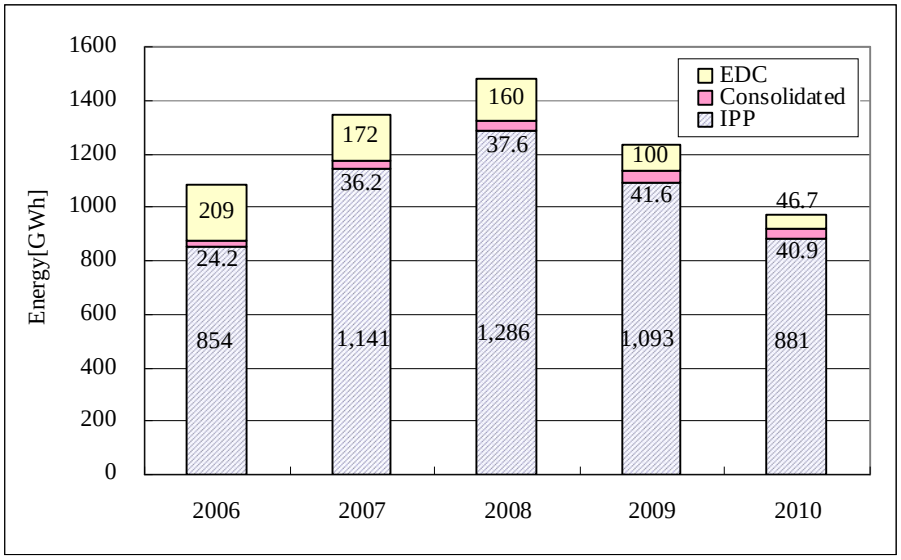
Figure 2-20 shows details of generated electric power by types of fuel in Cambodia.



Source: EAC Annual Report, 2011

Figure 2-20 Generated electric power by types of fuel

Details of Cambodia's generated electric power by power generation enterprises are shown in Figure 2-21. In 2010, IPP generated 91% of the total electric power.



Source: EAC Annual Report, 2011

Figure 2-21 Generated electric power by power generation enterprises

Details of generated electric power in EDC supply area including IPP and import are shown in Table 2-19.

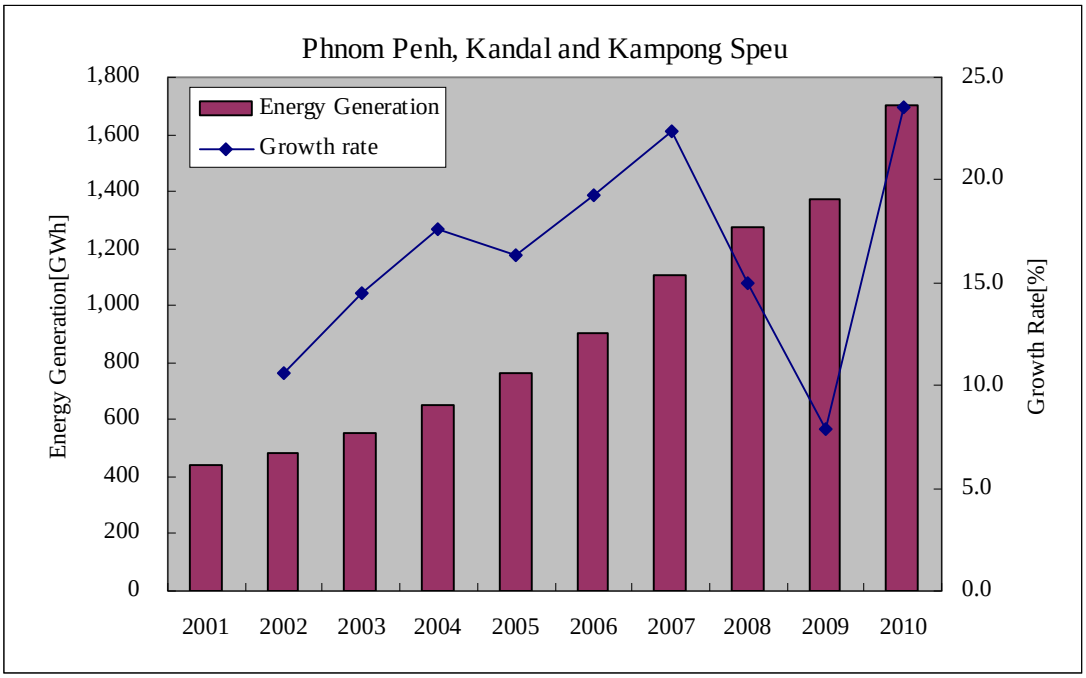
Table 2-19 Generated electric power by EDC

[GWh]

Location	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Phnom Penh, Kandal and Kampong Speu	439.0	485.6	555.7	653.4	760.4	906.7	1109.6	1275.8	1375.9	1699.9
Siem Reap	16.2	19.4	23.5	36.4	54.0	75.3	100.6	136.9	165.2	194.0
Sihanouk Ville	18.4	20.5	22.3	24.6	27.0	30.4	37.6	46.7	51.2	65.0
Kampong Cham	6.1	6.3	6.9	7.9	9.0	10.2	11.7	15.5	25.3	35.0
Ponhea Krek	0.4	0.4	1.9	4.0	7.7	11.9	16.6	18.4	26.9	26.0
Memot	1.1	1.1	2.5	3.9	6.5	11.9	12.6	9.2	10.6	10.4
Takeo	1.9	2.0	2.1	2.3	2.7	3.6	4.4	5.8	7.4	9.3
Battambang	10.3	11.4	13.6	16.6	19.0	21.5	24.7	32.3	38.3	49.7
Kampot	-	-	-	2.3	4.5	4.9	5.6	7.8	10.2	20.8
Kamponng Trach	-	-	0.2	0.7	1.0	1.4	2.1	3.9	5.4	8.7
Prey Veng	-	-	-	1.1	2.0	2.1	2.4	2.8	3.4	4.7
Banteay Meanchey	-	-	-	-	-	3.5	10.3	14.2	19.2	24.6
Steung Treng	-	-	-	-	-	1.6	2.6	3.5	4.4	5.8
Rattanakiri	-	-	-	3.0	3.6	4.8	5.0	5.8	6.4	8.2
Svay Rieng	-	-	-	-	-	2.1	5.4	9.5	12.9	18.2
Bavet	-	1.3	3.6	4.9	8.6	14.7	27.1	37.4	55.4	60.9
Mondulkiri	-				-	-	-	-	-	1.6
TOTAL	**493.4**	**547.9**	**632.1**	**761.1**	**905.9**	**1106.5**	**1378.1**	**1625.4**	**1817.9**	**2242.5**

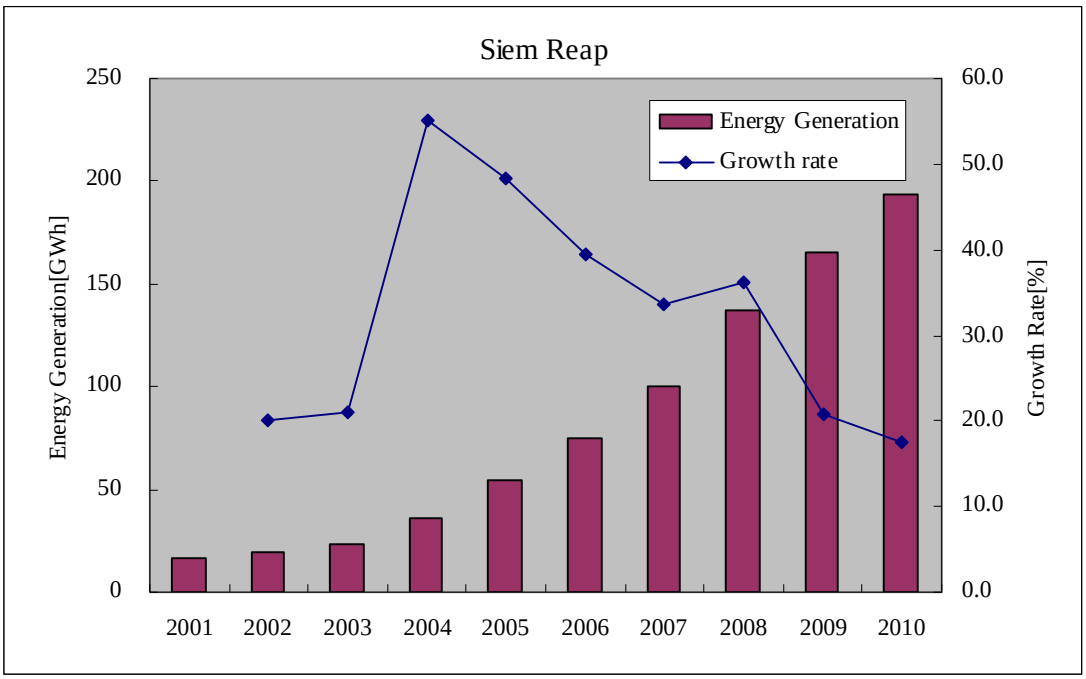
Source: EDC

Of Table 2-19 above, the 3 locations with the highest maximum electric power can be schematized as Figure 2-22, Figure 2-23, and Figure 2-24.



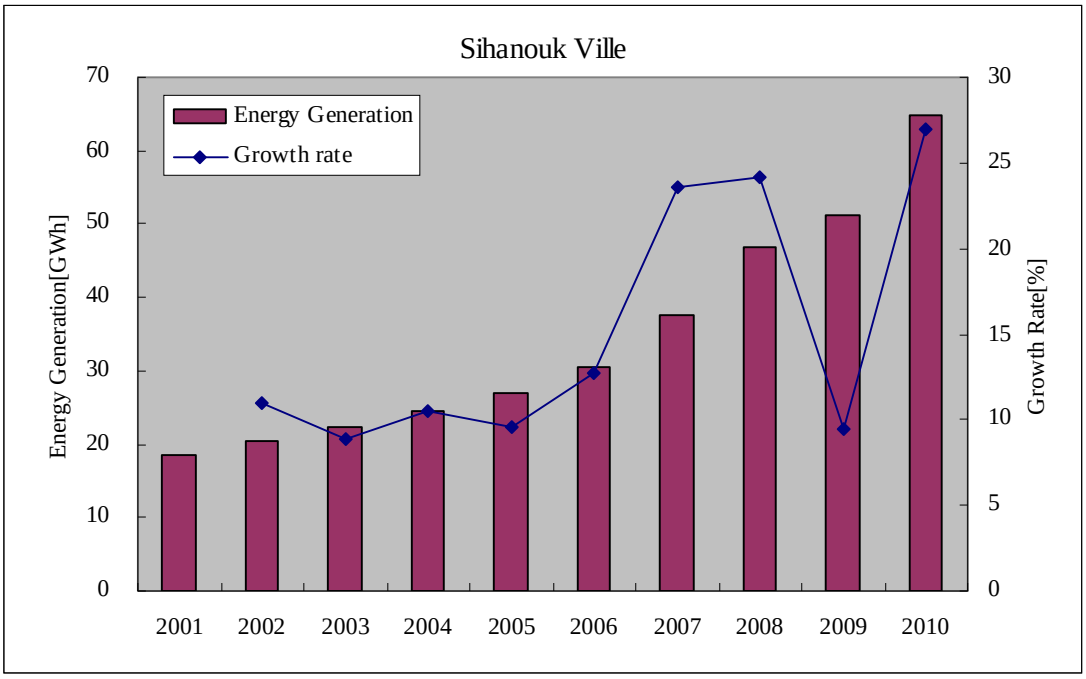
Source: EDC

Figure 2-22 Generated electric power and its growth rate in Phnom Penh, Kandal, and Kampong Speu



Source: EDC

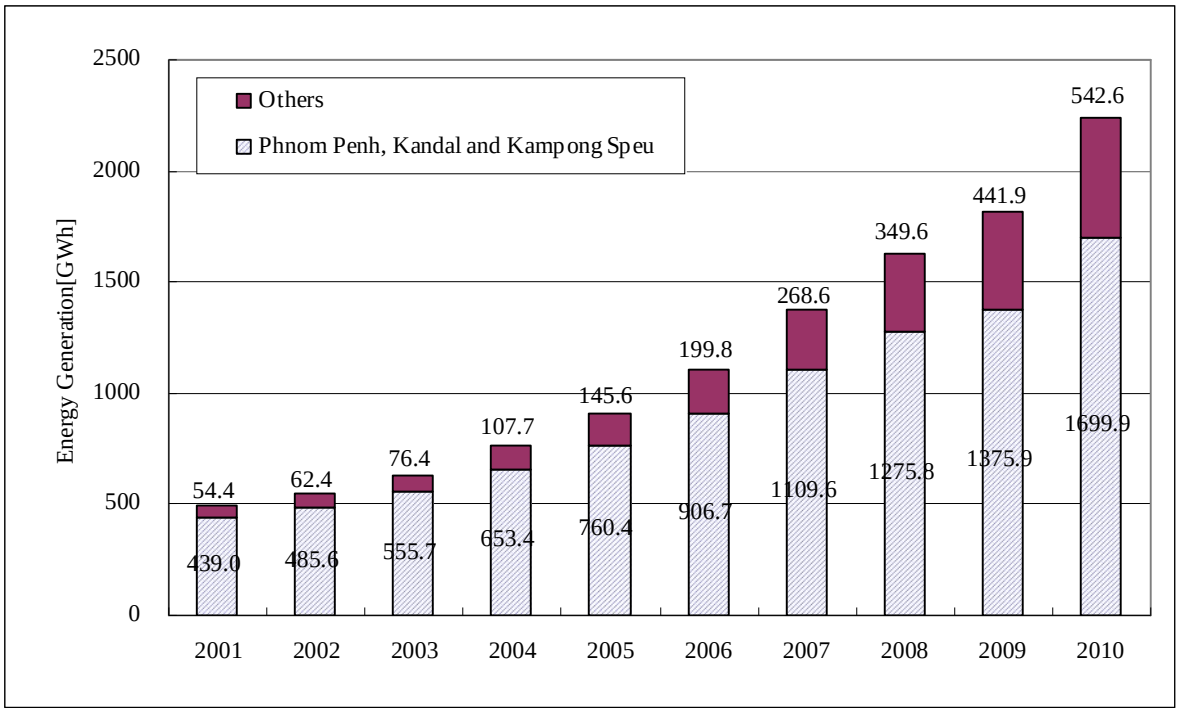
Figure 2-23 Generated electric power and its growth rate in Siem Reap



Source: EDC

Figure 2-24 Generated electric power and its growth rate in Sihanouk Ville

Of Table 2-19, general electric power of the metropolitan area (Phnom Penh, Kandal, and Kampong Speu) and the rest of the area (Others) can be schematized as Figure 2-25.



Source: EDC

Figure 2-25 Generated electric power in metropolitan and other areas

2.5.2 Electricity sales

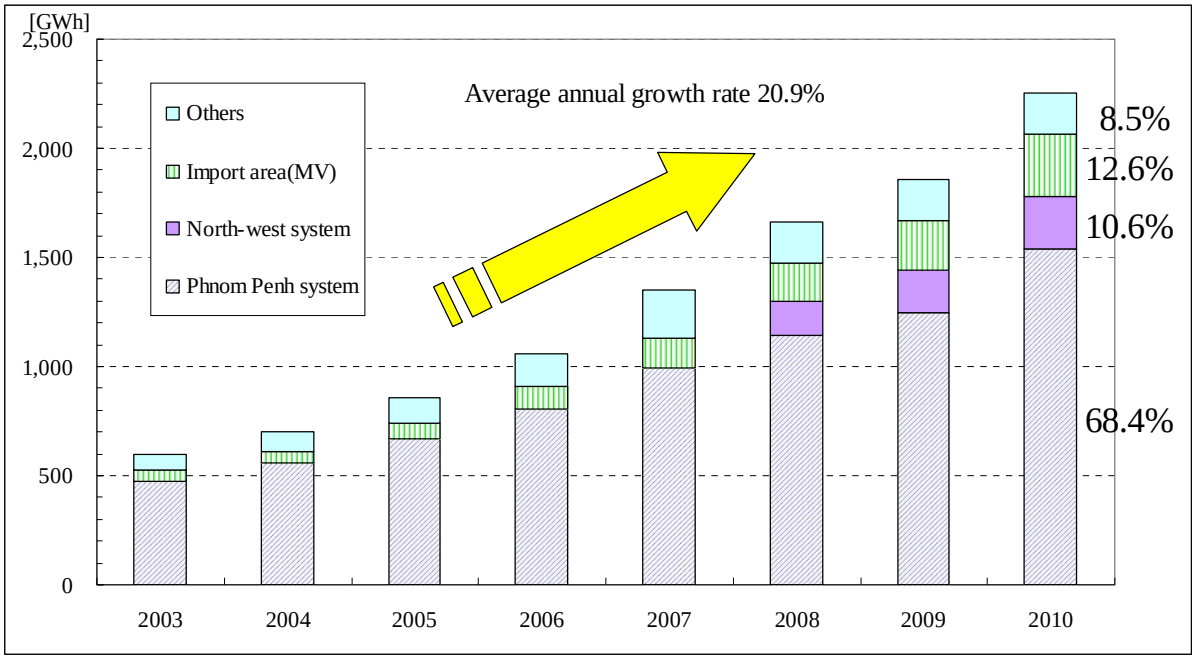
Changes in nationwide electricity sales from 2003 to 2010 are shown in Table 2-20 and Figure 2-26. The average annual increase from during this time was 20.9%, indicating the steady increase with the economic growth.

Table 2-20 Electricity sales

[GWh]

	Phnom Penh system	North-west system	Import area(MV)	Others	Total
2003	475.2	-	53.8	70.1	**599.1**
2004	557.7	-	54.2	90.4	**702.3**
2005	667.1	-	75.4	115.8	**858.3**
2006	805.7	-	100.2	151.3	**1057.2**
2007	990.5	-	141.3	217.3	**1349.1**
2008	1140.5	158.2	172.8	192.9	**1664.4**
2009	1245.8	196.0	225.7	190.7	**1858.2**
2010	1542.0	238.0	283.3	190.7	**2254.0**

Source: Survey Team



Source: Survey Team

Figure 2-26 Changes in electricity sales

The EDC electricity sales in 2010 and changes in electricity sales by types of Contracts are shown in Table 2-21andTable 2-22, respectively.

Table 2-21 EDC electricity sales

Area of Supply	Installed Capacity [kW]	Energy purchased [kWh]	Energy Sent Out by Generation [kWh]	Energy Transferred from/to other branches [kWh]	Energy Sold to other licensees [kWh]	Number of consumers	Energy Sold to consumers kWh]	Loss [%]
Phnom Penh Grid System	45,560	1,676,055,488	31,702,495		60,412,598	246,973	1,488,183,010	9.32
Banteay Meanchey Grid System	15,580	272,123,600	1,287,558		6,899,043	66,300	231,476,332	12.81
Kampot	3,080	3,951,740	665,179	15,841,180	546,046	7,168	14,559,593	26.16
Sihanoukville	5,600	51,522,280	8,655,407		721,770	10,632	57,086,359	3.94
Kampong Cham		34,951,440			12,499,998	10,474	18,683,236	10.78
Provincial Town of Prey Veng	1,640	4,032,974	631,732		418,520	4,445	3,695,679	11.80
Prov. Town of Steung Treng	1,640	5,748,768	50,784			2,634	4,768,664	17.78
Provincial Town of Ratanakiri	960	6,359,699	1,766,000			2,904	7,448,230	8.34
Provincial Town of Svay Rieng	1,000	18,039,900	108,640		173,730	10,789	16,280,618	9.34
Khum Bavit		60,861,000				2,494	57,564,164	5.42
Memot District		10,403,000				4,015	9,759,063	6.19
Ponhea Krek District		25,977,000			14,099,259	2,385	10,550,045	5.11
Kampong Trach		28,585,992		-15,841,180	4,060,892	2,513	8,188,704	1.73
Mondulkiri	670		1,821,545			1,328	1,571,300	13.74
Keoseyma		764,700				861	589,694	22.89
Total	75,730	2,199,377,581	46,689,340		99,831,856	375,915	1,930,404,691	9.61

Source: EAC Annual Report 2011

Table 2-22 Changes in EDC electricity sales by types of Contracts

Unit: GWh

Province	Year	Foreign Residence	Domestic residence	Commerci-al	Industry	Rehabili-tation*1	Govern-ment	Internal used	Total
Phnom Penh	1995	3.80	53.40	8.10	5.80		24.10	0.30	95.50
	1996	6.10	99.00	15.50	13.60		33.70	0.50	168.40
	1997	6.80	132.00	19.70	20.70		36.60	0.60	216.40
	1998		64.97	22.03	28.89	99.07	50.95		265.91
	1999		88.85	32.79	34.84	54.20	50.54		261.22
	2000		158.78	49.32	35.59	24.81	51.89		320.39
	2001		168.99	66.06	43.21	27.79	58.08		364.13
	2002		202.86	85.01	46.36	17.31	63.55		415.09
	2003		227.33	110.40	59.49	12.50	68.45		478.17
	2004		252.71	138.46	82.32	12.34	71.94		557.77
	2005		279.79	186.49	109.95	11.21	79.68		667.12
	2006	35.61	278.17	251.05	154.51	14.43	70.32	1.61	805.70
	2007	34.32	320.41	307.13	236.76	13.95	76.67	1.68	990.92
	2008	41.49	373.49	367.94	252.90	22.18	82.80	1.65	1142.45
	2009	41.42	429.39	396.81	244.65	37.70	93.10	1.80	1244.87
	2010		591.30	488.50	333.30	8.10	119.00		1540.20
Sihanouk ville	1995								
	1996								
	1997								
	1998								
	1999								
	2000								
	2001	0.23	7.49	1.70	0.65		0.43	0.04	10.54
	2002	0.25	8.30	1.92	0.98		0.98	0.10	12.53
	2003	0.46	9.78	2.44	1.07	-0.10	1.84	0.15	15.64
	2004	0.54	11.08	2.87	0.93	0.40	1.11	0.08	17.01
	2005	0.52	11.70	3.63	0.69	4.61	1.33	0.11	22.59
	2006		12.20	9.64	1.94	0.00	1.42	0.11	25.32
	2007		13.99	13.74	2.95	1.66	0.00	0.11	32.46
	2008		16.31	19.95	3.16	0.00	1.79	0.05	41.26
	2009		17.96	20.18	2.84	0.00	2.16	0.20	43.34
	2010		20.41	25.15	9.00	2.72	0.43	0.27	57.98
Siem Reap	1995		2.80					0.30	3.10
	1996		3.60					0.40	4.00
	1997		1.30	2.40			0.60	0.40	4.70
	1998		1.70	2.40			0.90	0.50	5.50
	1999		3.60	1.60			0.90	0.30	6.40
	2000		6.00	2.80			1.50	0.10	10.40
	2001		8.30	3.10			2.00	0.07	13.47

Province	Year	Foreign Residence	Domestic residence	Commerci -al	Industry	Rehabili -tation*1	Govern -ment	Internal used	Total
	2002		9.00	5.25			1.00	0.10	15.35
	2003	4.10	10.87	2.80		0.10	1.25	0.10	19.22
	2004	7.34	15.37	4.00		0.50	1.35	0.02	28.58
	2005		19.53	21.24	0.48	0.50	1.61	0.19	43.55
	2006		23.93	35.48	0.56	0.00	1.85	0.16	61.98
	2007		28.75	51.56	0.74	0.00	1.95	0.14	83.14
	2008		32.77	81.04	0.95	0.00	2.16	0.32	117.24
	2009		34.23	103.97	1.02	0.00	5.07	0.49	144.77
	2010		38.19	122.61	1.07	1.89	6.82	0.49	171.05
Kampong Cham	1995								
	1996								
	1997								
	1998								
	1999								
	2000		1.40	0.13			0.82	0.05	2.40
	2001		2.34	0.08		0.02	0.93	0.05	3.42
	2002		2.80	0.05		0.08	0.97	0.04	3.94
	2003		3.47	0.03			1.14	0.05	4.70
	2004		4.14	0.04		0.10	1.20	0.05	5.53
	2005		4.77	0.05			1.43	0.06	6.31
	2006		5.09	1.02	0.43	0.00	1.77	0.06	8.37
	2007		5.76	1.25	0.77	0.00	1.82	0.06	9.66
	2008		6.89	4.29	0.00	0.00	1.67	0.42	13.26
	2009		8.04	3.79	0.00	8.01	2.29	0.09	22.22
	2010		7.92	6.17	0.57	13.88	2.65	0.09	31.28
Battambang	1995								
	1996								
	1997								
	1998								
	1999								
	2000		4.38	1.87			0.54	0.02	6.81
	2001		5.63	2.00				0.07	7.71
	2002		5.67	2.14			0.79	0.09	8.69
	2003		6.66	2.50			0.97	0.08	10.19
	2004		8.88	2.98			1.05	0.12	13.03
	2005		10.47	3.33			1.14	0.08	15.02
	2006		12.24	3.19	0.00	0.00	1.27	0.08	16.78
	2007		15.99	3.72	0.00	0.00	1.39	0.08	21.18
	2008		20.54	5.30	0.79	0.00	1.89	0.07	28.59
	2009		17.81	12.74	1.71	0.00	1.94	0.08	34.27
	2010		22.72	15.90	2.29	1.76	2.62	0.09	45.39
Takeo	1995		0.02						0.02

Province	Year	Foreign Residence	Domestic residence	Commerci -al	Industry	Rehabili -tation*1	Govern -ment	Internal used	Total
	1996		0.03						0.03
	1997		0.04						0.04
	1998		1.10						1.10
	1999		0.60						0.60
	2000		1.00						1.00
	2001		1.40						1.40
	2002		1.50					0.01	1.51
	2003	0.08	0.87	0.47	0.03		0.30	0.02	1.77
	2004	0.08	1.02	0.55	0.03		0.34	0.02	2.05
	2005	0.10	1.06	0.72	0.05		0.43	0.03	2.39
	2006		1.32	1.21	0.05	0.00	0.46	0.07	3.11
	2007		1.54	1.79	0.01	0.00	0.59	0.07	4.00
	2008		2.04	2.33	0.01	0.00	0.67	0.06	5.11
	2009		2.50	3.29	0.01	0.00	0.07	0.01	5.87
	2010		3.05	4.20	0.00	0.09	1.01	0.07	8.41
Svay Reang	2001								
	2002		0.50	0.73				0.00	1.23
	2003		0.64	2.81				0.01	3.45
	2004		0.95	3.78				0.01	4.74
	2005		1.41		6.89			0.01	8.31
	2006		2.29	11.41	0.17	0.00	0.09	0.01	13.98
	2007		3.51	19.05	2.05	0.00	0.26	0.01	24.88
	2008		5.30	25.27	4.08	0.00	0.29	0.01	34.95
	2009		6.13	36.89	8.88	0.00	0.30	0.01	52.21
	2010		7.17	40.82	13.58	0.00	0.38	0.01	61.97
Memoth	2001								
	2002		0.53		0.47			0.00	1.00
	2003		0.80		1.40			0.01	2.21
	2004		1.02		2.48	0.06		0.02	3.58
	2005		1.56		4.64	0.04		0.02	6.26
	2006		2.20	0.00	9.01	0.00	0.00	0.02	11.24
	2007		2.78	0.00	9.13	0.00	0.00	0.03	11.94
	2008		3.16	0.13	5.34	0.00	0.03	0.00	8.66
	2009		3.48	6.14	0.03	0.00	0.00	0.00	9.66
	2010		3.90	5.07	0.00	0.00	0.00	0.04	9.01
Ponhea kreak	2001								
	2002		0.24		0.10			0.00	0.34
	2003		0.45		1.24			0.01	1.70
	2004		0.71		2.95	0.03		0.02	3.71
	2005		1.00		4.68	0.03		0.02	5.73
	2006		1.36	7.44	2.43	0.00	0.00	0.02	11.26
	2007		1.72	11.33	2.66	0.00	0.00	0.03	15.73

Province	Year	Foreign Residence	Domestic residence	Commerci -al	Industry	Rehabili -tation*1	Govern -ment	Internal used	Total
	2008		6.89	4.29	0.00	0.00	1.67	0.42	13.26
	2009		2.58	0.17	5.11	17.67	0.00	0.03	25.56
	2010		2.96	0.36	6.85	14.48	0.00	0.03	24.68
Kampong Trach	2003		0.14					0.00	0.14
	2004		0.62					0.01	0.63
	2005		0.93					0.01	0.93
	2006		1.21	0.00			0.00	0.01	1.22
	2007		1.43	0.00		0.61	0.01	0.00	2.05
	2008		1.94	0.00		1.73	0.00	0.01	3.68
	2009		2.34	2.77			0.00	0.01	5.12
	2010		3.17	5.02			0.01	0.00	8.20
Kampot	2004		1.18			0.02	0.30		1.49
	2005		2.19				0.75	0.01	2.95
	2006		0.63	1.68	0.16	0.00	0.80	0.03	3.30
	2007		2.81	1.34	0.07	0.00	0.70	0.03	4.95
	2008		3.75	2.37	0.00	0.00	0.83	0.05	7.01
	2009		4.67	3.09	0.00	0.00	1.26	0.07	9.09
	2010		5.67	4.30	0.00	4.17	1.15	0.08	15.38
Preyveng	2001		0.50				0.19		0.69
	2002		0.56				0.27		0.83
	2003		0.66				0.32		0.98
	2004		0.71				0.42		1.12
	2005		0.80				0.45		1.25
	2006		0.74	0.42	0.00	0.00	0.39	0.02	1.57
	2007		1.20	0.36	0.00	0.00	0.39	0.03	1.97
	2008		1.35	0.52	0.00	0.00	0.51	0.03	2.41
	2009		1.55	0.67	0.00	0.00	0.64	0.03	2.88
	2010		1.90	0.98	0.00	0.40	0.83	0.06	4.17
Rattanakiri	2004		0.58	0.15			0.09	0.00	0.82
	2005		1.50	0.42			0.26	0.01	2.19
	2006		2.06	0.42	0.00	0.00	0.27	0.01	2.77
	2007		1.93	1.22	0.32	0.00	0.33	0.03	3.84
	2008		2.81	1.62	0.28	0.00	0.25	0.03	4.99
	2009		3.33	1.75	0.23	0.00	0.40	0.06	5.77
	2010		4.20	2.23	0.33	0.00	0.68	0.08	7.53
Stung Treng	2004		0.58	0.15			0.09	0.00	0.82
	2005		1.50	0.42			0.26	0.01	2.19
	2006		0.68	0.39	0.09	0.00	0.18	0.00	1.34
	2007		1.10	0.68	0.04	0.00	0.38	0.01	2.21
	2008		1.55	1.09	0.00	0.00	0.42	0.01	3.06
	2009		2.00	1.47	0.00	0.00	0.61	0.01	4.09
	2010		2.31	1.72	0.00	0.00	0.74	0.07	4.84

Province	Year	Foreign Residence	Domestic residence	Commerci -al	Industry	Rehabili -tation*1	Govern -ment	Internal used	Total
Banteay Meanchey	2004								
	2005								
	2006		1.40	0.86	0.03	0.00	0.22	0.01	2.52
	2007		4.66	3.19	0.10	0.00	0.80	0.04	8.79
	2008		6.08	4.69	0.66	0.00	1.04	0.09	12.56
	2009		7.45	5.56	2.41	0.43	1.34	0.09	17.28
	2010		8.74	6.84	3.31	1.91	1.71	0.10	22.62
Kampong Speu	2011								
Kratie	2011								
Mondolkiri	2011								

*1: Rehabilitation means sales volume to REEs.

Source: EDC

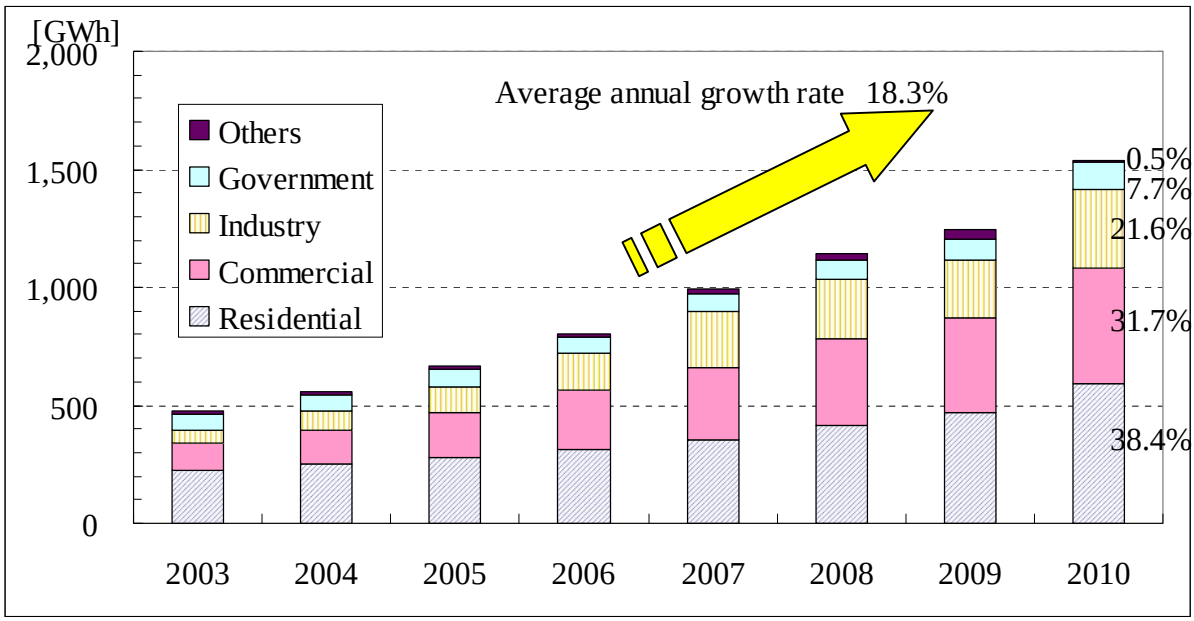
Table 2-23 and Figure 2-27 show changes in electricity sales by types of Contracts from 2003 to 2010 for the Phnom Penh system. The portion that accounts for the commercial sector has increased gradually.

Table 2-23 Electricity sales by types of Contracts in the Phnom Penh system

[GWh]

	Residential	Commercial	Industry	Government	Others	Total
2003	227.3	110.4	59.5	68.5	12.5	478.2
2004	252.7	138.5	82.3	71.9	12.3	557.8
2005	279.8	186.5	110.0	79.7	11.2	667.1
2006	313.8	251.1	154.5	70.3	16.0	805.7
2007	354.7	307.1	236.8	76.7	15.6	990.9
2008	415.0	367.9	252.9	82.8	23.8	1142.5
2009	470.8	396.8	244.7	93.1	39.5	1244.9
2010	591.3	488.5	333.3	119.0	8.1	1540.2

Source: EDC



Source: EDC

Figure 2-27 Changes in electricity sales in the Phnom Penh system

2.5.3 Maximum electric power

Table 2-24 shows production of maximum electric power by EDC.

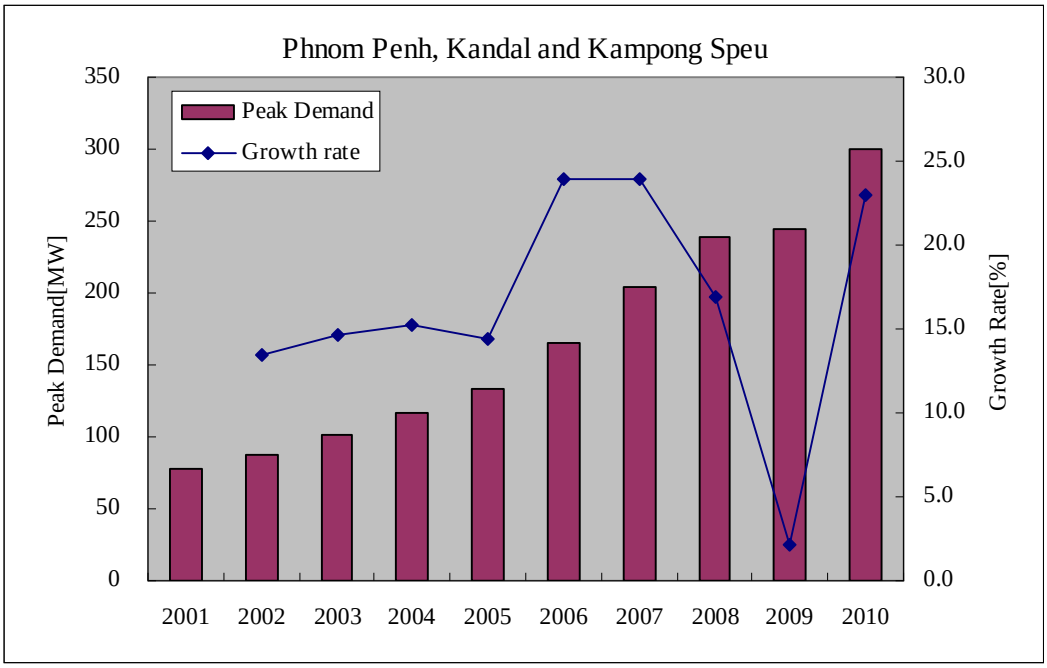
Table 2-24 Electric power supplied by EDC (maximum electric power)

[MW]

Location	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Phnom Penh, Kandal and Kampong Speu	77.6	88.0	100.9	116.3	133.1	165.0	204.5	239.0	244.1	300.2
Siem Reap	3.1	3.1	4.8	6.4	10.9	14.4	18.9	27.6	30.0	35.0
Sihanouk Ville	3.5	3.5	4.7	4.9	5.2	7.4	8.6	9.5	10.2	13.4
Kampong Cham	1.4	1.4	1.6	1.5	1.7	2.1	2.5	2.5	6.8	7.3
Ponhea Krek	-	-	0.9	1.5	2.2	1.9	4.1	4.1	5.5	5.0
Memot	-	-	1.0	1.6	2.6	1.2	3.8	3.8	3.0	3.0
Takeo	0.5	0.5	0.6	0.7	0.7	1.0	1.1	1.4	2.3	2.7
Battambang	2.5	2.8	3.2	3.9	4.4	5.2	5.6	7.0	8.0	10.5
Kampot	-	-	-	1.1	1.3	1.3	1.3	1.9	2.4	4.5
Kamponng Trach	-	-	0.1	0.2	0.3	0.2	0.7	0.8	1.2	2.1
Prey Veng	-	-	-	0.7	0.2	0.5	0.6	0.8	0.8	0.9
Banteay Meanchey	-	-	-	-	1.5	2.3	2.6	3.9	4.3	5.5
Steung Treng	-	-	-	-	0.8	0.5	0.7	1.0	1.1	2.0
Rattanakiri	-	-	-	1.1	1.5	1.5	1.3	1.7	1.8	1.9
Svay Rieng	-	-	-	-	0.9	0.8	1.3	2.2	2.8	3.7
Bavet	-	-	0.8	0.8	1.7	2.7	4.5	4.8	9.5	11.0
Mondulkiri	-	-	-	-	-	-	-	-	-	0.5
TOTAL	**88.7**	**99.3**	**118.5**	**140.6**	**168.9**	**207.9**	**262.2**	**312.0**	**333.6**	**409.1**

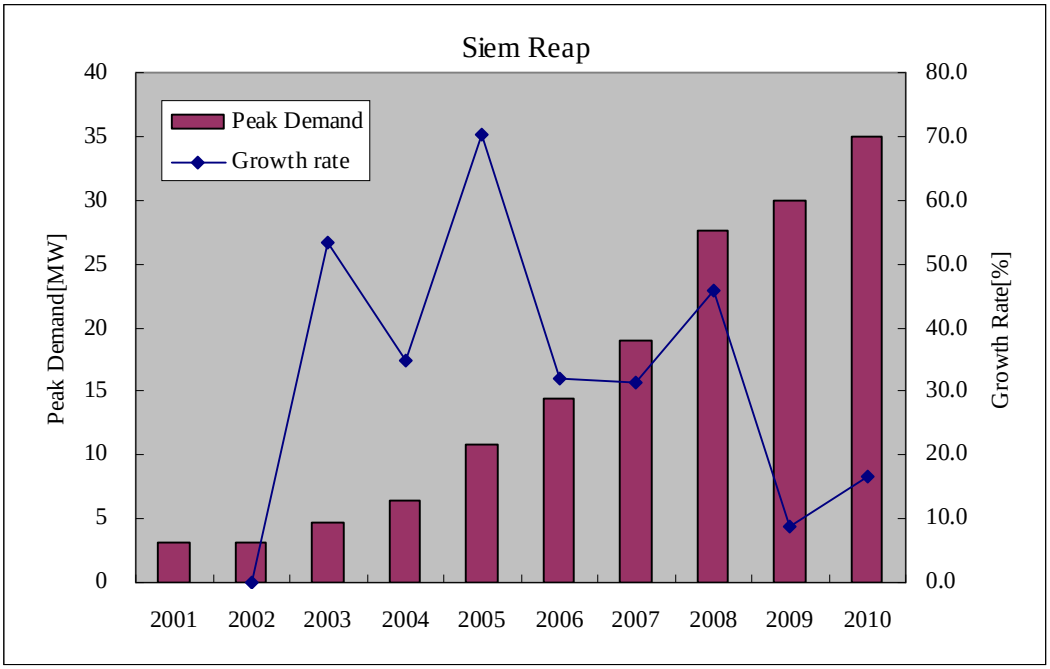
Source: EDC

Of Table 2-24, changes since 2001 observed in the 3 locations with the highest maximum electric power can be schematized as Figure 2-28, Figure 2-29, and Figure 2-30.



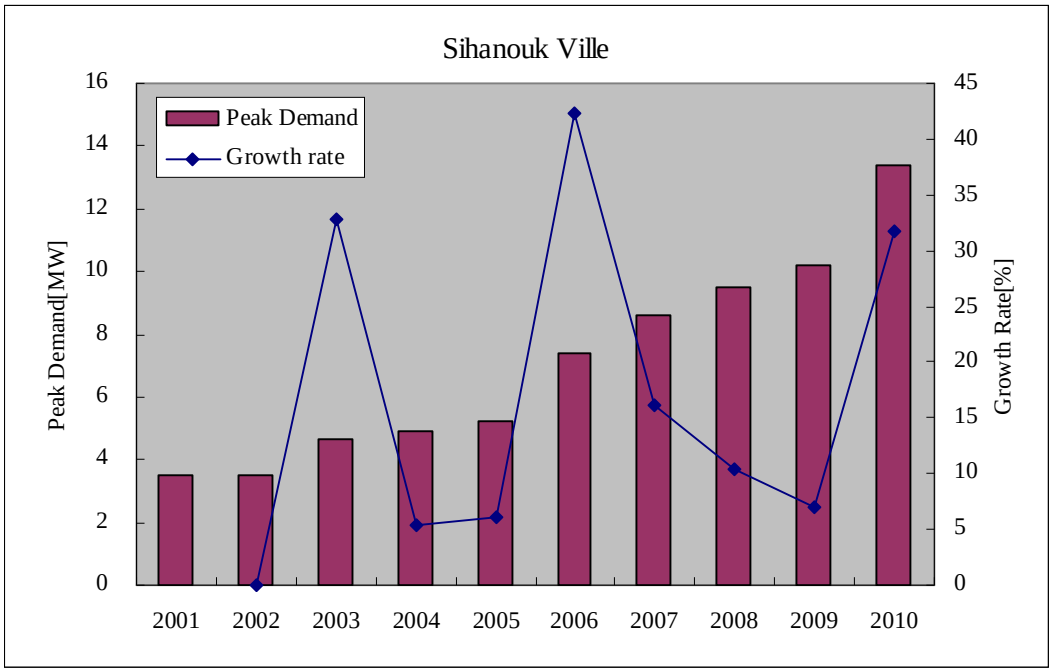
Source: EDC

Figure 2-28 Maximum electric power and its growth rate in Phnom Penh, Kandal, and Kampong Speu



Source: EDC

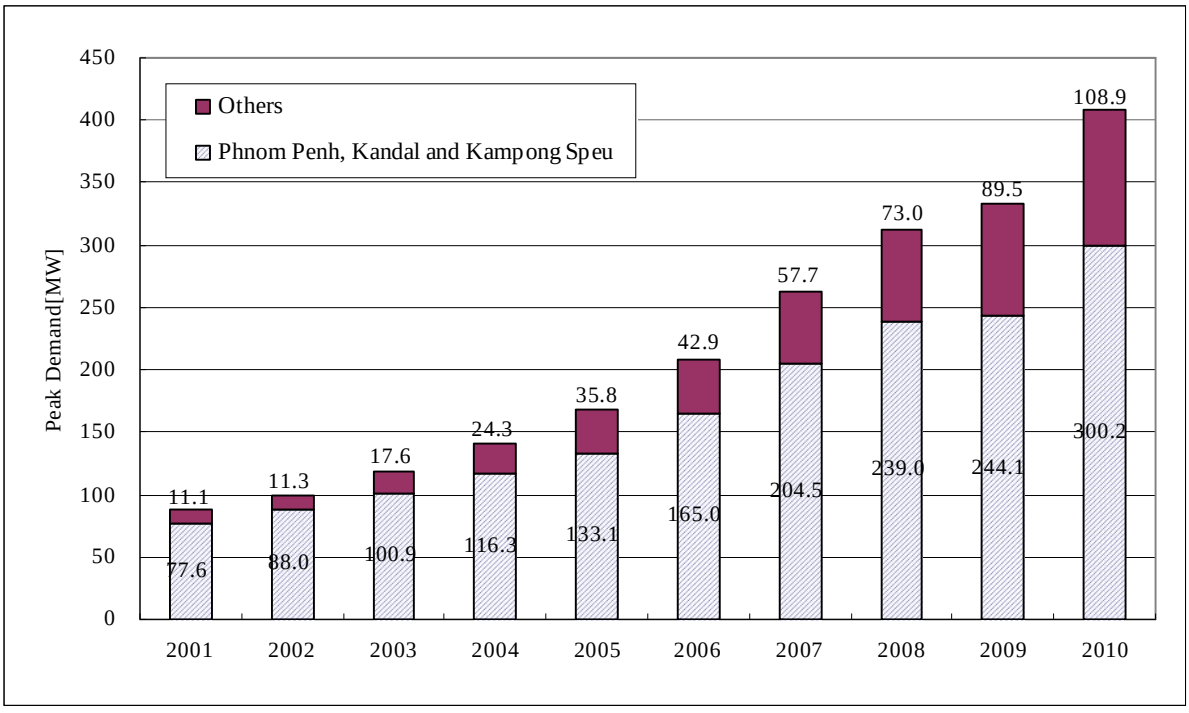
Figure 2-29 Maximum electric power and its growth rate in Siem Reap



Source: EDC

Figure 2-30 Maximum electric power and its growth rate in Sihanouk Ville

Figure 2-31 shows changes in the maximum electric power in the metropolitan and other areas.

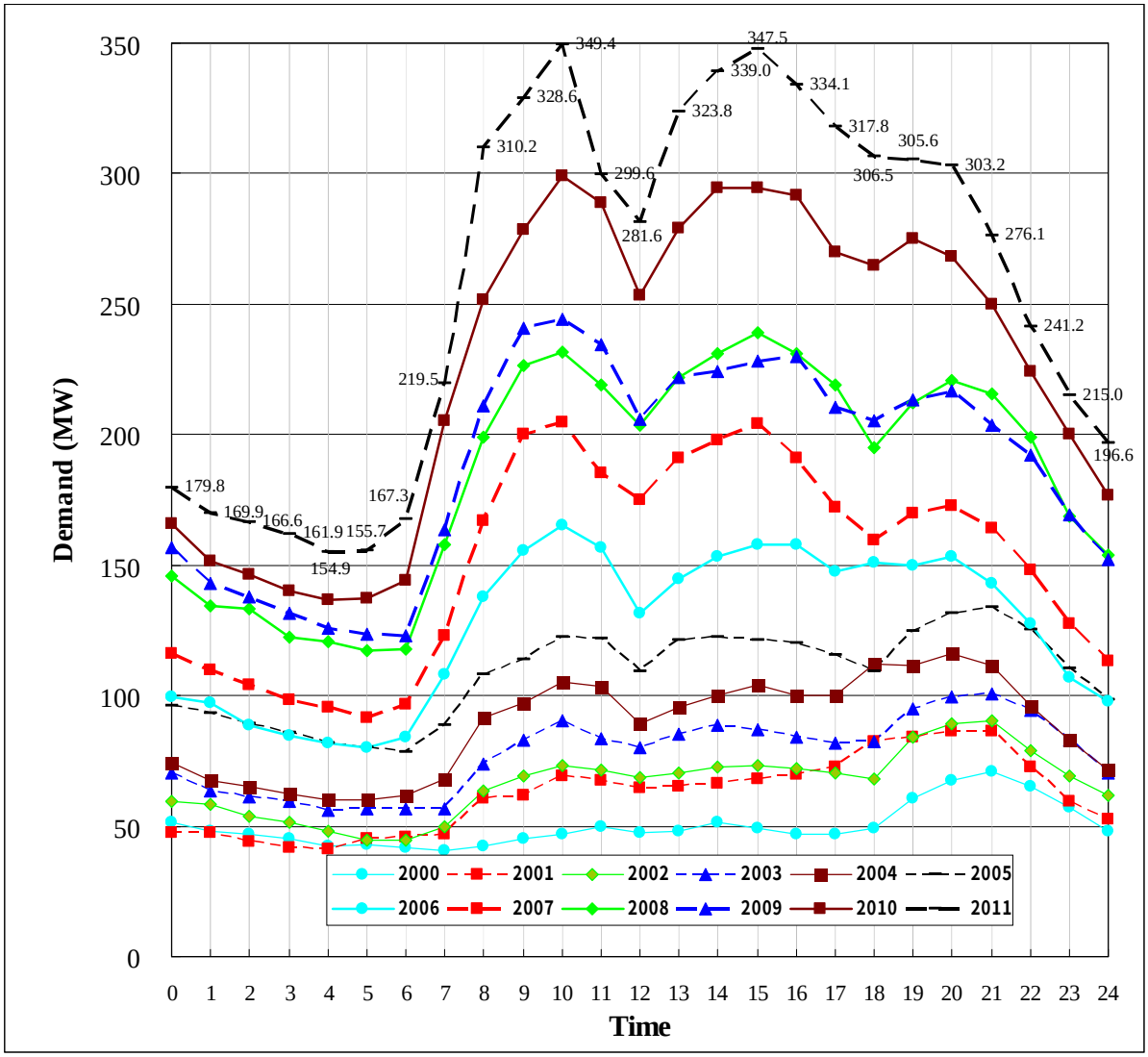


Source: EDC

Figure 2-31 Comparison of metropolitan and other areas in terms of maximum electricity power

2.5.4 Daily load curve

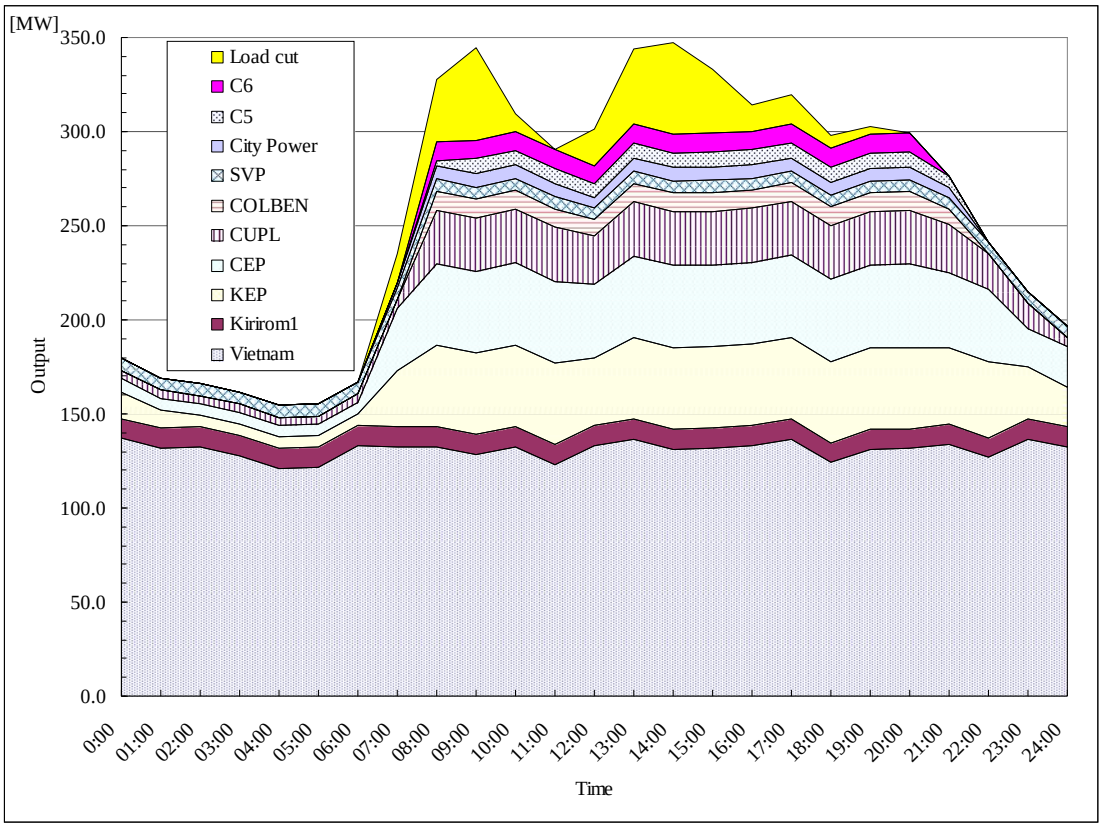
Daily load curves of the days the maximum electricity power were recorded in the Phnom Penh system from 2000 to 2011 are shown in Figure 2-32. The peaks started to appear at 10 a.m. and 3 p.m. since 2006, indicating that the demand of commercial use is increasing.



Source: EDC

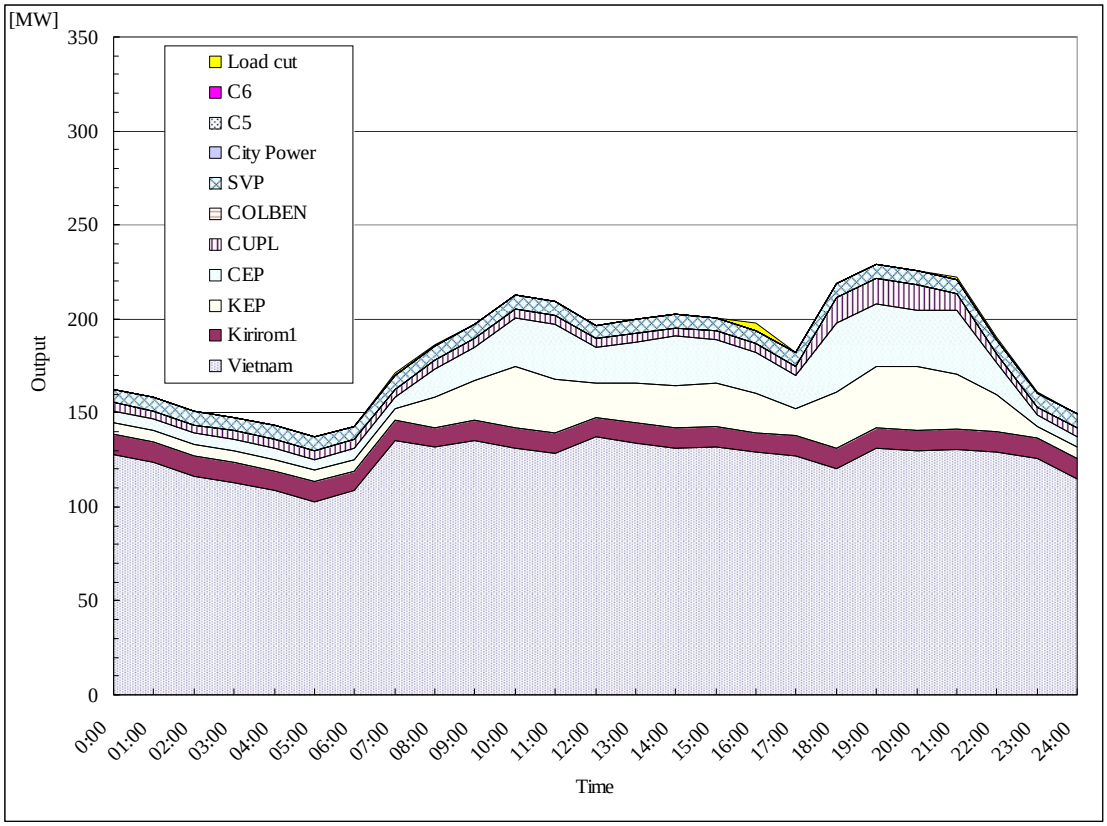
Figure 2-32 Daily load curve for the Phnom Penh system

For the daily load curves of October 24, 2011 Monday (the day the maximum electric power was observed) and October 9, 2011 Sunday (holiday of the month), data collected from each generator output can be schematized as Figure 2-33 and Figure 2-34.



Source: EDC

Figure 2-33 Daily load curve by generators (2011/10/24 Monday)

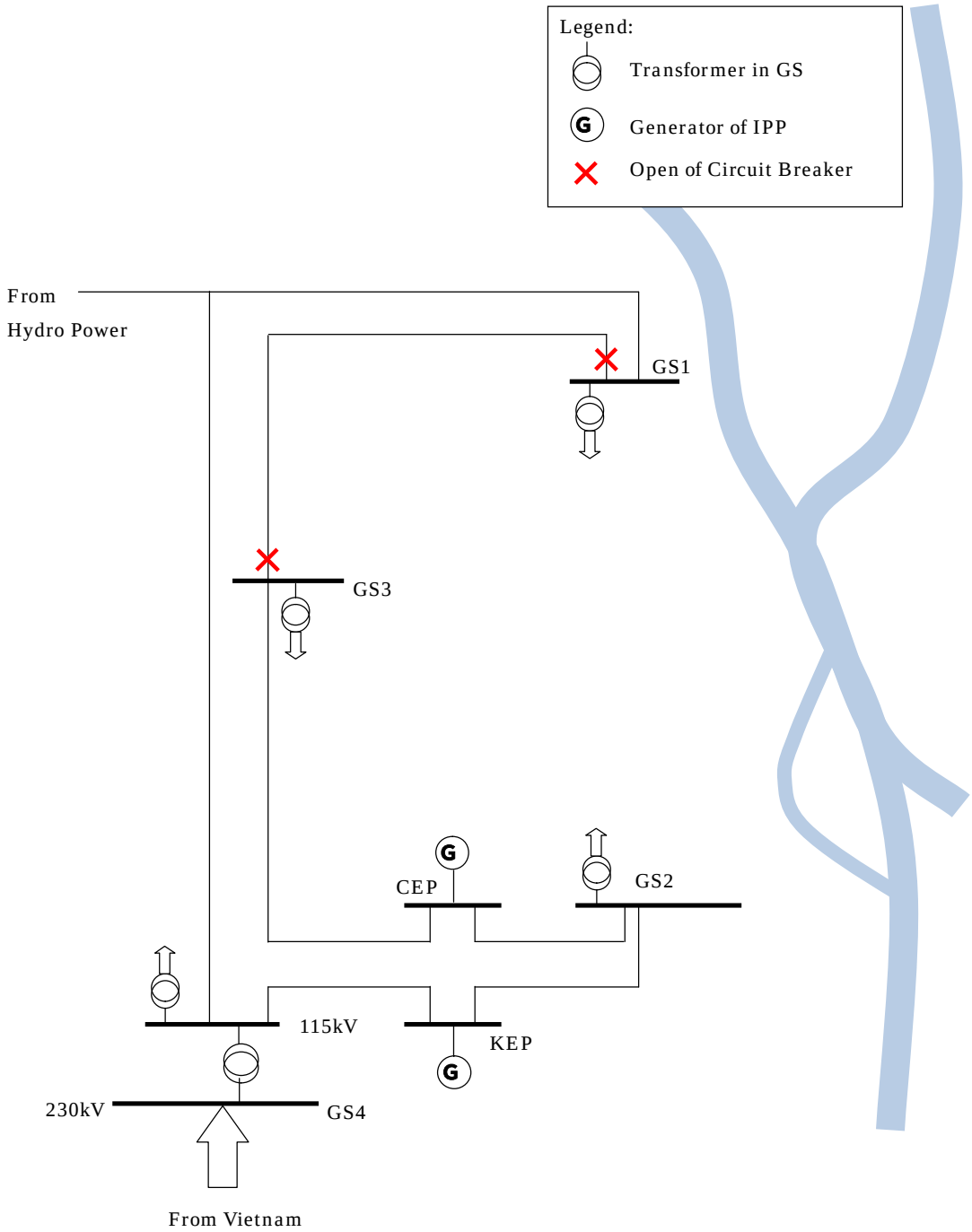


Source: EDC

Figure 2-34 Daily load curve by generators (2011/10/9 Sunday)

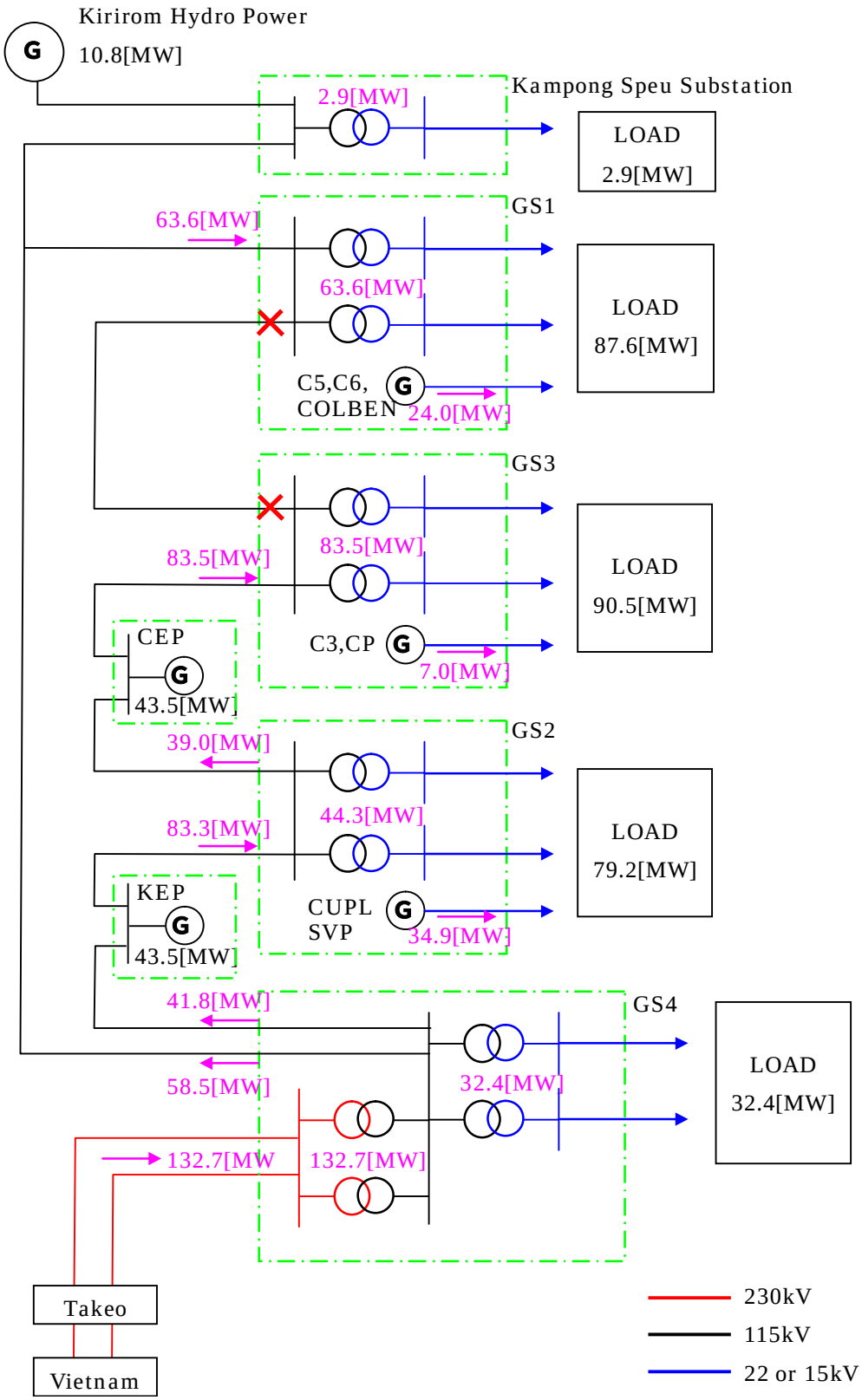
2.5.5 Power flow in the Phnom Penh system

Figure 2-35 shows the power system of the Phnom Penh City in 2011. The Phnom Penh system recorded the unprecedented highest power demand of 350MW (supply: 300MW, scheduled blackout: 50MW) on October 24, 2011 at 10 o'clock. Figure 2-36 shows the power flow at that time. Load factors about transformers at each GS and each transmission line are known from this map. (Numerical values were based on records from EDC and do not necessarily have consistency. e.g., the total load is not 300MW due to errors.) There are some generation plants connected by 22kV under GS1, GS2 and GS3. Therefore each GS connected by 115kV is supplying power by 22kV or 15kV distribution lines.



Source: EDC

Figure 2-35 Power system of the Phnom Penh City (as of November 2011)

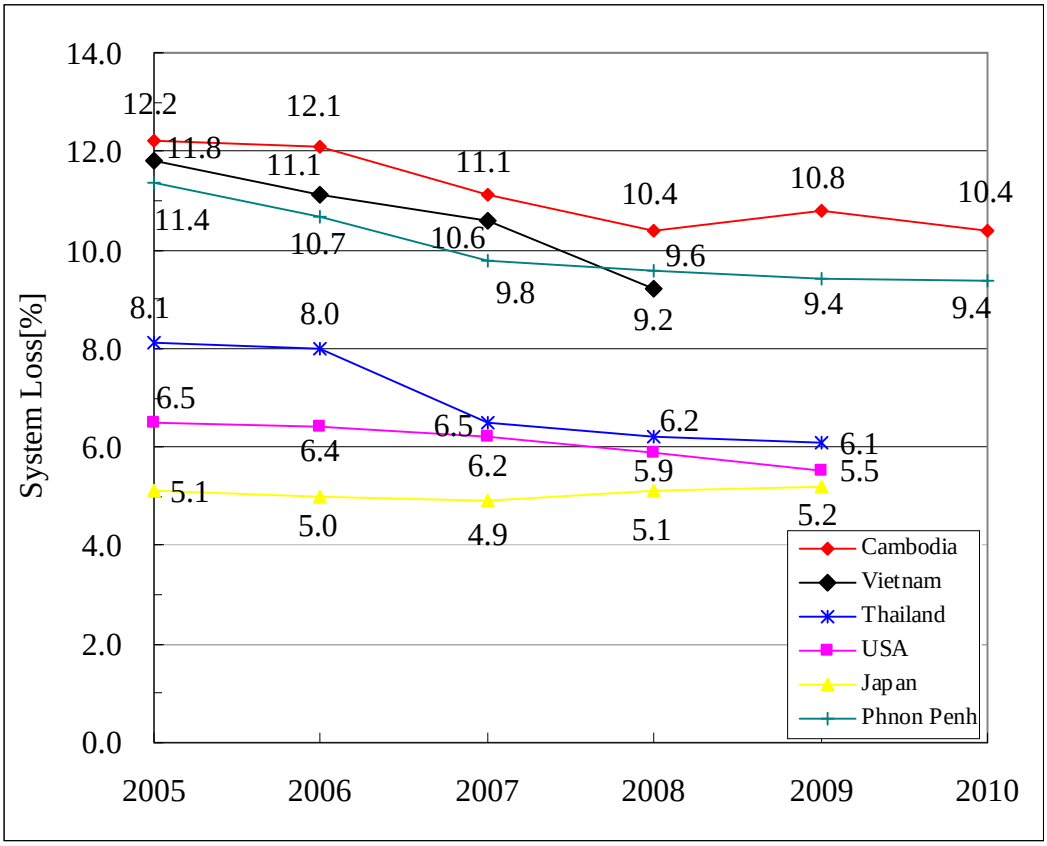


Source: EDC

Figure 2-36 Power flow of the Phnom Penh City (2011/10/24/ at 10:00)

2.5.6 Transmission and distribution loss rate

Figure 2-37 shows changes in transmission and distribution loss rates in the entire Cambodia, the Phnom Penh system, neighboring countries, Japan and the U.S. The transmission and distribution loss rate of Cambodia is similar to that of Vietnam, but when compared to that of Thailand, the U.S., and Japan, there still appear to be a room for improvement.



Source: EDC, Foreign Electricity Business Statistics 2011, Electricity Business Handbook

Figure 2-37 Transmission and distribution loss rates

2.5.7 Number of consumers

Changes in the numbers of consumers observed in EDC are shown in Table 2-25. Number of consumers in all areas is increasing. In 2010, Phnom Penh and Battambang are more than twice and three times compared to 2001, respectively.

Table 2-25 Changes in the numbers of consumers observed in EDC

Branch	Year	Domestic	Commercial-Small Business	Industrial	Industrial (7:00am-5:00pm)	Ambassador -guest house	Guest House in Industry	Hotel	Hotel (pay in dollars)	Licencees	Administration	Internal used	Total
Phnom Penh	2001	102,575	7,768	564						320	654	27	111,908
	2002	121,830	9,355	617						288	676	29	132,795
	2003	128,713	10,281	670						256	671	20	140,611
	2004	137,657	11,434	701						239	670	25	150,726
	2005	149,077	11,849	725						226	705	23	162,605
	2006	162,884	12,626	808						202	781	24	177,325
	2007	177,124	13,781	897						196	836	23	192,857
	2008	194,087	15,730	914						192	895	23	211,841
	2009	204,686	17,853	940						117	997	-	224,593
	2010	218,184	20,663	1,013						52	1,080	-	240,992
Sihanouk ville	2001	6,336	448	70	1	40		44			35		6,974
	2002	6,710	487	82	1	43		44	1		36		7,404
	2003	6,716	485	86	1	43		44	1		36		7,412
	2004	7,376	549	97	3	60	4	45	1		46		8,181
	2005	7,408	546	87	3	58	4	43	1		45		8,195
	2006	7,701	660	92								4	8,457
	2007	7,956	752	90								5	8,803
	2008	8,204	839	94						-	113	4	9,254
	2009	8,584	950	103						-	126	4	9,767
	2010	9,300	1,040	96						47	145	4	10,632
Siem Reap	2001	8,026	69					90			93		8,278
	2002	8,106	235					223			96		8,660
	2003	8,953	261					272			94		9,580
	2004	9,883						728			108		10,719
	2005	11,104	916	2							158		12,180
	2006	12,327	1,235	2								39	13,603
	2007	13,116	1,598	2								26	14,742
	2008	14,099	2,345	2						2	127	26	16,601
	2009	15,237	2,825	1						3	137	26	18,229
	2010	16,378	3,370	1						3	172	27	19,951
Kampong Cham	2001	3,632						3		6	33	2	3,676
	2002	4,386						2		3	34	2	4,427
	2003	4,955	1					5		2	34	2	4,999
	2004	4,906	3					11		2	156	3	5,081
	2005	5,169	7					11		2	166	3	5,358
	2006												-
	2007												-
	2008	6,710	235	-							152	4	7,101
	2009	7,740	311	-						4	166	4	8,225
	2010	9,511	729	49						4	181	4	10,478
Battambang	2001	9,203	248								129	8	9,588
	2002	9,786	271								126	8	10,191
	2003	13,701	281								126	8	14,116
	2004	15,065	276								139	8	15,488
	2005	15,840	272								150	9	16,271
	2006												-
	2007												-
	2008	19,239	693	2						-	147	12	20,093
	2009	22,816	917	2						-	155	12	23,902
	2010	30,044	1,234	3						29	156	12	31,478
Takeo	2001	2,231											2,231
	2002	2,020	318	17			15				35		2,405
	2003	2,098	320	17			15				42		2,492
	2004	2,147	329	20			17				42		2,555
	2005	2,088	392	33			25				66		2,604
	2006												-
	2007												-
	2008	4,276	937	2						-	72	5	5,292
	2009	4,538	1,017	1						-	77	5	5,638
	2010	4,799	1,080							1	101	6	5,987
Svay Reang	2001												-
	2002	1,004						2					1,006
	2003	1,204						2					1,206
	2004	1,424						2					1,426
	2005	1,656	5										1,661
	2006												-
	2007												-
	2008	2,196	11	4							1	1	2,213
	2009	2,284	11	5							1	-	2,301
	2010	2,478	14	5							3	1	2,501

Branch	Year	Domestic	Commercial-Small Business	Industrial	Industrial (7:00am-5:00pm)	Ambassador -guest house	Guest House in Industry	Hotel	Hotel (pay in dollars)	Licencees	Administration	Internal used	Total
Memoth	2001												-
	2002	1,496		2								2	1,500
	2003	1,787		6								2	1,795
	2004	1,991		3								2	1,996
	2005	2,765		6								3	2,774
	2006												-
	2007												-
	2008	3,583	2	49							7	3	3,644
	2009	3,644	77	7							-	3	3,731
	2010	3,839	169	7							-	3	4,018
Ponhea kreak	2001												-
	2002	772		1								1	774
	2003	990		3								1	994
	2004	1,202		5								1	1,208
	2005	1,423		2							1	1	1,427
	2006												-
	2007												-
	2008	2,074	16	4						-	1	-	2,095
	2009	2,173	30	4						2	-	1	2,210
	2010	2,300	79	4						2	-	1	2,386
Kampong Trach	2003	1,333											1,333
	2004	1,643											1,643
	2005	1,788											1,788
	2006	1,882		1									1,883
	2007	2,027		1									2,028
	2008	2,157	1								1		2,159
	2009	2,256	30								1		2,287
	2010	2,456	58								-	1	2,515
Kampot	2004												-
	2005												-
	2006	4,205	328								30	1	4,564
	2007	5,042	369								68	1	5,480
	2008	5,589	414								74	2	6,079
	2009	5,773	463								76	2	6,314
	2010	6,536	508							30	67	3	7,144
Preyveng	2001	2,165									21		2,186
	2002	2,254									21		2,275
	2003	2,442									21		2,463
	2004	2,542									22		2,564
	2005	2,564									23		2,587
	2006												-
	2007												-
	2008	3,351	53								55	1	3,460
	2009	3,433	64								57	-	3,554
	2010	4,306	68							11	60	2	4,447
Rattanakiri	2004	2,098	48								46		2,192
	2005	2,465	54								50		2,569
	2006												-
	2007												-
	2008	2,289	310	18							47	3	2,667
	2009	2,354	338	25							48	5	2,770
	2010	2,457	371	27							49	6	2,910
Stung Treng	2004												-
	2005												-
	2006												-
	2007												-
	2008	2,072	255								1	50	2,378
	2009	2,176	267								1	58	2,502
	2010	2,291	278								65	2	2,636
Banteay Meanchey	2004												-
	2005												-
	2006												-
	2007												-
	2008	12,129	1,224	2						-	2	107	13,464
	2009	12,507	1,312	2						1	98	21	13,941
	2010	13,255	1,367	2						2	135	3	14,764
Kampong Speu	2011												
Kratie	2011												
Mondolkiri	2011												

Source: EDC

2.6 Power facility

2.6.1 Power generation facility

Cambodia's power generation facility by fuels is shown in Table 2-26. More than 90% of power generation facilities are diesel or HFO generators. It causes high electricity tariff.

Table 2-26 Power generation facility by fuels

No.	Type of Generation	Installed Capacity, kW		Proportion of Installed Capacity in % for 2010	Energy Sent Out, GWh		Proportion of Energy Sent Out in % for 2010
		End of Year 2009	End of Year 2010		Year 2009	Year 2010	
1	Hydropower	13,350	13,330	3.70	47.425	31.734	3.28
2	Diesel/HFO	340,003	327,972	91.08	1,152.650	898.730	92.81
3	Wood, other bio mass	5,776	5,776	1.60	6.486	5.819	0.60
4	Coal	13,000	13,000	3.61	28.033	32.081	3.31
	Total	372,129	360,078	100.00	1234.594	968.364	100.00

Source: EAC Annual Report 2011

Power generation facility and generated electric power of IPP (2010) that holds the generation license are shown in Table 2-27. Most of generators are small scale. There is no middle and large scale power plant such as more than 100MW.

Table 2-27 IPP power generation facility and generated electric power (2010)

Name of Licensee	Location of the Generation Plant	Sell electricity to	Installed Capacity, kW	Energy Sent Out, kWh
Cambodia Utilities Pte. Limited	C 2 Power Plant, Phnom Penh	EDC Phnom Penh	37,100	120,223,125
CETIC International Hydropower Deve- lopment Co., Ltd	Kirirom Plateau of Koh kong Province, (Koh Kong and Kampong Speu)	EDC Phnom Penh	12,000	24,194,232
Khmer Electrical Power Co., Ltd	Phum Dam Nak Thom, Sangkat Steung Mean Chey (Phnom Penh)	EDC Phnom Penh	48,192	230,384,140
City Power Group Corporation	Phum Tror Peang Chrey, Sangkat Kar Kap, Khan Dang Kor (Phnom Penh)	EDC Phnom Penh	8,100	18,273,703
Colben Energy (CAMBODIA) Ltd	Land Lot No. 283, Phum Boung Salang, Sangkat Russey Keo, Phnom Penh	EDC Phnom Penh	21,400	35,795,403
Colben Energy (CAMBODIA) Ltd	EDC's power plant, Phum No. 3, Khum no.3, Sngkat Mita Pheap, sihanoukville	EDC Sihanoukville	14,600	51,522,280
SHC (Cambodia) International Pte Ltd	Rattanakiri's power plant	EDC Rattanakiri	800	4,653,960
(Cambodia) Electricity Private Co, Ltd	Phum Tuol Pongro, Sangkat Chom Chao, Khan Dang Kor, Phnom Penh	EDC Phnom Penh	48,192	247,286,730
Kampot Power Plant co., Ltd	Cement factory of Kampot cement Co., Ltd at Banteay Meas District, Kampot Province	Kampot Cement Co. Ltd (Industry)	23,160	57,939,360
SL Garment Processing (Cambodia) Ltd	Phum Russey, Sangkat Steungmeanchey, Khan Meanchey, Phnom Penh	EDC Phnom Penh	4,500	4,046,520
Han Seng Land and Property Co. Ltd	Khum Roleab, Sampouvmeas District, Pursat Province	Nareth Co. Ltd Electricity Development	2,000	6,873,240

S.O.K. Company Limited	Road No.1, Group 7, Phum 7, Khum khsam, Kampong Chhanang	Sovanny Electricity Development Co. Ltd	2160	5,331,725
Sovanna Phum Investment Co., Ltd	Khum Samrong Thom, Kean Svay District, Kandal Province	EDC Phnom Penh	13,000	32,081,460
Tai Seng Import Export & Construction Co. Ltd	Khum Kachanh, Banlung District, Ratnakiri Province	EDC Rattanakiri	1,200	1,705,739
Kratie City Power Co., Ltd	Phum O-Reusey 2, Khum O-Reusey, Kratie District, Kratie Province	Electricity of Kratie Province	1,670	5,112,373
GTS Power Ltd	Phum Beung Kok, Khum Beung Kok, Kampong Cham District, Kampong Cham Province	EDC Kampong Cham	7,500	31,388,394
Sinohydro Kamchay Hydroelectric Project Co. Ltd	Trial run of part plant	EDC Kampot		3,951,740
Total			245,574	880,764,125

Source: EAC Annual Report 2011

Changes in power generation facility supplied to EDC (including import) are shown in Table 2-28. It shows main part of generation facility is gradually changing from diesel to HFO and import from neighboring conuntries.

Table 2-28 Power generation facility supplied to EDC (including import)

Year / Location		Capacity [MW]	2002	2003	2004	2005	2006	2007	2008	2009	2010
Phnom Penh	TOTAL	Installed	129.10	129.10	140.50	178.50	214.78	224.78	247.28	453.48	429.48
		Output	101.00	105.00	121.40	142.30	192.40	200.49	217.49	317.49	317.89
EDC		Installed	62.00	62.00	65.00	65.00	45.60	45.60	45.60	45.60	44.00
		Output	50.00	50.00	58.40	43.40	42.60	42.60	42.60	42.60	41.00
CUPL	IPP (HFO)	Installed	37.10	37.10	37.10	37.10	37.10	37.10	37.10	37.10	37.10
		Output	30.00	30.00	31.00	31.90	31.90	31.99	31.99	31.99	31.99
JUPITER	IPP (DO)	Installed	18.00	18.00	26.40	26.40	-	-	-	-	-
		Output	15.00	15.00	22.00	22.00	-	-	-	-	-
CETIC	IPP (Hydro)	Installed	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
		Output	6.00	6.00	10.00	10.00	11.00	11.00	11.00	11.00	11.00
KEP	IPP (HFO)	Installed	-	-	-	32.00	49.20	49.20	49.20	49.20	49.20
		Output	-	-	-	30.00	45.00	45.00	45.00	45.00	45.00
CITY POWER	IPP (HFO)	Installed	-	-	-	5.20	7.68	7.68	7.68	7.68	7.68
		Output	-	-	-	5.00	6.90	6.90	6.90	6.90	6.90
CEP	IPP (HFO)	Installed	-	-	-	-	49.20	49.20	49.20	49.20	49.20
		Output	-	-	-	-	45.00	45.00	45.00	45.00	45.00
COLBEN	IPP (HFO)	Installed	-	-	-	-	14.00	14.00	14.00	20.20	20.20
		Output	-	-	-	-	10.00	10.00	10.00	10.00	10.00
TH	IPP	Installed	-	-	-	-	-	10.00	10.00	10.00	-
		Output	-	-	-	-	-	8.00	8.00	8.00	-
COLBEN PPSEZ	IPP (HFO)	Installed	-	-	-	-	-	-	12.40	12.40	-
		Output	-	-	-	-	-	-	10.00	10.00	-
Suvannaphum	IPP (Coal)	Installed	-	-	-	-	-	-	10.10	10.10	10.10
		Output	-	-	-	-	-	-	7.00	7.00	7.00
VIETNAM	Import	PPA	-	-	-	-	-	-	-	200.00	200.00

Year											
		Output	-	-	-	-	-	-	-	100.00	120.00
Siem Reap	TOTAL	Installed	9.20	9.20	10.50	10.50	15.80	58.80	50.50	50.50	50.50
		Output	6.90	6.90	10.50	10.50	15.00	58.80	50.50	50.50	50.50
	IPP	Installed	9.20	9.20	-	-	5.30	8.30	-	-	-
		Output	6.90	6.90	-	-	4.50	8.30	-	-	-
	EDC	Installed	-	-	10.50	10.50	10.50	10.50	10.50	10.50	10.50
		Output	-	-	10.50	10.50	10.50	10.50	10.50	10.50	10.50
	Import	PPA	-	-	-	-	-	40.00	40.00	40.00	40.00
		Output	-	-	-	-	-	40.00	40.00	40.00	40.00
Sihanoukville	TOTAL	Installed	10.00	10.00	7.40	7.40	7.40	15.40	15.40	19.60	19.60
		Output	7.00	7.00	6.30	6.20	6.20	13.20	13.20	15.00	15.00
	EDC	Installed	10.00	10.00	7.40	7.40	7.40	7.40	7.40	5.60	5.60
		Output	7.00	7.00	6.30	6.20	6.20	6.20	6.20	5.00	5.00
	IPP	Installed	-	-	-	-	-	8.00	8.00	14.00	14.00
		Output	-	-	-	-	-	7.00	7.00	10.00	10.00
Kampong Cham	IPP	Installed	3.59	3.59	4.71	4.71	3.40	3.40	7.68	7.68	7.68
		Output	2.00	2.00	4.26	4.26	1.90	1.90	7.00	7.00	7.00
Ponhea Krek	Import	PPA	0.70	0.70	2.00	2.00	2.00	5.00	5.00	5.00	5.00
		Output	0.70	0.70	2.00	2.00	2.00	5.00	5.00	5.00	5.00
Memot	Import	PPA	1.75	1.75	3.00	3.00	3.00	5.00	5.00	5.00	5.00
		Output	1.75	1.75	3.00	3.00	3.00	5.00	5.00	5.00	5.00
Takeo	TOTAL	Installed	-	-	-	1.56	1.56	1.56	1.56	4.56	4.56
		Output	-	-	-	1.50	1.50	1.50	1.50	4.50	4.50
	EDC	Installed	-	-	-	1.56	1.56	1.56	1.56	1.56	1.56
		Output	-	-	-	1.50	1.50	1.50	1.50	1.50	1.50
	Import	PPA	-	-	-	-	-	-	-	3.00	3.00
		Output	-	-	-	-	-	-	-	3.00	3.00
Battambang	TOTAL	Installed	6.76	6.76	7.72	8.72	8.72	29.22	21.60	21.60	23.20
		Output	5.00	5.00	5.90	6.50	6.50	26.90	20.80	20.80	22.40
	EDC	Installed	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	3.20
		Output	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	2.40
	IPP	Installed	5.16	5.16	6.12	7.12	7.12	7.62	-	-	-
		Output	4.20	4.20	5.10	5.70	5.70	6.10	-	-	-
	Import	PPA	-	-	-	-	-	20.00	20.00	20.00	20.00
		Output	-	-	-	-	-	20.00	20.00	20.00	20.00
Kampot	EDC	Installed	-	-	-	3.08	3.08	3.08	3.08	3.08	3.08
		Output	-	-	-	3.00	3.00	3.00	3.00	3.00	3.00
Kampong Trach	Import	PPA	-	1.00	1.00	1.00	1.00	3.00	3.00	3.00	10.00
		Output	-	1.00	1.00	1.00	1.00	3.00	3.00	3.00	10.00
Prey Veng	TOTAL	Installed	-	-	-	2.74	1.64	1.64	1.64	2.44	2.44
		Output	-	-	-	2.35	1.50	1.50	1.50	2.30	2.30
	EDC	Installed	-	-	-	1.64	1.64	1.64	1.64	1.64	1.64
		Output	-	-	-	1.50	1.50	1.50	1.50	1.50	1.50
	IPP	Installed	-	-	-	1.10	-	-	-	-	-
		Output	-	-	-	0.85	-	-	-	-	-
	Import	PPA	-	-	-	-	-	-	-	0.80	0.80
		Output	-	-	-	-	-	-	-	0.80	0.80
Banteay Meanchey	TOTAL	Installed	-	-	-	3.08	3.08	23.08	23.08	23.08	23.08
		Output	-	-	-	3.00	3.00	23.00	23.00	23.00	23.00
	EDC	Installed	-	-	-	3.08	3.08	3.08	3.08	3.08	3.08
		Output	-	-	-	3.00	3.00	3.00	3.00	3.00	3.00

Year											
	Import	PPA	-	-	-	-	-	20.00	20.00	20.00	20.00
		Output	-	-	-	-	-	20.00	20.00	20.00	20.00
Stung Treng	TOTAL	Installed	-	-	-	1.64	1.64	1.64	1.64	1.64	3.64
		Output	-	-	-	1.50	1.50	1.50	1.50	1.50	3.50
	EDC	Installed	-	-	-	1.64	1.64	1.64	1.64	1.64	1.64
		Output	-	-	-	1.50	1.50	1.50	1.50	1.50	1.50
	Import	PPA	-	-	-	-	-	-	-	-	2.00
		Output	-	-	-	-	-	-	-	-	2.00
Ratana Kiri	TOTAL	Installed	-	-	1.52	1.52	1.52	1.76	1.76	2.56	2.56
		Output	-	-	1.36	1.36	1.36	1.76	1.76	2.36	2.36
	IPP	Installed	-	-	0.56	0.56	0.56	0.80	0.80	1.60	1.60
		Output	-	-	0.40	0.40	0.40	0.80	0.80	1.40	1.40
	EDC	Installed	-	-	0.96	0.96	0.96	0.96	0.96	0.96	0.96
		Output	-	-	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Svay Rieng	TOTAL	Installed	-	-	-	2.00	8.30	8.30	8.30	8.30	8.30
		Output	-	-	-	2.00	8.30	8.30	8.30	8.30	8.30
	EDC	Installed	-	-	-	-	0.80	0.80	0.80	0.80	0.80
		Output	-	-	-	-	0.80	0.80	0.80	0.80	0.80
	Import	PPA	-	-	-	2.00	7.50	7.50	7.50	7.50	7.50
		Output	-	-	-	2.00	7.50	7.50	7.50	7.50	7.50
Bavet	Import	PPA	0.80	0.80	0.80	2.00	2.00	5.00	5.00	5.00	5.00
		Output	0.80	0.80	0.80	2.00	2.00	5.00	5.00	5.00	5.00
Mondul Kiri	EDC	Installed	-	-	-	-	-	-	-	-	0.67
		Output	-	-	-	-	-	-	-	-	0.67
Keosema	Import	PPA	-	-	-	-	-	-	-	-	0.36
		Output	-	-	-	-	-	-	-	-	0.36
TOTAL		Installed	161.90	162.90	179.15	232.65	278.92	390.66	401.52	616.52	604.15
		Output	125.15	126.15	156.52	192.47	250.16	359.85	367.55	473.75	485.78

Source: EDC Annual Report

C5 power plant (5MW x 2 units) in Phnom Penh and Siemreap power plant (3.5MW x 3 units) in Siemreap were provided to EDC as Japanese grant aid projects. C5 power plant is mainly using for peak time after connecting to Vietnam by 230kV transmission line. It is directly connected to the office of Prime Minister for use in an emergency. And Siemreap power plant has standed ready to supply power in case of emergency since the end of 2007.

2.6.2 Transmission and distribution facility

The high voltage (115kV-230kV, HV) transmission facility in Cambodia is shown in Table 2-29.

Table 2-29 Transmission facility in Cambodia (HV)

High Voltage Line		Voltage [kV]	Length [km]	Owner ship
From	To			
Vietnam Border	Takeo GS	230	50.1	EDC
Takeo GS	GS 4 Phnom Penh	230	45.9	EDC
Kirirom hydro	GS Kampong Speu	115	65.2	EDC
GS Kampong Speu	GS 1 Phnom Penh	115	46.2	EDC
KEP	GS 4 Phnom Penh	115	24.6	EDC
KEP	GS 2 Phnom Penh	115	6.6	EDC
CEP	GS 2 Phnom Penh	115	7.0	EDC
CEP	GS 3 Phnom Penh	115	5.0	EDC
GS 1 Phnom Penh	GS 3 Phnom Penh	115	11.3	EDC
GS 4 Phnom Penh	T - Connection	115	31.7	EDC
Thai Border	Industrial Estate GS	115	4.0	CPTL
Industrial Estate GS	Banteay Meanchey GS	115	43.0	CPTL
Banteay Meanchey GS	Siem Reap GS	115	85.0	CPTL
Banteay Meanchey GS	Battambang GS	115	53.0	CPTL

Source: EAC Annual Report 2011, EDC

The transformation facility in Cambodia is shown in Table 2-30.

Table 2-30 Transformation facility in Cambodia

Substation	Transformers		Number of 22 kV feeders connected	Owner ship
	Voltage[kV]	Capacity[MVA]		
GS1	115/22/15	30/30/12(ONAN)	21	EDC
		50/50/20(ODAF)		
	115/22	30(ONAN)		
		50(ODAF)		
GS2	115/22/15	30/30/12(ONAN)	20	EDC
		50/50/20(ODAF)		
	115/22	30(ONAN)		
		50(ODAF)		
GS3	115/22	30(ONAN)	17	EDC
		50(ODAF)		
	115/22	30(ONAN)		
		50(ODAF)		
GS4	230/115	200	10	EDC
	230/115	200		
	115/22	50		
	115/22	50		
Takeo	230/22	16	2	EDC
Kampong Speu	115/22	6.3	6	EDC
Banteay Meanchey	115/22	25	2	CPTL
Siem Reap	115/22	50	5	CPTL
Battambang	115/22	25	2	CPTL

Source: EDC Annual Report

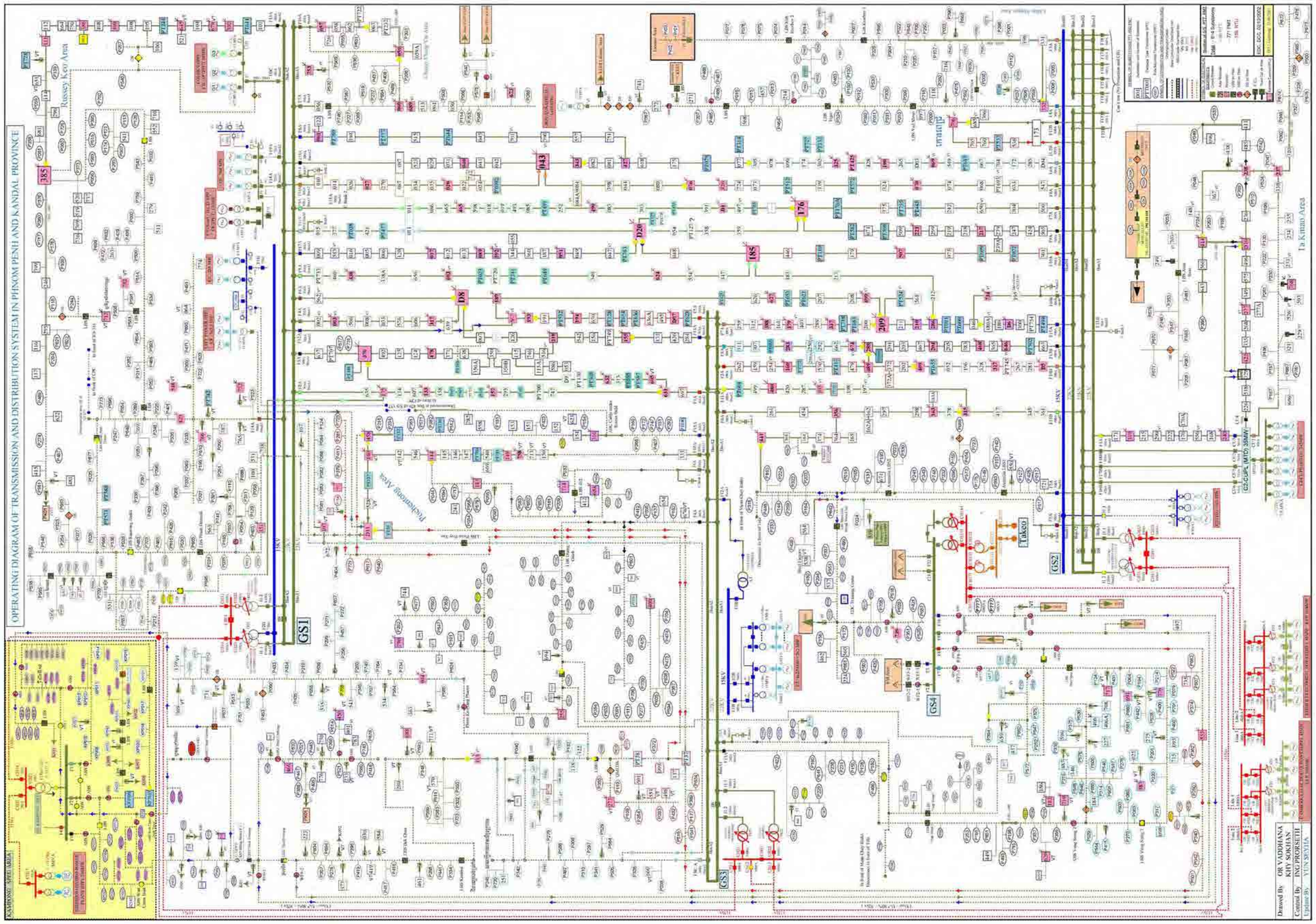
EDC-owned distribution lines (MV and LV) are shown in Table 2-31.

Table 2-31 EDC-owned distribution lines (MV and LV)

Location	Length of Medium Voltage lines in km			Length of Low Voltage lines in km		
	Overhead	Underground	Total	Overhead	Underground	Total
Phnom Penh, Kandal	581.13	351.51	932.64	829.92	135.95	965.87
Kampong Speu	59.21	1.73	60.94	71.45	1.73	73.18
Sihanoukville	38.91	30.21	69.12	82.36	6.87	89.23
Siem Reap	107.69	84.37	192.06	193.05	31.91	224.96
Kampong Cham	45.08	4.10	49.18	106.48		106.48
Pohneakrek	23.59		23.59	15.96		15.96
Memut	23.10		23.10	26.07		26.07
Takeo	30.65	1.11	31.76	72.29	1.86	74.35
Battambang	362.34	5.06	367.40	172.16	1.67	173.83
Banteay Meanchey	27.30	2.24	29.54	106.71	0.51	107.22
Monkulborei	15.27	0.06	15.33	33.63	0.28	33.91
Kampot	66.17	2.25	68.42	78.45	0.80	79.25
Kampong Trach	25.05		25.05	20.13		20.13
Prey Veng	54.02	0.27	54.29	42.74	0.16	42.90
Steung Treng	75.34	1.85	77.19	33.81	0.44	34.25
Svay Rieng	124.20	3.78	127.98	106.00	1.52	107.52
Bavet	11.21		11.21	20.16	0.37	20.53
Mondulkiri	27.53	0.47	28.00	32.00		32.00
Keosyma	20.00		20.00	24.00		24.00
Ratanakiri (*Part = 10 kV)	19.90*	0.35	20.25	33.40	0.35	33.75

Source: EDC Annual Report, 2011

Figure 2-38 shows the transmission and distribution system in Phnom Penh.



Source: EDC

Figure 2-38 Transmission and distribution system in Phnom Penh

2.7 Demand forecast

Long-term demand forecasting is a fundamental and necessary condition for planning an economical facility development. Overestimation can lead to uneconomical facility setup and underestimation can cause undersupply. It is therefore important to forecast the demand appropriately.
Cambodia has so far forecasted the demands as shown in Table 2-32.

Table 2-32 Previous Electricity Demand Forecasts

No.	Project	Date	Agency
1	Strengthening Energy Planning in the Department of Energy	Oct. 1996	ADB
2	Power Transmission Master Plan & Rural Electrification Strategy	Jun. 1998	WB
3	Feasibility Study on the Sihanoukville Combined Cycle Power Development Project in the Kingdom Cambodia Progress Report	Aug. 2000	JICA
4	Update of Power rehabilitation 2 Project Preparation Study	Mar. 2001	ADB
5	Electric Power Development in Cambodia	Jun. 2002	Cam-Tai Electric Power Co., Ltd.
6	TA project no. 5920-reg indicative Mater Plan on Power Interconnection in GMS Countries	Aug. 2003	ADB
7	Rural Electrification and Transmission Project & Great Mekong Sub-region Power Project	Dec. 2006	WB

Source: Survey Team

Amongst these, the official demand forecast of Cambodia is that described in "Rural Electrification and Transmission Project & Great Mekong Sub-region Power Project" (WB report), which was performed by WB in 2006.

2.7.1 How demands were forecasted

In general, nationwide power demand is forecasted based on the regression analysis using previous GDP growth rates, population growth rates, income, and electricity tariffs as variables. When forecasting demands for small-scale systems in non-electrified villages where no chronological data are available, household power demands are estimated and pooled.
In WB reports, the following indexes are used mainly for demand forecasting:

(1) GDP

GDP is the most important index for forecasting electricity consumption. GDP growth rates and the resulting ripple effect on the living standard impact the growth of electricity consumption greatly.

(2) Population growth

Population growth is a factor that determines electricity consumption. The higher the population growth, the higher the growth rate of electricity consumption. Thus, population growth and power demand are positively correlated

(3) Rural electrification rate

The RGC aims to electrify at least 70% of household by the year 2030. In general, electrification rates rapidly increase for a few years after setting up new distribution lines and thus electricity becomes available. Additionally, electricity consumption can increase as a result of inexpensive electricity supply from grids in areas where it has been electrified by REE but the electricity consumption was low due to high charges. Thus, electrification is considered another important factor in forecasting power demand.

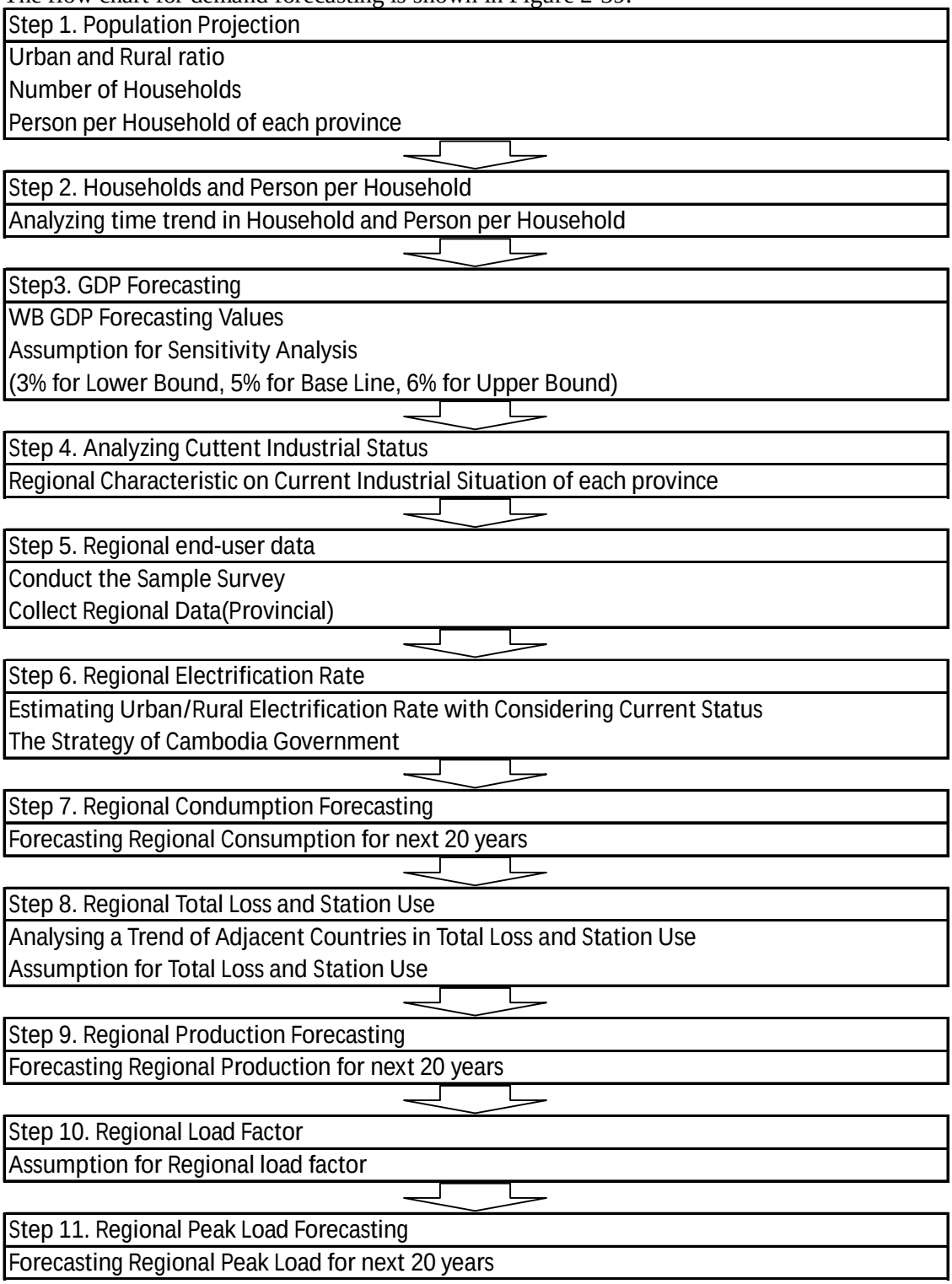
(4) Household power demand (End-user demand)

Average electricity consumption per household is difficult to calculate, since data such as electricity

comsumption per household in REE are not fully available. Thus, forecasts are made based on sample surveys by MIME and usages (e.g., duration of electricity supply, electrical appliances, and electricity tariffs).

Demand forecasts can be obtained by entering data from the above indexes to the software (REDFOS 2006).

The flow chart for demand forecasting is shown in Figure 2-39.



Source: Rural Electrification and Transmission Project & Great Mekong Sub-region Power Project, WB

Figure 2-39 Flowchart for Load Forecast

2.7.2 Demand forecast by area

The demand forecasted by WB in 2006 includes the demand supplied by EDC as well as that supplied by REE and the electricity consumption through batteries, encompassing all electricity demands in a province. Demand forecasting consists of high, base, and low cases. The main difference amongst the cases is the GDP growth, which are 6%, 5%, and 3%, respectively. The WB demand forecast is the official Cambodian forecast. WB's forecasting data are being submitted to the RGC as software, so that data can be amended and actual results will be reflected. In 2010, MIME, EAC, and EDC recalculated the WB's data on the basis of the actual demand up to the year 2009 (Table 2-33~Table 2-35).

Table 2-33 Demand forecast (Base case)

Category	Province Name	Senarios	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Peak Load (MW)	Banteay Meanchey	Base	15.84	17.65	19.40	21.53	23.85	26.61	29.38	32.93	36.84	40.82	45.10	49.80	54.97	60.66
	Battambang		30.44	33.91	36.00	39.95	44.25	49.31	54.00	60.08	66.77	74.14	82.25	91.18	101.02	111.86
	Kampong Cham		39.34	43.82	47.75	52.13	57.16	63.45	68.37	73.14	82.16	88.46	95.53	103.28	113.02	123.24
	Kampong Chhnang		9.17	10.30	11.41	12.76	14.25	16.31	18.45	20.71	23.13	25.82	28.83	32.19	35.95	40.16
	Kampong Speu		8.71	9.82	10.91	12.23	13.66	15.66	17.69	19.93	22.40	25.12	27.89	30.94	34.30	38.02
	Kampong Thom		10.50	11.82	13.11	14.67	16.37	18.72	21.14	23.83	26.81	30.12	33.62	37.30	41.41	46.00
	Kampot		68.60	71.02	72.74	75.22	77.81	80.98	83.87	86.88	90.00	93.23	96.56	99.97	103.47	107.05
	Kandal		31.62	34.95	38.14	41.77	45.72	50.42	55.13	60.24	65.77	71.79	79.63	88.27	97.82	108.35
	Kep		1.15	1.33	1.51	1.72	1.96	2.25	2.53	2.84	3.18	3.55	4.02	4.54	5.12	5.61
	Koh Kong		17.64	19.47	20.73	22.32	24.04	26.49	29.02	31.74	34.67	37.85	41.32	44.61	48.15	51.94
	Kratie		7.18	8.42	9.41	10.39	11.32	12.44	13.43	14.46	15.55	16.69	17.87	19.11	20.39	21.86
	Mondul Kiri		1.82	2.03	2.25	2.50	2.79	3.12	3.47	3.84	4.26	4.71	5.20	5.68	6.19	6.75
	Oddar Meanchey		2.19	2.51	2.82	3.20	3.60	4.10	4.59	5.11	5.68	6.28	6.94	7.64	8.39	9.18
	Pailin		2.02	2.30	2.57	2.90	3.28	3.72	4.18	4.77	5.43	6.18	6.92	7.69	8.55	9.52
	Phnom Penh		417.42	451.98	483.78	523.69	566.81	615.94	665.81	719.56	777.47	839.83	906.98	971.55	1,040.63	1,114.50
	Preah Vihear		4.26	4.84	5.42	6.10	6.85	7.77	8.67	9.65	10.72	11.88	13.14	14.50	15.96	17.27
	Prey Veng		35.34	37.88	41.26	45.34	49.70	55.10	60.13	65.49	71.19	77.27	83.76	90.46	97.62	105.32
	Pursat		8.79	9.90	11.00	12.34	13.82	15.86	18.01	20.42	23.11	25.95	29.03	32.47	36.33	40.64
	Ratanak Kiri		8.90	9.58	10.30	11.30	12.43	13.75	15.13	16.66	18.36	20.24	22.34	24.68	27.27	30.16
	Siemreap		38.80	42.53	46.24	50.46	54.94	60.27	65.38	71.71	77.93	84.62	91.81	99.54	107.85	116.77
	Sihanoukville		19.95	21.58	23.34	25.20	27.16	29.49	31.48	33.01	34.62	36.31	38.72	40.63	42.65	45.47
	Stung Treng		8.72	9.95	11.05	12.07	13.14	14.43	15.59	17.72	19.31	21.26	23.65	26.19	29.02	32.18
	Svay Rieng		9.62	10.74	11.79	13.05	14.43	16.10	17.76	19.58	21.56	23.74	26.55	29.69	33.20	37.11
	Takeo		8.73	9.79	10.83	12.09	13.46	15.12	16.78	18.59	20.57	22.63	25.28	28.23	31.51	35.17
	Total		806.72	878.11	943.76	1,024.93	1,112.79	1,217.41	1,319.99	1,432.88	1,557.47	1,688.49	1,832.94	1,980.15	2,140.78	2,314.80

Category	Province Name	Senarios	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Production (GWh)	Banteay Meanchey	Base	74.94	85.04	95.18	107.52	121.19	137.55	154.44	173.08	193.61	214.56	237.05	261.77	288.95	318.84
	Battambang		143.97	163.40	176.58	199.47	224.83	254.84	283.83	315.78	350.95	389.66	432.29	479.24	530.96	587.95
	Kampong Cham		167.12	192.64	215.70	241.66	269.60	303.22	331.15	359.01	408.73	444.76	484.38	528.03	576.19	629.41
	Kampong Chhnang		44.97	51.41	57.97	65.97	74.90	85.73	96.98	108.86	121.55	135.70	151.51	169.17	188.94	211.07
	Kampong Speu		42.71	49.04	55.45	63.19	71.79	82.29	92.96	104.73	117.71	132.03	146.61	162.60	180.28	199.83
	Kampong Thom		51.50	59.01	66.61	75.81	86.03	98.38	111.12	125.25	140.92	158.29	176.69	196.06	217.66	241.79
	Kampot		246.38	261.29	274.01	289.91	306.74	326.30	345.29	365.29	386.30	408.35	431.39	455.41	480.40	506.37
	Kandal		141.26	159.22	177.08	197.59	220.28	247.36	275.27	306.04	339.95	377.31	418.52	463.97	514.12	569.49
	Kep		5.12	6.04	7.00	8.16	9.44	11.01	12.64	14.44	16.45	18.67	21.13	23.86	26.89	29.49
	Koh Kong		83.43	93.80	101.68	111.46	122.15	134.60	147.44	161.26	176.14	192.32	209.94	226.66	244.62	263.89
	Kratie		27.03	32.45	37.10	41.85	46.61	52.29	57.64	63.34	69.49	76.04	82.97	90.41	98.25	107.24
	Mondul Kiri		5.73	6.59	7.48	8.56	9.77	11.22	12.76	14.48	16.41	18.56	20.97	23.39	26.03	28.99
	Oddar Meanchey		6.91	8.13	9.40	10.92	12.63	14.74	16.88	19.26	21.89	24.77	27.95	31.45	35.29	39.41
	Pailin		9.57	11.06	12.61	14.50	16.64	19.22	21.97	25.07	28.55	32.47	36.38	40.42	44.95	50.03
	Phnom Penh		2,376.76	2,573.57	2,754.63	2,981.90	3,227.40	3,507.14	3,791.11	4,097.19	4,426.90	4,781.99	5,164.33	5,532.03	5,925.35	6,345.97
	Preah Vihear		13.44	15.70	18.03	20.85	24.01	27.89	31.90	36.36	41.32	46.82	52.93	59.71	67.12	74.11
	Prey Veng		99.07	112.81	126.50	142.99	161.09	183.43	205.44	229.47	255.69	284.29	315.51	348.65	384.81	424.42
	Pursat		41.59	47.70	53.96	61.61	70.21	80.59	91.51	103.74	117.41	131.83	147.49	164.99	184.56	206.47
	Ratanak Kiri		24.94	28.53	31.57	35.65	40.28	45.78	51.69	58.38	65.94	74.48	84.16	95.11	107.51	121.55
	Siemreap		183.53	204.89	226.83	251.93	279.12	311.52	343.66	376.89	409.59	444.75	482.55	523.19	566.85	613.76
	Sihanoukville		92.61	102.10	112.45	123.60	135.61	149.86	162.68	173.48	184.98	197.23	210.30	224.24	239.13	254.93
	Stung Treng		32.86	38.36	43.57	48.65	54.09	60.66	66.91	77.61	86.26	95.91	107.74	120.44	134.72	150.82
	Svay Rieng		42.98	48.93	54.74	61.72	69.50	78.96	88.68	99.46	111.44	124.76	139.57	156.08	174.48	195.03
	Takeo		38.98	44.59	50.27	57.18	64.87	74.19	83.80	94.47	106.30	118.96	132.88	148.36	165.62	184.86
	Total		3,997.43	4,396.30	4,766.41	5,222.64	5,718.78	6,298.77	6,877.75	7,502.97	8,194.47	8,924.52	9,715.22	10,525.23	11,403.67	12,355.72

Source: EDC

Table 2-34 Demand forecast (High case)

Province Name	Senarios	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Banteay Meanchey		17.35	19.61	21.88	24.64	27.71	31.37	35.17	40.03	45.49	51.28	57.68	64.87	72.96	82.08
Battambang		33.36	37.74	40.67	45.83	51.56	58.32	64.95	73.50	83.13	93.96	106.18	119.94	135.48	153.03
Kampong Cham		42.58	48.00	52.96	58.57	65.08	73.20	80.09	87.08	99.91	109.53	120.53	132.89	148.41	165.30
Kampong Chhnang		10.06	11.48	12.93	14.70	16.70	19.43	22.38	25.60	29.18	33.28	37.99	43.39	49.61	56.78
Kampong Speu		9.46	10.82	12.19	13.86	15.71	18.27	20.96	24.01	27.44	31.32	35.47	40.15	45.47	51.53
Kampong Thom		11.50	13.15	14.82	16.85	19.12	22.22	25.54	29.32	33.62	38.51	43.92	49.87	56.71	64.57
Kampot		71.86	74.96	77.37	80.61	84.03	88.11	91.95	95.97	100.17	104.56	109.10	113.80	118.64	123.62
Kandal		34.67	38.93	43.15	48.04	53.47	59.94	66.68	74.17	82.48	91.71	103.69	117.23	132.53	149.86
Kep		1.24	1.46	1.68	1.95	2.24	2.60	2.98	3.39	3.85	4.37	5.02	5.77	6.61	7.40
Koh Kong		19.65	22.07	23.85	26.07	28.51	31.88	35.45	39.37	43.65	48.39	53.64	58.64	64.09	70.02
Kratie		7.66	9.06	10.22	11.38	12.53	13.90	15.16	16.51	17.95	19.48	21.09	22.83	24.66	26.76
Mondul Kiri		1.99	2.27	2.55	2.89	3.27	3.72	4.21	4.75	5.35	6.03	6.80	7.59	8.47	9.46
Oddar Meanchey	High	2.34	2.71	3.09	3.54	4.04	4.66	5.27	5.95	6.69	7.51	8.40	9.37	10.45	11.60
Pailin		2.25	2.60	2.96	3.40	3.90	4.51	5.16	6.00	6.96	8.06	9.23	10.49	11.95	13.63
Phnom Penh		476.28	595.36	732.29	878.75	1,019.34	1,162.05	1,301.50	1,431.65	1,571.95	1,721.29	1,877.92	2,045.06	2,227.07	2,425.28
Preah Vihear		4.62	5.33	6.04	6.90	7.87	9.04	10.24	11.57	13.05	14.69	16.52	18.55	20.77	22.92
Prey Veng		37.92	41.18	45.46	50.65	56.31	63.30	70.12	77.58	85.72	94.64	104.44	114.96	126.57	139.46
Pursat		9.75	11.16	12.62	14.41	16.43	19.19	22.20	25.64	29.58	33.91	38.76	44.34	50.74	58.11
Ratanak Kiri		9.95	10.92	11.97	13.42	15.06	17.01	19.12	21.51	24.23	27.32	30.84	34.86	39.43	44.66
Siemreap		41.63	46.13	50.71	55.94	61.58	68.26	74.87	83.06	91.40	100.52	110.50	121.42	133.37	146.45
Sihanoukville		21.20	23.16	25.29	27.56	29.99	32.86	35.42	37.57	39.87	42.33	45.70	48.57	51.65	55.80
Stung Treng		9.58	11.08	12.49	13.86	15.33	17.10	18.80	21.67	24.02	26.91	30.47	34.33	38.72	43.70
Svay Rieng		10.58	12.01	13.41	15.10	17.00	19.31	21.72	24.42	27.46	30.88	35.32	40.41	46.26	52.99
Takeo		9.59	10.94	12.30	13.96	15.82	18.07	20.43	23.06	26.01	29.22	33.35	38.09	43.51	49.75
Total		876.34	966.87	1,053.31	1,159.77	1,276.89	1,416.18	1,557.68	1,715.87	1,893.65	2,084.74	2,299.07	2,522.37	2,770.68	3,045.33

Province Name	Senarios	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Banteay Meanchey		82.05	94.49	107.33	123.05	140.79	162.12	184.84	210.39	239.11	269.55	303.16	340.95	383.48	431.40
Battambang		157.82	181.83	199.52	228.85	261.96	301.44	341.38	386.34	436.92	493.88	558.06	630.43	712.10	804.34
Kampong Cham		180.87	211.02	239.23	271.49	306.96	349.80	387.89	427.46	497.00	550.69	611.15	679.41	756.63	844.18
Kampong Chhnang		49.34	57.32	65.69	76.00	87.77	102.13	117.61	134.58	153.39	174.93	199.66	228.07	260.77	298.46
Kampong Speu		46.40	54.02	61.94	71.62	82.58	96.03	110.19	126.18	144.23	164.64	186.42	211.02	239.00	270.87
Kampong Thom		56.42	65.65	75.28	87.08	100.48	116.77	134.24	154.11	176.70	202.43	230.82	262.11	298.04	339.38
Kampot		258.08	275.80	291.43	310.70	331.24	355.04	378.56	403.53	429.98	457.96	487.43	518.38	550.82	584.76
Kandal		154.91	177.33	200.34	227.25	257.62	294.06	332.97	376.83	426.27	482.03	544.99	616.14	696.60	787.67
Kep		5.55	6.65	7.80	9.21	10.81	12.77	14.86	17.23	19.91	22.95	26.40	30.31	34.74	38.92
Koh Kong		92.93	106.33	116.99	130.18	144.84	161.96	180.13	200.01	221.77	245.86	272.52	297.94	325.62	355.75
Kratie		28.86	34.93	40.28	45.86	51.59	58.43	65.09	72.30	80.18	88.73	97.94	108.00	118.81	131.28
Mondul Kiri		6.29	7.36	8.48	9.86	11.45	13.37	15.47	17.88	20.63	23.79	27.41	31.26	35.61	40.62
Oddar Meanchey	High	7.39	8.80	10.29	12.10	14.16	16.73	19.40	22.41	25.79	29.59	33.84	38.60	43.93	49.78
Pailin		10.64	12.51	14.51	16.98	19.84	23.30	27.12	31.51	36.57	42.39	48.51	55.16	62.81	71.63
Phnom Penh		2,795.41	3,494.26	4,297.94	5,157.53	5,982.74	6,820.32	7,638.76	8,402.63	9,226.09	10,102.57	11,021.91	12,002.85	13,071.11	14,234.44
Preah Vihear		14.57	17.26	20.11	23.59	27.56	32.45	37.67	43.59	50.31	57.93	66.56	76.35	87.34	98.39
Prey Veng		106.30	122.64	139.39	159.73	182.52	210.70	239.57	271.82	307.87	348.20	393.41	443.10	498.95	561.96
Pursat		46.11	53.79	61.92	71.95	83.48	97.49	112.77	130.27	150.31	172.29	196.95	225.27	257.81	295.24
Ratanak Kiri		27.91	32.54	36.71	42.32	48.82	56.63	65.31	75.37	87.02	100.52	116.18	134.35	155.45	179.96
Siemreap		196.94	222.27	248.76	279.31	312.85	352.77	393.49	436.55	480.40	528.35	580.81	638.19	701.00	769.74
Sihanoukville		98.44	109.56	121.83	135.19	149.74	166.95	183.06	197.47	213.05	229.92	248.21	268.05	289.59	312.84
Stung Treng		36.08	42.71	49.24	55.87	63.12	71.92	80.68	94.92	107.31	121.40	138.78	157.88	179.75	204.83
Svay Rieng		47.27	54.70	62.25	71.44	81.92	94.73	108.45	124.09	141.93	162.32	185.66	212.41	243.15	278.51
Takeo		42.86	49.82	57.11	66.05	76.24	88.66	101.99	117.16	134.43	153.59	175.31	200.18	228.71	261.50
Total		4,347.87	4,846.85	5,326.56	5,917.20	6,570.10	7,335.48	8,124.35	8,992.49	9,970.09	11,024.61	12,189.56	13,407.27	14,754.25	16,244.61

Source: EDC

Table 2-35 Demand forecast (Low case)

Category	Province Name	Senarios	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Peak Load (MW)	Banteay Meanchey	Low	13.22	14.33	15.32	16.54	17.83	19.39	20.83	22.72	24.72	26.60	28.50	30.50	32.62	34.84
	Battambang		25.36	27.46	28.33	30.57	32.92	35.71	37.96	40.98	44.17	47.54	51.10	54.85	58.81	62.97
	Kampong Cham		31.70	34.68	37.06	39.63	42.50	46.17	48.48	50.42	54.59	57.00	59.64	62.42	66.05	69.57
	Kampong Chhnang		7.64	8.34	8.98	9.75	10.57	11.77	12.92	14.04	15.14	16.32	17.57	18.90	20.32	21.82
	Kampong Speu		7.41	8.15	8.83	9.64	10.50	11.75	12.94	14.20	15.53	16.94	18.24	19.59	21.01	22.51
	Kampong Thom		8.78	9.61	10.37	11.27	12.22	13.60	14.92	16.32	17.80	19.37	20.88	22.32	23.83	25.42
	Kampot		62.54	63.76	64.32	65.49	66.72	68.39	69.76	71.18	72.64	74.13	75.65	77.18	78.74	80.31
	Kandal		26.33	28.26	29.95	31.81	33.77	36.16	38.32	40.56	42.88	45.30	48.59	52.06	55.72	59.57
	Kep		0.98	1.11	1.23	1.37	1.52	1.71	1.88	2.06	2.25	2.46	2.71	2.99	3.28	3.48
	Koh Kong		14.22	15.18	15.70	16.43	17.19	18.43	19.61	20.85	22.14	23.50	24.94	26.30	27.73	29.23
	Kratie		5.90	6.88	7.62	8.29	8.90	9.62	10.22	10.83	11.45	12.07	12.69	13.33	13.95	14.68
	Mondul Kiri		1.51	1.65	1.77	1.91	2.07	2.25	2.43	2.61	2.80	3.00	3.22	3.39	3.56	3.73
	Oddar Meanchey		1.92	2.15	2.37	2.62	2.89	3.22	3.53	3.84	4.17	4.52	4.87	5.25	5.63	6.02
	Pailin		1.64	1.80	1.95	2.13	2.33	2.56	2.79	3.08	3.40	3.74	4.04	4.31	4.60	4.91
	Phnom Penh		349.22	367.71	382.73	402.89	424.05	448.39	471.59	495.89	521.34	547.98	575.86	602.09	629.43	657.91
	Preah Vihear		3.64	4.03	4.39	4.82	5.27	5.83	6.34	6.88	7.44	8.03	8.65	9.29	9.95	10.42
	Prey Veng		30.85	32.28	34.32	36.81	39.37	42.65	45.38	48.16	50.99	53.86	56.77	59.51	62.28	65.09
	Pursat		7.16	7.80	8.39	9.11	9.87	10.98	12.07	13.23	14.48	15.68	16.90	18.19	19.57	21.03
	Ratanak Kiri		7.10	7.37	7.62	8.05	8.50	9.05	9.57	10.11	10.70	11.32	11.98	12.68	13.43	14.22
	Siemreap		33.76	36.26	38.64	41.34	44.14	47.57	50.62	54.42	57.87	61.48	65.24	69.16	73.24	77.47
	Sihanoukville		17.68	18.79	19.96	21.17	22.43	23.98	25.15	25.83	26.54	27.26	28.44	29.20	29.98	31.25
	Stung Treng		7.09	7.88	8.51	9.02	9.53	10.16	10.64	11.70	12.35	13.17	14.20	15.23	16.35	17.58
	Svay Rieng		7.98	8.64	9.19	9.85	10.55	11.41	12.18	12.97	13.80	14.65	15.80	17.00	18.27	19.61
	Takeo		7.24	7.88	8.46	9.17	9.91	10.81	11.63	12.48	13.36	14.20	15.30	16.47	17.69	18.99
	Total		680.88	721.97	755.99	799.69	845.54	901.57	951.73	1,005.36	1,062.55	1,120.11	1,181.78	1,242.23	1,306.03	1,372.63

Category	Province Name	Senarios	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Production (GWh)	Banteay Meanchey	Low	62.55	69.03	75.15	82.59	90.59	100.20	109.49	119.40	129.94	139.80	149.79	160.32	171.42	183.12
	Battambang		119.96	132.31	138.99	152.63	167.25	184.55	199.51	215.38	232.15	249.87	268.58	288.31	309.10	330.99
	Kampong Cham		134.65	152.44	167.39	183.71	200.46	220.65	234.80	247.51	271.56	286.57	302.41	319.10	336.72	355.31
	Kampong Chhnang		37.49	41.64	45.60	50.40	55.56	61.85	67.90	73.79	79.60	85.78	92.36	99.35	106.78	114.67
	Kampong Speu		36.34	40.69	44.86	49.85	55.21	61.78	68.00	74.61	81.62	89.04	95.87	102.97	110.45	118.30
	Kampong Thom		43.09	48.00	52.67	58.26	64.25	71.49	78.40	85.75	93.54	101.79	109.77	117.29	125.23	133.61
	Kampot		224.61	234.58	242.26	252.42	263.02	275.59	287.23	299.31	311.80	324.69	337.96	351.59	365.57	379.89
	Kandal		117.63	128.74	139.05	150.48	162.68	177.39	191.32	206.07	221.64	238.07	255.40	273.65	292.87	313.09
	Kep		4.36	5.03	5.70	6.49	7.34	8.38	9.39	10.48	11.65	12.91	14.26	15.71	17.25	18.31
	Koh Kong		67.27	73.13	77.01	82.02	87.33	93.62	99.64	105.92	112.48	119.40	126.69	133.64	140.90	148.50
	Kratie		22.24	26.51	30.03	33.40	36.62	40.47	43.88	47.42	51.13	54.98	58.92	63.04	67.21	72.04
	Mondul Kiri		4.78	5.34	5.88	6.53	7.24	8.09	8.92	9.83	10.80	11.84	12.97	13.96	14.95	16.02
	Oddar Meanchey		6.07	6.98	7.88	8.96	10.13	11.58	12.97	14.48	16.09	17.81	19.64	21.60	23.69	25.83
	Pailin		7.75	8.67	9.56	10.65	11.83	13.25	14.67	16.21	17.87	19.67	21.24	22.67	24.19	25.82
	Phnom Penh		1,988.45	2,093.72	2,179.25	2,294.04	2,414.52	2,553.15	2,685.21	2,823.60	2,968.50	3,120.20	3,278.97	3,428.32	3,583.99	3,746.15
	Preah Vihear		11.47	13.05	14.61	16.46	18.47	20.94	23.33	25.92	28.69	31.66	34.85	38.25	41.82	44.72
	Prey Veng		86.49	96.13	105.23	116.09	127.60	141.96	155.04	168.76	183.13	198.14	213.82	229.39	245.52	262.30
	Pursat		33.87	37.59	41.15	45.48	50.16	55.80	61.31	67.22	73.56	79.68	85.86	92.43	99.43	106.86
	Ratanak Kiri		19.91	21.94	23.37	25.37	27.54	30.13	32.68	35.44	38.42	41.64	45.12	48.88	52.93	57.31
	Siemreap		159.70	174.68	189.56	206.42	224.27	245.84	266.04	286.02	304.18	323.13	342.90	363.50	384.93	407.20
	Sihanoukville		82.07	88.88	96.16	103.87	112.02	121.86	129.96	135.79	141.81	148.04	154.49	161.16	168.07	175.18
	Stung Treng		26.71	30.38	33.55	36.37	39.23	42.73	45.67	51.23	55.16	59.43	64.68	70.05	75.93	82.38
	Svay Rieng		35.65	39.36	42.68	46.61	50.82	55.99	60.81	65.92	71.32	77.01	83.02	89.35	96.03	103.06
	Takeo		32.35	35.91	39.30	43.37	47.72	53.02	58.06	63.40	69.05	74.65	80.44	86.55	92.99	99.79
	Total		3,365.46	3,604.72	3,806.90	4,062.45	4,331.87	4,650.27	4,944.24	5,249.46	5,575.71	5,905.82	6,249.99	6,591.10	6,947.98	7,320.44

Source: EDC

The time when a province is connected to a main system in association with the transmission lines plan is shown in Table 2-36. A yellow background indicates that the province in question will have been connected to the national grid as of December 31 of that year. A blue background indicates that the province in question will have been connected to the north-west grid as of the end of that year.

Table 2-36 Connection to a main system

No.	Provincial Name	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
1	Phnom Penh																				
2	Kandal																				
3	Kampong Speu																				
4	Takeo																				
5	Kampot																				
6	Kep																				
7	Sihanoukville																				
8	Kampong Cham																				
9	Banteay Meanchey																				
10	Battambang																				
11	Siemreap																				
12	Kampong Chhnang																				
13	Pursat																				
14	Koh Kong																				
15	Kratie																				
16	Stung Treng																				
17	Ratanak Kiri																				
18	Prey Veng																				
19	Svay Rieng																				
20	Mondul Kiri																				
21	Kampong Thom																				
22	Preah Vihear																				
23	Oddar Meanchey																				
24	Pailin																				

Source: EDC

The rate of grid connection and electrical load were obtained from the provincial wide power demand and the demand of each main system was forecasted (Table 2-37).

Table 2-37 Demand forecasts for main systems

Based Case	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Peak in Main Grid (MW)	351	495	587	710	814	925	1,093	1,217	1,332	1,452
Peak in Whole country (MW)	671	762	856	961	1,078	1,203	1,322	1,439	1,567	1,699
Energy in Main Grid (GWh)	1,940	2,735	3,244	3,919	4,499	5,112	6,038	6,724	7,357	8,019
Energy in Whole Country (GWh)	3,400	3,914	4,453	5,050	5,717	6,424	7,099	7,753	8,466	9,205

High Case	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Peak in Main Grid (MW)	507	724	898	1,114	1,299	1,496	1,801	2,022	2,242	2,478
Peak in Whole country (MW)	897	1,062	1,243	1,443	1,643	1,858	2,070	2,283	2,519	2,770
Energy in Main Grid (GWh)	2,802	4,001	4,962	6,154	7,173	8,266	9,947	11,172	12,387	13,689
Energy in Whole Country (GWh)	4,549	5,494	6,534	7,683	8,831	10,057	11,271	12,475	13,807	15,227

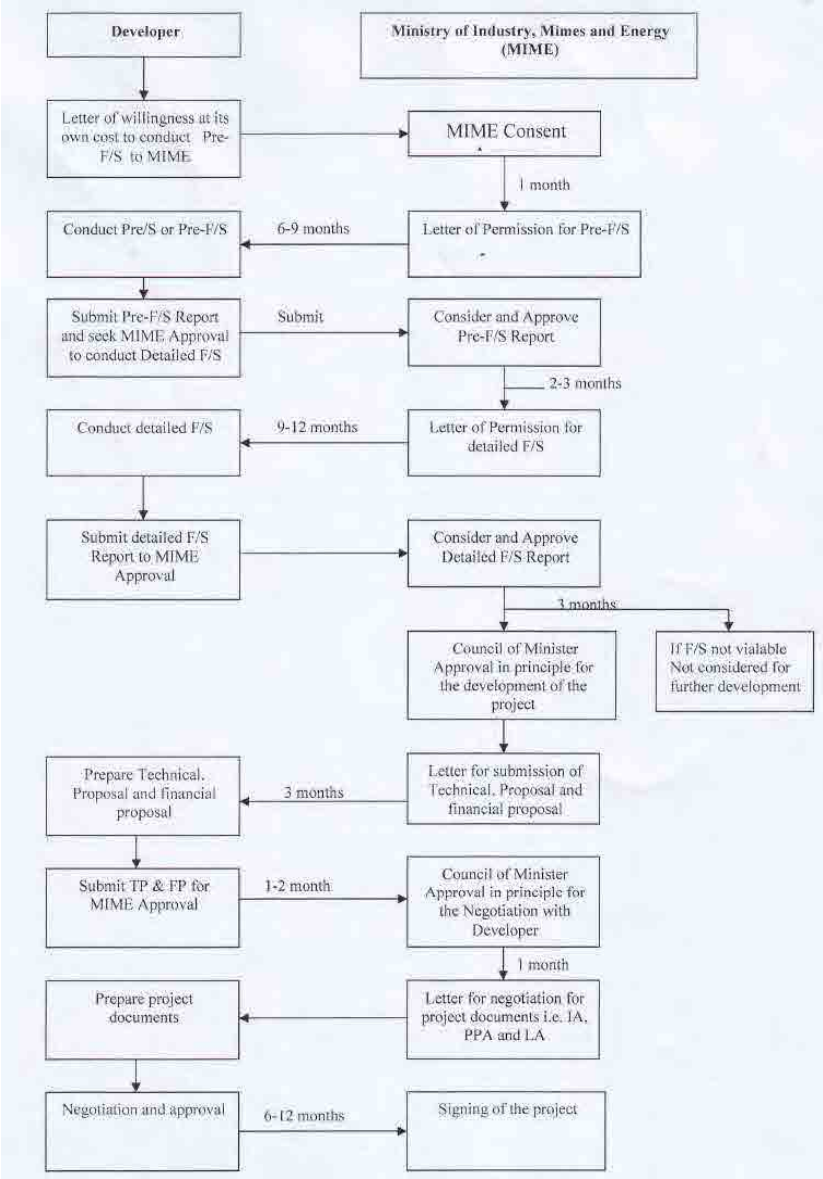
Low Case	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Peak in Main Grid (MW)	237	327	365	426	466	514	588	651	703	758
Peak in Whole country (MW)	507	546	581	624	669	724	774	828	886	945
Energy in Main Grid (GWh)	1,309	1,806	2,016	2,355	2,577	2,840	3,250	3,594	3,885	4,188
Energy in Whole Country (GWh)	2,483	2,709	2,909	3,154	3,414	3,724	4,011	4,312	4,637	4,968

Source: Survey Team

2.8 Electricity development plan

2.8.1 Processes for power development

Processes involved in the power development are shown in Figure 2-40. The right to investigate into the feasibility of business belongs to MIME and MIME provides an MOU to the developer. Subsequently, the developer must complete the FS usually within 2 years, but the deadline depends on the project. After the completion of the FS, MIME holds an internal examination meeting followed by a Stakeholders Meeting where EAC, EDC, and provincial government participate. The technology screening is done basically by MIME staffs only, and no in-house consultants of a foreign origin are involved. When the environmental impact evaluation report is complete, the Ministry of Environment holds a public hearing separately where NGO can participate. Thereafter, the Implementation Agreement (IA) which includes PPA is reviewed and judged by the committee organized by the order of The RGC. Committee members and roles are: MIME – Chairman, MEF – financial affairs, EAC – charges, and EDC – technology. IA usually includes the government-guaranteed buyout condition for taking over the equipment in case of project failure.
Regarding demining, the government document dated on December 28, 2010 shows that the government budget shall be used for it. The projects that have not been signed IA yet shall include demining costs in its investment cost plan such as financial proposal. And all expences for demining shall be covered by EDC budget for EDC projects including future projects financed by development partners.



Source: MIME

Figure 2-40 Processes involved with power development

2.8.2 Power development plan

Power development plans as of January 2012 are shown in Table 2-38 and Table 2-39. Table 2-38 summarizes projects that are almost fixed, such as those with existing PPAs. Since construction progress reports have been submitted to Cambodia, these projects are likely to commence as scheduled, with a possibility of slight delay in the timing of operation. Generators shown in Table 2-39 are at the planning stage (e.g., before FS) and no details are available for the progress of most generators. However, we have come to know through MIME that the PPA of No. 4 (Lower Sesan hydropower station) has been negotiated while the investigation committee was in Cambodia and progressing smoothly. No. 17 (Sambor hydropower station) has, according to MIME, a plan to create a dam in the mainstream of the Mekong River and such development plan may be difficult to achieve.

Table 2-38 Power Development Projects Planned for the Next Few Years

No.	Project Name	Type	Capacity	Scheduled commencement Progress	Company	Condition as of Dec. 2011	Connection Point to National grid	T/L
1	Kamchay	Hydro	194.1MW	Mar 2012	Sinohydro Kamchay Hydroelectric Project Co. Ltd. (China)	Under construction	180MW: Kampot S/S 14.1MW: Local	180MW: 230kV 14.1MW: 22kV
2	Kirirom III	Hydro	18MW	Apr 2012	CETIC Hydropower Development Co. Ltd. (China)	Under construction	Kirirom I P/P	115kV
3	Stung Atay	Hydro	120MW	2012	C.H.D. (Cambodia) Hydropower Development Co. Ltd. (China)	Under construction	O'soam S/S	115kV
4	Stung Tatay	Hydro	246MW	2013	Cambodian Tatay Hydropower Limited. (China)	Under construction	O'soam S/S	230kV
5	Lower Stung Russei Churum	Hydro	338MW	2013	China Huadian Lower Russei Churum Hydroelectric Project (Cambodia) Company Limited (China)	Under construction	O'soam S/S	230kV
6	100 MW Coal Fired Power Plant on BOO Basin in the Preah Sihanouk Province	Coal	100MW	2013	Leader Universal Holding Berhad (Malaysia)	Under construction	Sihanouk Province Terminal S/S	230kV
7	270 MW Phase 1 of the 700MW Coal Fired Power Plant on BOO Basin in the Preah Sihanouk Province	Coal	270MW	2014 (135MW) 2015 (135MW)	Cambodia International Investment Development Group Co. Ltd. (China)	PPA singed with EDC	Preaah Sihanouk Province Terminal S/S	230kV
8	100 MW Coal Fired Power Plant on BOO Basin in the Preah Sihanouk Province	Coal	100MW	2016	Cambodia International Investment Development Group Co. Ltd. (China)	PPA signed with EDC	Sihanouk Province Terminal S/S	230kV
9	430 MW Phase 2 of the 700MW Coal Fired Power Plant on BOO Basin in the Preah Sihanouk Province	Coal	430MW	2017	Cambodia International Investment Development Group Co. Ltd. (China)	FS completed	Sihanouk Province Terminal S/S	230kV

Source: MIME

Table 2-39 Power Development Projects under Study

No.	Project Name	Type	Capacity	Scheduled commencement Progress	Company	Discription
1	Steung Sen	Hydro	38 MW	2015	Royal Group(Cambodia)	LoP:PreF/S
2	Chhay Areng	Hydro	108 MW	2016	China Southern Power Grid Co., Ltd (CSG)	LoP:PreF/S
3	Prek Laang	Hydro	90 MW	2016	KTC(Korea)	LoP:PreF/S
4	Lower Sesan 2	Hydro	400 MW	2016	EVNI(Vietnam)	Under negotiation
5	Prek Leang 1	Hydro	64 MW	2016	KTC(Korea)	LoP:PreF/S
6	Prek Leang 2	Hydro	64 MW	2016	KTC(Korea)	LoP:PreF/S
7	Lower Sesan 3	Hydro	375 MW	2017	KTC(Korea)	-
8	Steung Pursat 1	Hydro	40 MW	2017	KTC(Korea)	LoP:PreF/S
9	Steung Pursat 2	Hydro	17 MW	2017	Guangxi Guohong(China)	LoP:PreF/S
10	Steung Battambang 1	Hydro	24 MW	2017	KTC(Korea)	LoP:PreF/S
11	Steung Reussei Chrom Upper	Hydro	32 MW	2017	KTC(Korea)	LoP:PreF/S
12	Sre Pok 3	Hydro	330 MW	2018	China Huadian Corporation	-
13	Sre Pok 2	Hydro	235 MW	2018	China Huadian Corporation	-
14	Steung Treng	Hydro	980 MW	2018	IDICO	MOU:PreF/S-F/S
15	Sekong	Hydro	148 MW	2018	EVNI(Vietnam)	MOU:PreF/S-F/S
16	Steung Reussei Chrom Kandal	Hydro	125 MW	2018	KTC(Korea)	LoP:PreF/S
17	Sambour	Hydro	2,600 MW	2019	China Southern Power Grid Co., Ltd (CSG)	LoP:PreF/S
18	Steung Battambang 2	Hydro	36 MW	2019	KTC(Korea)	LoP:PreF/S

*1: LoP means Letter of Permission for Pre-FS
Source: MIME

2.8.3 Development plans for transmission lines

Development plans for transmission lines are shown in Table 2-40.

Table 2-40 Transmission Line Development Plan

No.	Name	Voltage [kV]	Scheduled Completion Year	Source	Status
1	Takeo − Kampot	230	2012	KfW(Germany) (Grant)	Completed
2	WPP – Kampong Chhnang – Pursat - Battambang	230	2012	Chinese Private Company (Cambodia Power Grid) (BOT)	Mostly-completed
3	NPP - Kampong Cham	230	2012	Malaysian Private Company(Cambodia Transmission Limited) (BOT)	Under Construction (35%)
4	Stung Atay – O' soam	115	2012	Chinese Private Company (Cambodia Power Grid) (BOT)	Under Construction
5	O' soam - Pursat	230	2012	Chinese Private Company (Cambodia Power Grid) (BOT)	Under Construction (70%)
6	Kampot - Sihanoukville	230	2013	ADB, JICA (loan)	Under Construction
7	Lower Russey Chrum – O'soam	230	2013	Chinese IPP (China Huadian)	Under Construction
8	Stung Treng - Lao	230	2014	TBD	FS finished
9	Stung Treng - Kratie	115	2015	India (loan)	Under FS
10	Kampong Cham-Kratie	115	2015	Leader (Malaysia) & LYP group (Cambodia) (BOT)	Under FS
11	WPP - Sihanoukville	230	2016	Chinese Private Comapnay(CHMC) (BOT)	FS finished
12	Kratie - Lower SeSan2 – Vietnam	230	2017	TBD	Under FS
13	EPP - Neak Loeung – Svay Rieng	115	2018	Chinese Private Comapnay(CHMC) (BOT)	Under FS
14	NPP - Chhay Areng – O'soam	230	2018	TBD	Before FS
15	Kampong Cham – Kampong Thom – Siem Reap	230	2019	KTC(Korea) (BOT)	Before FS

Source: MIME, EDC

Current system structures and development plans are shown in Figure 2-41.

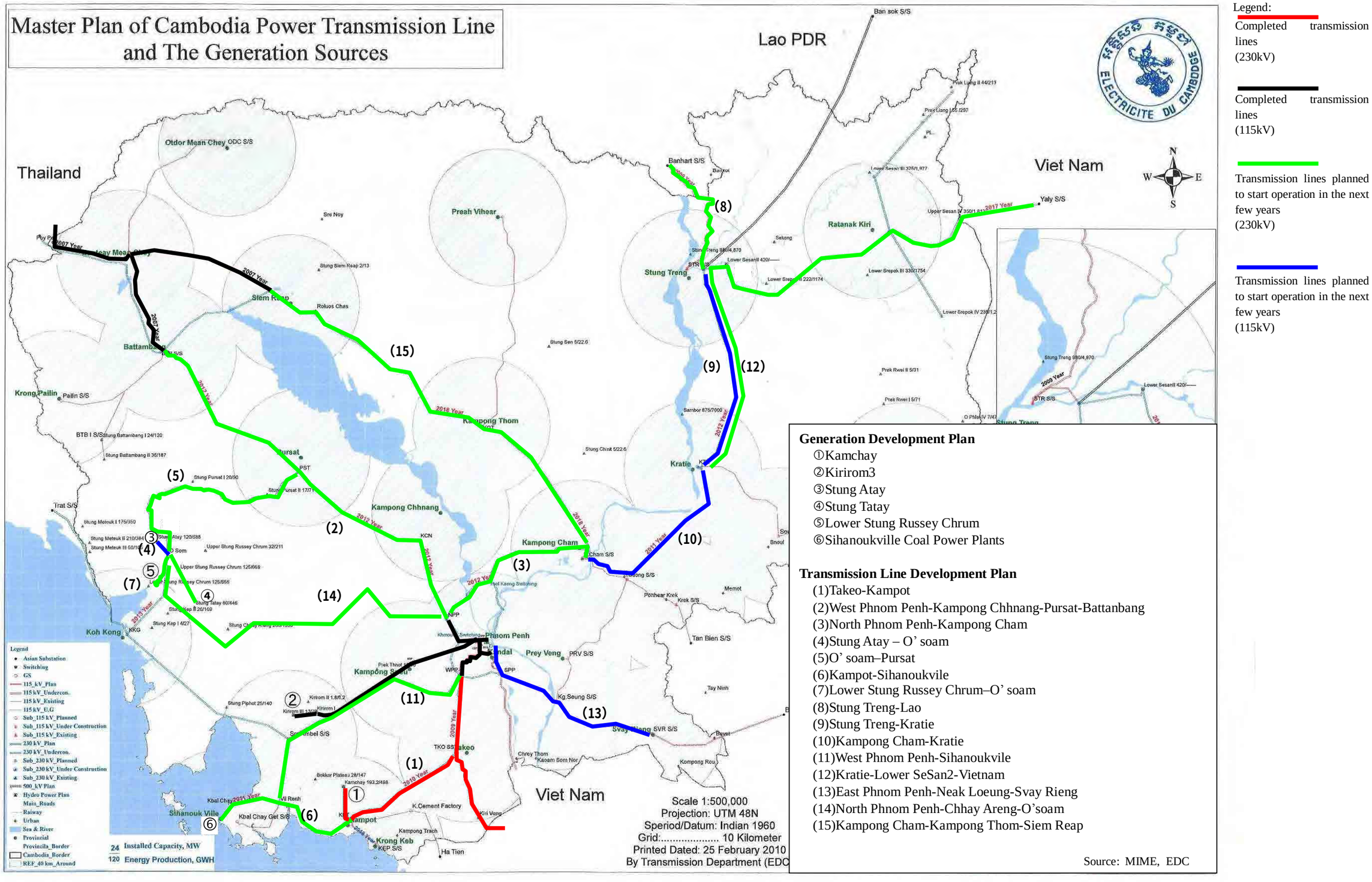


Figure 2-41 System structures and development plan

2.9 Environmental friendliness

2.9.1 Environmental friendliness for power development

Unfavorable observations were reported for large-scale hydropower developments, such as the Kamchay Hydropower commencing the construction before the EIA was finalized (2008) and an NGO finding the submerged area of Stug Tatay too large and may impact the environment greatly. For the hydropower stations at the height of development, MIME and MOE recognize that the environmental impact evaluations have been processed appropriately in accordance with Cambodian Laws. However, since documents for the environmental impact evaluation were not submitted, Cambodia should coordinate the country point of view on environment.
Among the hydropower project in Table 2-38, Kamchay, Sung Tatay and Lower Stung Russey Chrum were considered the utilization of Clean Developmenet Mechanism (CDM) scheme and Project Design Documents (PDD) on them have been published already. In the PDDs, the results of public consultation with representative of local government and local people etc. are shown. On the other hand, the information related to negotiation with stakeholders is not clear in the case of Stung Atay and Kirirom III.

2.9.2 Environmental friendliness for transmission line and substation development

Impact on social environment and ecosystem by the construction of transmission lines and substations:
As the result of hearing investigation to EDC, in the center of the Phnom Penh City, it is obligated to use underground cables for all 22kV distribution lines. Naturally, transmission lines of 115kV and above must also use underground but not aerial cables.

2.9.3 Environmental friendliness for power distribution

A problem associated with Polychlorinated Biphenyl (PCB) contained in the transformer oil of old transformers has been raised. Old transformers are resold by repair shops. The PCB-containing transformer oil is used in other transformers being resold and thus PCB contamination has been spreading.
On-site investigation of this problem is underway by UNIDO and the final report is scheduled to be completed by the end of February 2012.

2.10 Support from other donors and private enterprises

Cambodia has been supported by foreign donors in various ways. At present, most organizations support rural electrification by extending grids, as shown in Table 2-41.

Table 2-41 Grid Extension Project for Rural Electrification

Loan or Grant Name	Amount	Province	Scope
KfW (Grant)	22 MEuro	Kampot & Takeo	22kV grid extension, Transmission line project from Takeo to Kampot
JICA (Loan)	2,632MJPY	Sihanouk Ville, Kampot	Counterpart loan with ADB for Transmission from Kampot to Sihanoukville. 22 kV grid extension
Aus-Aid (Grant)	5 MUS$	Svay Rieng	22 kV grid extension
China Exim Bank (Loan)	53 MUS$	Kampong Cham, Prey Veng, Kampong Speu, Sihanouk Ville	22 kV grid extension
ADB (Loan)	45 MUS$	Siem Reap, Kampong Thom, and Surrounding area of Phnom Penh	22 kV grid extension
Royal Government of Cambodia (Loan)	80 MUS$	Pursat, Battambang, Banteay Meanchey, Svay Rieng, Kampong Chhnang, Paillin, Oddor Meanchey, Preah Vihear, Kratie, Steung Treng, Rattanakiri, Mondulkiri	22 kV grid extension

Source: EDC

Trends in major organizations' support are described below.

2.10.1 Trend in the WB support

WB has stopped engaging in a new project for not just the power sector but all sectors in Cambodia. Around 2009, it was disclosed that the resident relocation associated with the Boeng Kak Lake project supported by the WB fund was not performed in accordance with the Social Safeguard Guideline. In March 2011, decisions were made by the WB Board Meeting that on-going projects will be continued but preparation of all new projects shall be stopped. At present, the RGC is also involved in resolving the problem and WB and the RGC have started negotiating. Speedy resolution is wanted.

(1) Trend in REF

The WB monetary support for REF will end at the end of January 2012. Activities of REF are as follows: ① REF has planned to connect 50,000 new distribution lines in concert with EAC before the end of year 2011. This goal has been achieved in October 2011. ② REF aims to introduce 12,000 SHSs. In early January, 2012, over 10,100 SHSs have been introduced and including applicants, the total number of SHSs will be 12,000. Thus, it is realistic to achieve this goal by the end of January. ③ FS has been performed by a micro hydropower station, but the results showed that it is impossible to achieve this goal for economic reasons.
The RGC is close to the agreement for REF to continue with their activities as an EDC organization following the completion of the current fiscal year on January 31, 2012. After this day, the main operating costs will be covered by the repayment of the SHS system subsidy and other costs will be supplemented by EDC. Amongst present activity plans, ② introduction of SHS shall be continued for the moment. ① Connection of distribution lines shall be resumed as soon as budgeted. REF used to supplement costs of connections, but thereafter, expenses will be covered by a 3-year interest-free loan and repayment will be made through electricity tariffs.

2.10.2 Trend in the ADB support

ADB's support policy is described in "Country Partnership Strategy: Cambodia 2011–2013." ADB supports the RGC to achieve (1) inclusive economic growth and (2) social development and gender equity. With regard to the power sector, prioritization of the ADB support is in the order of (1) rural electrification by grid extension, (2) extension of transmission lines, and (3) capacity building, and is planning to provide EDC with a US$30 million loan in 2012. ADB projects include (1) installation of MV sub-transmission lines (22kV) in local areas and (2) strategic support in capacity building. Since there projects can contribute in the development of social infrastructure in local area, ADB will have a role in the REE support.
Continuation of GMS's large area coordination project using 500kV transmission lines has been postponed and is expected to resume after the year 2014, since the development of hydropower stations in Laos stopped due to the economic crisis. Accordingly, ADB has switched to a plan to electrify rural areas. ADB's rural electrification project emphasizes on the grid extension and the FS for the project using distribution line extension is underway. Areas of most interest for the grid extension are Siemreap, Kampong Tom, Kandal, and Kampot. The capacity building shall be incorporated as a soft component in this 5-year project, starting around the year 2013. The FS for the capacity building is also underway and the results are expected to be generated in February 2012.
Due to the low population density, prioritization of the northeast area is low.

Table 2-42 Projects supported by ADB

Program Name	Province	Type	Major Support Contents and Effectiveness by the Support [1)]	Stage	Start Year	End Year
Second Power Transmission and Distribution Project	Sihanoukville and Kampot	**Extension of T/L**	230kV Transmission Line between Kampot and Sihanoukville	**Under Construction**	2006	2013
Rural Electrification Project	Kampot, Siem Reap, Kandal and Takeo	**Extension of T/L**	--	**FS**	2012 or 2013	2017 or 2018

Source: ADB

2.10.3 Trend in support from Korea

Korea International Cooperation Agency (KOICA) provides strategic support in four areas, i.e., infrastructure, rural development, human resource development, and health and amongst these, it mainly focuses on roads and renewable energy sources at present. The renewable energy source project is offered gratuitously and ordered to the contracter at full turnkey.
MIME has indicated that hydropower stations to be completed in the next 5 years will be able to provide sufficient electricity supply nationwide up until the year 2017 and that it is possible to export electricity to Vietnam and Thailand. KOICA projects that although the supply capacity improves with the said hydropower stations, delayed installation of transmission lines can cause non-electrification in some part of Cambodia. Thus, Cambodia plans to have a model project in the field of renewable energy source development for continuous economic evolution. More specifically, Cambodia aims to support the consolidation of energy foundation in rural and impoverished areas thorough the development of renewable energy sources such as solar energy generation. The hybrid power systems (solar energy/diesel/battery) are under construction in Kampot and Siem Reap. Additionally, a new solar energy project has started in Siem Reap.

Table 2-43 Projects supported by KOICA

Program Name	Province	Type	Major Support Contents and Effectiveness by the Support [1)]	Stage	Start Year	End Year
Establishment of Hybrid(PV/Diesel/Batteries) Power System	Kampot(Koh Sla), Siem Reap(Phnom Kulen)	**Solar**	Support Contents - Kampot (PV 60kW, Diesel 30kW, Batteries 288kWh) - Siem Reap (PV 30kW, Diesel 20kW, Batteries 144kWh)	**UnderConstruction**	2010	2012
Solar Electrification Project on the Basis of Photovoltaic Generation System	Siem Reap(Kan Chun Run)	**Solar**	Support Contents - PV 100kWp, Diesel 50kW - T/L	**Pre FS**	2012	2014

Source: KOICA

A multi-purpose-like dam using an irrigation facility is under development with the aid of loans from Korea. This project is named "Kran Ponley Water Resources Development Project," and is located west of the Kampong Chhnang province. The project involves irrigation water management with 3 dams and 3 water gate facilities. The An Long Chrey station (maximum output: 170kW) and the Krapeu Truom station (maximum output: 30kW) are scheduled to be built at 2 of the 3 dams and are expected to commence operation in early 2012.

2.10.4 Trend in the KfW support

In Cambodia, Kreditanstalt für Wiederaufbau (KfW) focuses on rural development and health as its priority areas. Regarding the power sector, KfW is conscious of expensive electricity tariff and power supply shortage; it runs the transmission line project of 230 kV in the southwest area in the rural development, promoting rural electrification mainly by expanding grid around the transmission channel of the area.

2.10.5 Trend in support from China

As for power supply development, development information is mainly on the large-sized hydropower of BOT scheme developed by a Chinese private company represented by Kamchay hydropower station ready for the operation, as in Table 2-38. There is no specific information on the rural electrification plan using a micro hydropower or other technical option. Nevertheless, Kamchay hydropower station supplies electricity to the near 22 kV transmission line by a power generator of small capacity provided in the same area. In the plan, all of the other hydropower stations are supposed to supply electricity to the 115 kV transmission line or the 230 kV transmission line. Most of the large-sized power stations waiting for the operation are planned by China, which implicitly shows a big presence of China in the Cambodian power sector.
Whereas for the transmission line development, most projects are run by private companies, where the transmission lines are developed by the BOT scheme to connect the hydropower station to develop to the HV transmission system (National Grid, NGD) as shown in Table 2-40.
Furthermore, through loans from the Export-Import Bank of the Republic of China, regional electrification via EDC is planned for four regions.

2.11 Rural Electrification

On November 30, 2011, RGC issued the "Strategy and Plan for Development of Rural Electrification in the Kingdom of Cambodia (SPDRE)", a specific strategy and plan to achieve essential targets for rural electrification as PRAKAS (ministry ordinance). This plan was discussed by MIME, EAC, REF, and EDC based on the result obtained by the cooperation of international organizations, and set up as the national goal according to SPRDRE. Under this plan, each organization is supposed to make an action for the targets below:

① For village area, achievement of rural electrification rate of 100% including battery illumination by 2020
② For household electrification, achievement of electrification rate of at least 70% by the grid quality electricity by 2030

Here describes the current status of rural electrification, SPDRE, and other references.

2.11.1 Current status and policies

(1) Summary of Cambodia

According to the latest population census surveyed in 2008, 14,073 Villages were confirmed in 1,417 Communes and 204 Sangkat (Table 2-44).
Population of Cambodia is shown in Table 2-45 along with neighboring countries. The population of Cambodia is approximately 13 million and the growth rate is approximately 1.5%. Amongst other Southeast Asian countries, Cambodia is less populated but the population growth is average.

Table 2-44 Findings of the 2008 General Population Census of Cambodia

No.	Contents	Number	Remarks
1	Number of Municipality	1	Phnom Penh
2	Number of Provinces	23	
3	Number of Districts	159	within 23 Provinces
4	Number of Khans	8	within Phnom Penh Municipality
5	Number of Cities	26	within 23 Provinces
6	Number of Communes	1,417	within 159 Districts
7	Number of Sangkats	204	within Phnom Penh and Krongs
8	Number of Villages	14,073	within Communes and Sangkats

Source: 2008 General Population Census of Cambodia (CMB2008),March 2008

Table 2-45 Population Growth Rate in South East Asia

Name of the country	Population in mid-2008 (in thousands)	Annual Growth Rate (percent)
Southeast Asia	576,637	1.2
Brunei Darussalam	398	2
Cambodia	13,396	1.5
Indonesia	234,342	1.1
Lao People's Democratic Republic	5,983	1.7
Malaysia	27,663	1.8
Myanmar	49,221	0.8
Philippines	90,457	2
Singapore	4,490	1.2
Thailand	63,121	0.4
Timor-Leste	1,193	3.5
Vietnam	86,373	1.3

Note: For all countries except Cambodia the source for the data is 2008 ESCAP Population Data Sheet, Bangkok, 2008. Cambodia's population is as per the 2008 Census.

Source: 2008 General Population Census of Cambodia (CMB2008),March 2008

Provinces studied in this report, Mondul Kiri and Ratanak Kiri, account for lower percentages of the total population of Cambodia (ranked as the 23rd and the 19th, respectively, of all 24 provinces including 23 provinces + Phnom Penh, Table 2-46); however, population growth rates are approximately four times more than the average rate of entire Cambodia (ranked as the 3rd and the 4th,Table 2-47).

Although populations are growing, absolute numbers are small and prioritization of electrification of these provinces may be low. However, due to the high growth rates, the need for electrification is expected to increase further.

Table 2-46 Population Ratio by Province

Rank in 2008	Province/ Municipality	Percent to total population of		Rank in 1998
		1998	2008	
1	Kampong Cham	14.07	12.54	1
2	Phnom Penh	8.74	9.91	3
3	Kandal	9.4	9.45	2
4	Battambang	6.93	7.65	5
5	Prey Veng	8.27	7.07	4
6	Siem Reap	6.09	6.69	7
7	Takeo	6.91	6.31	6
8	Kampong Speu	5.24	5.35	8
9	Banteay Meanchey	5.05	5.06	9
10	Kampong Thom	4.98	4.71	10
11	Kampot	4.62	4.37	11
12	Svay Rieng	4.18	3.6	12
13	Kampong Chhnang	3.65	3.53	13
14	Pursat	3.15	2.96	14
15	Kratie	2.3	2.38	15
16	Preah Sihanouk	1.5	1.65	16
17	Otdar Meanchey	0.6	1.39	21
18	Preah Vihear	1.04	1.28	17
19	Ratanak Kiri	0.82	1.12	19
20	Koh Kong	1.01	0.88	18
21	Stung Treng	0.71	0.83	20
22	Pailin	0.2	0.53	24
23	Mondul Kiri	0.28	0.46	22
24	Kep	0.25	0.27	23

Note: 1998 and 2008 Populations of Koh Kong and Preah Sihanouk provinces are for areas according to the new frame. Ranks are based on these populations.

Source: 2008 General Population Census of Cambodia (CMB2008),March 2008

Table 2-47 Population Growth in Cambodia

Province	Cambodia- Total Population		Annual Growth Rate (percent)
	1998	2008	
Cambodia- Total	**11,437,656**	**13,395,682**	**1.54**
Banteay Meanchey	577,772	677,872	1.56
Battambang	793,129	1,025,174	2.56
Kampong Cham	1,608,914	1,679,992	0.43
Kampong Chhnang	417,693	472,341	1.22
Kampong Speu	598,882	716,944	1.79
Kampong Thom	569,060	631,409	1.03
Kampot	528,405	585,850	1.03
Kandal	1,075,125	1,265,280	1.62
Koh Kong	116,061	117,481	0.12
Kratie	263,175	319,217	1.93
Mondul Kiri	32,407	61,107	6.34
Phnom Penh	999,804	1,327,615	2.83
Preah Vihear	119,261	171,139	3.61
Prey Veng	946,042	947,372	0.01
Pursat	360,445	397,161	0.69
Ratanak Kiri	94,243	150,466	4.67
Siem Reap	696,164	896,443	2.52
Preah Sihanouk	171,735	221,396	2.54
Stung Treng	81,074	111,671	3.2
Svay Rieng	478,252	482,788	0.09
Takeo	790,168	844,906	0.66
Otdar Meanchey	68,279	185,819	8.64
Kep	28,660	35,753	2.21
Pailin	22,906	70,486	11.24

Source: 2008 General Population Census of Cambodia (CMB2008),March 2008

(2) Current status of rural electrification

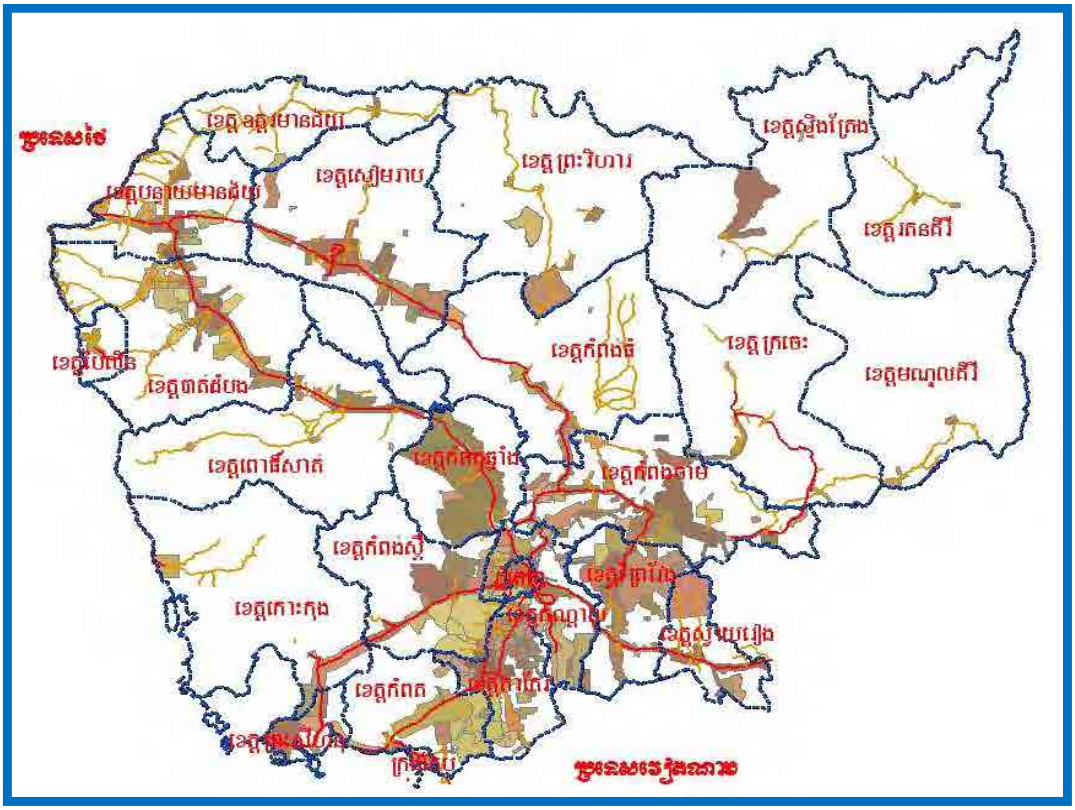
In the past, the RGC has worked on ① restoration and expansion of the electricity supply system in Phnom Penh, other cities and district towns, ② small scale import of electricity on a district town level in areas close to the border, ③ development of isolated mini-grids using diesel generators and renewable energy, ④ commencement of construction of coal fired power stations using imported coals and hydropower stations, ⑤ construction of substations and transmission lines for expansion of HV transmission lines and interconnections, and ⑥ expansion of NGD for progressive electrification of rural areas. In areas where government electricity supply is unavailable, distribution licenses have been provided to private sectors which cover approximately 51% of entire Cambodia as of late 2010.

Table 2-48 Number of electrified villages

No.	Name of Province	Total Number of Villages	Number of Villages Electrified	Percent of villages Electrified [%]
1	Banteay Meanchey	633	248	39.18
2	Battambang	749	439	58.61
3	Kampong Cham	1,768	1,010	57.13
4	Kampong Chhanang	557	234	42.01
5	Kampong Speu	1,358	719	52.95
6	Kampong Thom	737	203	27.54
7	Kampot	482	341	70.75
8	Kandal	1,087	979	90.06
9	Kohkong	118	33	27.97
10	Kratie	250	77	30.80
11	Mondolkiri	90	12	13.33
12	Phnom Penh	692	692	100.00
13	Preah Vihear	208	25	12.02
14	Prey Veng	1,137	463	40.72
15	Pursat	501	131	26.15
16	Ratanakiri	240	19	7.92
17	Siem Reap	923	362	39.22
18	Preah Sihanouk	108	89	82.41
19	Steung Treng	128	27	21.09
20	Svay Rieng	690	126	18.26
21	Takeo	1,116	720	64.52
22	Oddor Meanchey	231	52	22.51
23	Kep	16	11	68.75
24	Pailin	79	51	64.56
	Total	**13,898**	**7,063**	**50.82**

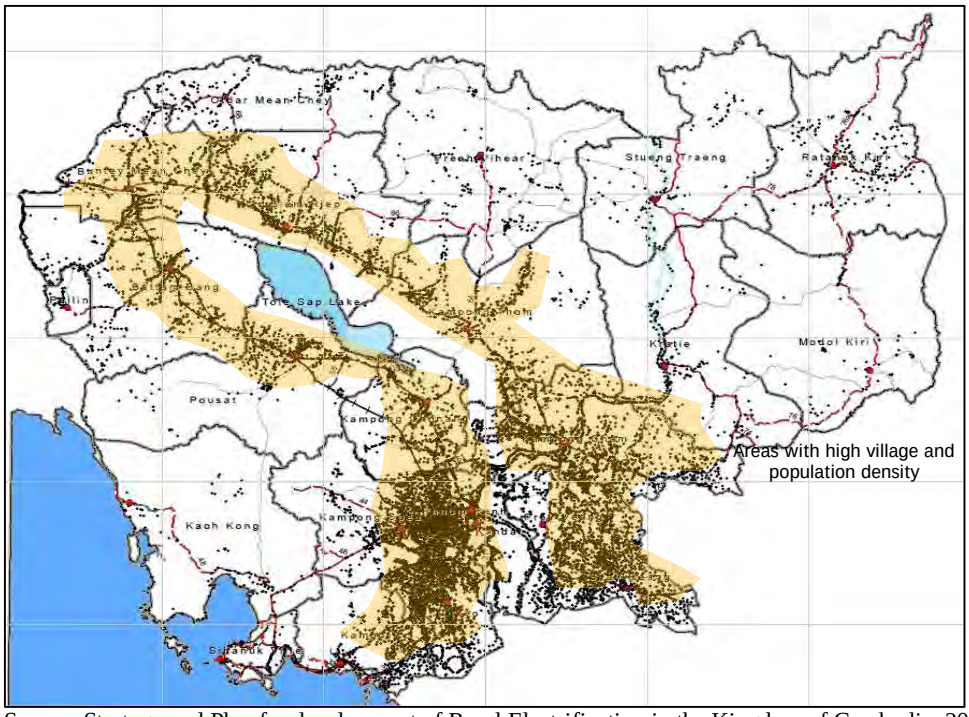
Source: Survey team

Although villages are licensed areas, not the entire villages may be electrified in a number of these private sector-led distribution networks. Additionally, many of these distribution networks use diesel generators and the cost of electricity is very high. Areas HV are permitted at the moment and population densities (location of Villages) are shown in Figure 2-42 and Figure 2-43. According to the statistics, at the end of year 2010, 1,491,140 households of 7,061 Villages fall into the licensed area, but only 561,519 households (37.65%) are connected to a system.



Source: Strategy and Plan for development of Rural Electrification in the Kingdom of Cambodia, 2011

Figure 2-42 Licensed Area in Cambodia



Source: Strategy and Plan for development of Rural Electrification in the Kingdom of Cambodia, 2011

Figure 2-43 Figure Villages

Table 2-49 Electrification Rate of Cambodia

Total	Urban	Rural
26.4	87.0	13.1

Source: 2008 General Population Census of Cambodia (CMB2008),March 2008

Table 2-50 Electrification Rates of Neighboring Countries

Country	Cambodia	Singapore	Malaysia	Thailand	Philippins
Electrification Ratio	**17.2**	**100**	**93.5**	**85.8**	**73.0**

Country	Indonesia	Vietnam	Laos	Myanmar
Electrification Ratio	**65.8**	**95.0**	**69.3**	**25.7**

Source: Statistics of Asian Countries, JEPIC, 2010

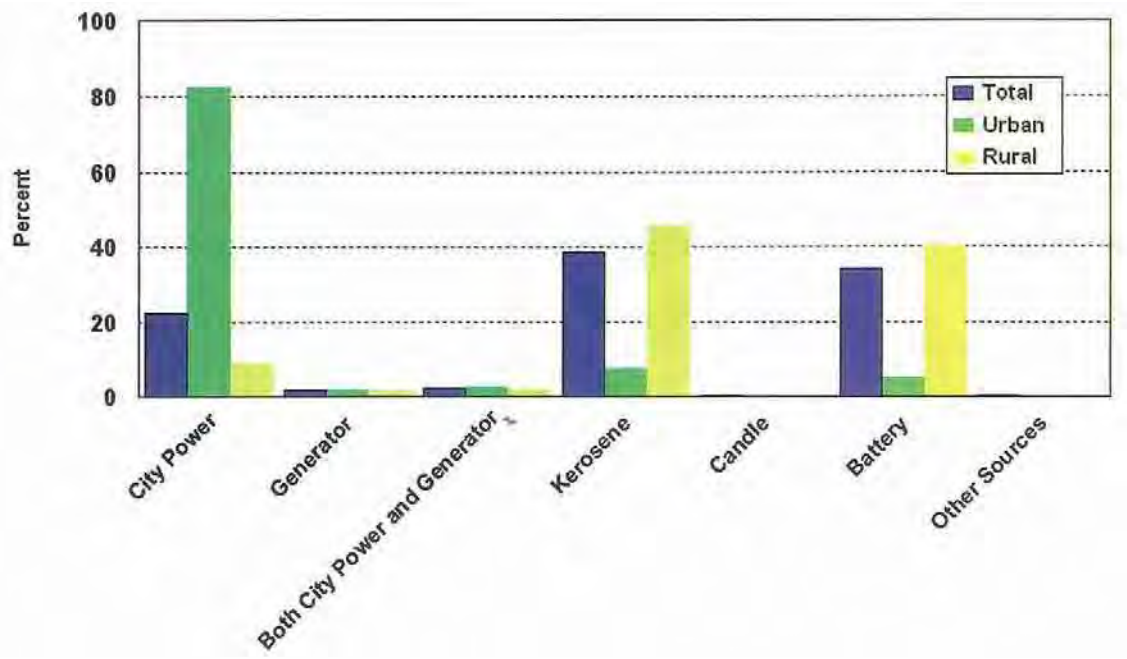
The electrification rates of Cambodia surveyed by the Census 2008 are shown in Table 2-49. Electrification rates in the metropolitan area, rural area, and the entire Cambodia are 87%, 13%, and 26.4%, respectively. The electrification rates of Cambodia in 2009 and the neighboring countries calculated by the number of consumers divided by the number of households are shown in Table 2-50. The electrification rate of Cambodia is extremely low compared to the neighboring countries.
Proportions of light sources in 1998 and 2008 are shown in Table 2-51 and Figure 2-44. In 2008, the proportions of electricity (except for batteries) used as the light source, i.e., the electrification rates, were over 80% in metropolitan areas (60% in 1998) and approximately 10% in rural areas (5% in 1998). As for use of batteries in 1998 and 2008, usages in metropolitan areas were 3% and 5%, respectively, and that in rural areas were 4 and 40%, respectively, indicating a great increase. The proportion of battery use can be interpreted as the index for possible electrification by mini-grids in the MP 2006. This increase may also mean that rural areas are ready to be electrified.

Table 2-51 Proportion of Households by Main Source of Light Used, Cambodia 1998 and 2008

Total/ Urban/ Rural	Year	Number of Households	Total	City power	Gene-rator	Both city power and generator	Kero-sene	Candle	Battery	Other Sources
Total	1998	2,162,086	100%	12.56%	1.0%	1.56%	79.86%		3.56%	1.47%
	2008	2,817,637	100%	22.47%	1.7%	2.20%	38.61%	0.41%	34.06%	0.53%
Urban	1998	364,581	100%	56.89%	2.1%	3.86%	33.48%		2.95%	0.74%
	2008	506,579	100%	82.53%	1.9%	2.65%	7.40%	0.38%	5.03%	0.15%
Rural	1998	1,797,505	100%	3.56%	0.8%	1.09%	89.28%		3.69%	1.61%
	2008	2,311,058	100%	9.31%	1.7%	2.10%	45.46%	0.41%	40.42%	0.61%

Note: In 1998, "Candle" was not shown separately as source of light
It was included with "other source"

Source: General Population Census of Cambodia 2008



Source: General Population Census of Cambodia 2008

Figure 2-44 Proportion of Households by Main Light and by Residence, Cambodia 2008

Table 2-52 shows proportions of light sources by provinces in 1998 and 2008. In the Mondulr Kiri province, electrification largely progressed from 9% to 25% from 1998 to 2008. The electrification rate in 2008 was slightly below the national average. However, the supply capacity has been enhanced following the Census survey in relation to the completion of O'Moleng and O'Romis hydropower stations in November 2008 (gratuitously supported by Japan) and the operation of the 22kV tie lines with Vietnam. As a result, the current electrification rate is thought to be increased further. When electrifying this province, analysis that reflects the impact of the changes will be needed. In the Ratanak Kiri province, the electrification rate increased from 15% to 22% from 1998 to 2008. Use of batteries also increased from almost no use in 1998 to 12% in 2008. Since the electrification rate is lower than that of the national average and the battery usage has greatly increased, this province may be growing suitable for rural electrification.

Table 2-52 Proportion of Households in Provinces by Main Source of Light Used, Cambodia in 1998 and 2008

Code	Province	Year	Number of Households	Total	Main Source of Light (%)							
					City power	Gene-rator	Both city power and enerator	(Sub-total)	Kero-sene	Candle	Battery	Other Sources
	Cambodia	1998	2,162,086	100	12.56	0.99	1.56	(15.11)	79.86		3.56	1.47
		2008	2,817,637	100	22.47	1.72	2.20	(26.39)	38.62	0.41	34.06	0.53
1	Banteay MeanChey	1998	110,994	100	8.19	1.14	2.75	(12.08)	84.62		2.86	0.44
		2008	144,658	100	26.19	2.23	2.03	(30.45)	50.82	0.39	18.31	0.03
2	Battambang	1998	146,661	100	10.01	1.39	2.51	(13.91)	83.19		2.69	0.20
		2008	209,702	100	21.13	1.94	2.01	(25.08)	55.34	0.79	18.75	0.05
3	Kampong Cham	1998	311,151	100	9.25	0.98	1.48	(11.71)	82.70		5.33	0.27
		2008	368,114	100	14.19	1.60	2.07	(17.86)	34.54	0.33	47.17	0.09
4	Kampong Chlmang	1998	81,201	100	4.62	0.68	0.75	(6.05)	89.93		3.86	0.17
		2008	100,801	100	9.13	1.22	1.70	(12.05)	54.65	0.20	33.08	0.03
5	Kampong Spueu	1998	114,959	100	2.57	0.74	0.66	(3.97)	94.92		0.97	0.14
		2008	149,270	100	9.13	1.05	0.92	(11.10)	40.43	0.27	48.16	0.04
6	Kampong Thom	1998	105,583	100	5.32	0.44	1.01	(6.77)	89.39		1.44	2.39
		2008	133,878	100	9.17	0.84	1.96	(11.97)	54.86	0.19	32.00	0.98
7	Kampot	1998	104,498	100	4.91	0.79	1.09	(6.79)	92.48		0.66	0.07
		2008	129,646	100	10.83	1.23	0.81	(12.87)	54.14	0.27	32.67	0.04
8	Kandal	1998	203,357	100	9.42	0.98	2.45	(12.85)	78.11		8.86	0.18
		2008	255,029	100	27.12	3.11	6.87	(37.10)	14.79	0.27	47.78	0.05
9	Koh Kong	1998	21,401	100	28.70	4.68	8.21	(41.59)	56.22		0.78	1.41
		2008	24,166	100	40.04	4.91	3.37	(48.32)	42.85	0.84	7.79	0.20
10	Kratie	1998	48,761	100	9.51	1.73	2.25	(13.49)	80.83		4.14	1.54
		2008	65,323	100	12.44	1.26	0.64	(14.34)	48.84	0.44	36.01	0.36
11	Mondul Kiri	1998	5,615	100	2.83	2.05	3.70	(8.58)	47.93		1.53	41.96
		2008	12,270	100	13.17	5.00	7.31	(25.48)	53.16	3.29	13.34	4.72
12	Phnom Penh	1998	167,758	100	75.50	1.86	2.76	(80.12)	17.52		1.50	0.85
		2008	250,597	100	89.82	1.83	3.11	(94.76)	1.74	0.29	2.94	0.26
13	Preah Vihear	1998	21,007	100	1.68	1.19	0.76	(3.63)	45.85		0.36	50.17
		2008	33,115	100	7.61	2.50	1.93	(12.04)	55.30	0.58	14.43	17.64
14	Prey Veng	1998	192,735	100	2.96	0.44	0.51	(3.91)	89.83		6.18	0.09
		2008	226,312	100	6.30	0.64	0.67	(7.61)	28.22	0.25	63.85	0.07
15	Pursat	1998	67,022	100	8.00	0.87	0.84	(9.71)	88.11		1.94	0.24
		2008	83,412	100	13.71	1.00	1.65	(16.36)	71.06	0.18	12.34	0.05
16	Ratanak Kikri	1998	16,646	100	12.77	0.83	1.26	(14.86)	42.09		0.34	42.71
		2008	27,485	100	15.54	4.62	1.53	(21.69)	55.92	2.36	12.87	7.16
17	Siem Reap	1998	125,387	100	7.61	0.75	1.12	(9.48)	88.81		1.62	0.09
		2008	179,754	100	20.09	1.88	1.45	(23.42)	57.90	0.28	18.37	0.04
18	Preah Sihanonk	1998	30,075	100	34.79	2.38	2.12	(39.29)	59.5		0.51	0.7
		2008	44,656	100	51.08	4.1	3.1	(58.28)	32.97	1.17	7.51	0.08
19	Stung Treng	1998	14,126	100	11.67	1.49	0.93	(14.09)	60.47		1.73	23.72
		2008	20,922	100	16.59	3.62	1.92	(22.13)	59.48	0.9	5.34	12.15
20	Svay Ricng	1998	97,796	100	3.5	0.49	0.74	(4.73)	91.35		3.8	0.13
		2008	114,758	100	10.49	1.07	0.56	(12.12)	32.67	0.18	54.94	0.09
21	Takeo	1998	153,863	100	3.35	0.47	0.7	(4.52)	92.72		2.71	0.06
		2008	183,742	100	9.59	0.88	1.31	(11.78)	34.52	0.23	53.39	0.09
22	Otdar Meanchey	1998	12,208	100	1.82	0.62	0.19	(2.63)	96.2		1	0.17
		2008	38,398	100	12.77	2.16	2.69	(17.62)	58.22	1.02	22.18	0.95
23	Kep	1998	5,282	100	4.92	1.86	2.37	(9.15)	89.68		1.12	0.06
		2008	7,193	100	14.33	2.82	2.31	(19.46)	64.1	0.36	16.07	0
24	Pailin	1998	4,000	100	11.13	8.18	3.85	(23.16)	69.83		2.35	4.68
		2008	14,436	100	37.69	2.87	2.14	(42.70)	38.02	4.7	14.5	0.09

Note: In 1998, "Candle" was not shown separately as source of light. It was included with "other source"

Source: General Population Census of Cambodia 2008

(3) Rural electrification policy

The fundamental policy of rural electrification is described in "Power sector strategies in Cambodia: 1999-2016" issued in 1999 as follows:

① Promote a well-balanced development for provinces at various stages of economic growth
② Adopt the scheme with the most cost effective and the best economic internal rate of return (EIRR)
③ Prepare to supply electricity for the appropriate number of Villages in a province

In response, MIME has set the following goals based on "Final Report on RE Strategy and programme" drafted by MERITEC by the WB support in 2001:

① Electrify 70% of rural households by the year 2030
② Electrify 90% of Villages by the year 2030 (Village electrification here means to electrify most community structures and 50% of households)

The RGC has set the following two phases as the rural electrification targets and Cambodian rural electrification activities thereafter have been performed on the basis of these phases.

① Achieve the village electrification rate of 100% by the year 2020, including lights using batteries
② Achieve the household electrification rate of 70% by the year 2030 with the grid quality

In the electric power policy section of "NATIONAL STRATEGIC DEVELOPMENT PLAN UPDATE 2009-2013" issued in 2010 by the RGC, it has been stated that the rural electrification shall be led by private enterprises in accordance with the Electricity Law. SPDRE, which is the specific strategic plan for achieving rural electrification targets, has been prepared by MIME, EAC, REF, and EDC on the basis of the discussion held by international organizations (Table 2-53). This strategic plan has gone effective as a ministerial ordinance (PRAKAS) on November 30, 2011. The ministerial ordinance consists of Introduction and seven Chapters, including coordination of past rural electrification-related activities, analysis of current status, strategies and plans for achieving aforementioned goals, and how to determine electricity tariffs (Table 2-54).

Table 2-53 Studies on the Rural Electrification Development

No.	Project	Fund	Implementation Agency	Period
1	Master Plan for development of Rural Electrification in the Kingdom of Cambodia by expansion of the electricity network from the national grid and by development of renewable energy sources	JICA	Nippon Koei Co., Ltd	Oct. 2004 - Jun 2006
2	Strategy and Implementation Plan for Rural Electrification Development in Cambodia	World Bank	AECOM NZ New Zealand Limited	Jul. 2009 - Dec. 2009
3	Sustainable Rural Electrification Plans for Cambodia	Government of France	Innovation Energie Dévelopment (IED)	2009 - April 2011

Source: Strategy and Plan for development of Rural Electrification in the Kingdom of Cambodia, 2011

Table 2-54 Contents of "Strategy and Plan for Development of Rural Electrification in the Kingdom of Cambodia"

Introduction
Chapter 1 : Achievement, Possibilities and Major challenges in Development of Rural Electrification in Cambodia
1.1 Achievement so far
1.2 Possibilities in Development of Rural Electrification
1.3 Major Challenges in Development of Cambodia Rural Electrification
Chapter 2 : Goal of the Rural Electrification Development Program in the Kingdom of Cambodia
Chapter 3 : Strategy for Rural Electrification Development in Cambodia
3.1 Strategy for resolution of electricity supply to rural areas in Cambodia
3.2 Strategy for allocating responsibilities for development of infrastructure for electricity supply in rural areas
3.3 Strategy for assigning the responsibility for planning of development of electricity supply infrastructure in rural areas
3.4 Scenarios of rural electrification development in Cambodia
Chapter 4 : Plan for Development of Rural Electrification in Cambodia
4.1 Decision on pace of extension of electricity supply from national grid to prepare the plan for rural electrification development in Cambodia
4.2 Plan for rural electrification development in Cambodia
4.2.1 Grid Extension Plan
4.2.2 Mini-grid Plan
4.2.3 Stand-alone Systems Plan
4.2.4 Plan for Development of Rural Electrification throughout Cambodia
Chapter 5 : Participation of EDC and Mobilization of Funds for Development of Rural Electrification in Cambodia
5.1 Participation of EDC
5.2 Mobilization of fund for Development of Rural Electrification in Cambodia
Chapter 6 : Tariff setting and Subsidy for Rural Areas
6.1 Policy for Tariff Setting
6.1.1 General Policy
6.1.2 Structure of electricity supply and tariff setting for the supply system connected to national grid
6.1.3 Policy for tariff setting for bulk sale from grid substation
6.1.4 Policy for allocating the cost of sources of electricity
6.1.5 Policy for tariff setting for bulk sale from EDC's Sub-transmission
6.1.6 Policy for tariff setting for retail sale in urban area and provincial towns
6.1.7 Policy for setting tariff for retail sale to rural consumers
6.2 Subsidy mechanisms to reduce the tariff in rural areas
6.2.1 Capital subsidy
6.2.2 Method of providing subsidy from consumers in urban areas to consumers in rural areas through tariff setting
6.2.3 Review of electricity business conditions for smooth implementation of subsidy mechanism in electricity tariff for rural areas
6.2.4 Flow of electricity payment and flow of subsidy in the electricity business
6.2.5 Adjustment mechanism between electricity sale tariff and Subsidy in the business of EDC
6.2.6 Strategy for subsidized tariff to domestic households in rural areas
6.2.7 Method to provide subsidy fund for poor household in rural areas consuming electricity less than the threshold limit in a month
Chapter 7 : Rural Electrification Fund Mechanism
Source: Strategy and Plan for development of Rural Electrification in the Kingdom of Cambodia, 2011

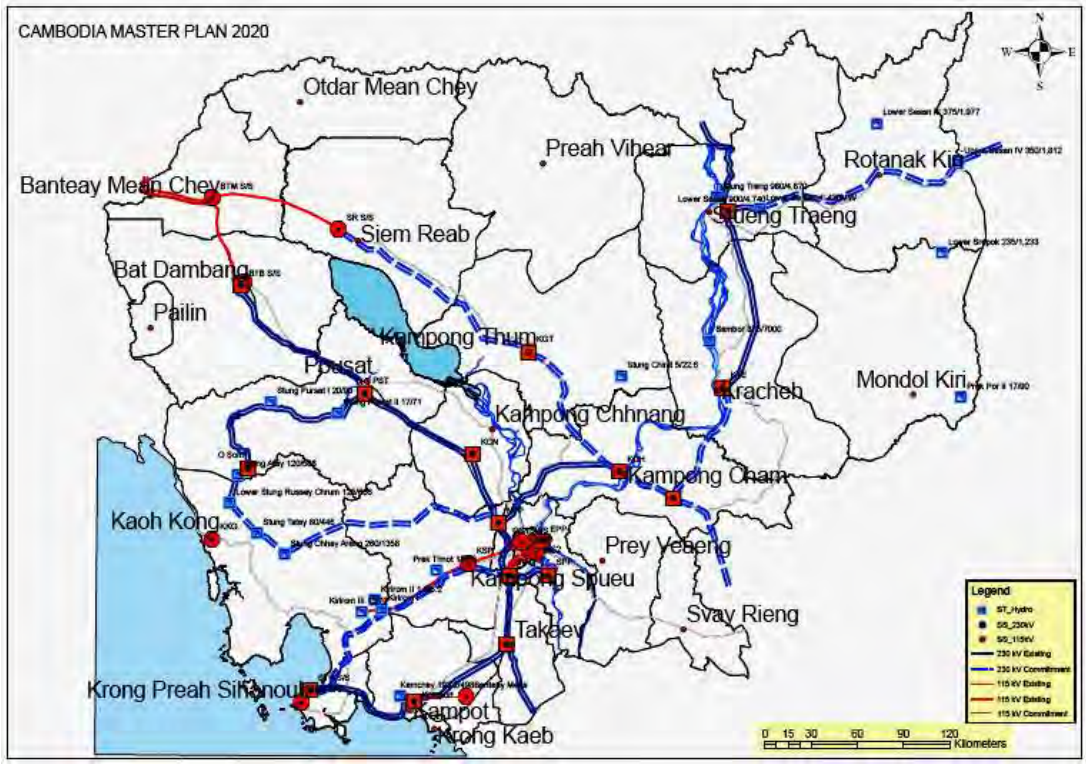
(4) Summary of SPDRE

Main contents of SPDRE on rural electrification planning are as follows.

a. Possibilities of rural electrification

The development of HV transmission system i.e. the "National Grid" will gradually establish grid substations in each district to provide an outlet for supplying electricity from national grid. The grid substations are to be located in the central area of each province to facilitate the development of sub transmission system to transmit electricity from national grid to rural areas. The projects for expansion of electricity supply from national grid and from networks importing electricity from neighboring countries to the rural areas are to be implemented as first priority, as they will provide electricity supply of better quality inexpensively compared to the supply from the existing diesel generators. The planned expansion of the national grid until 2020 is shown in Figure 2-45.

In the past, when the transmission lines were not yet developed, MIME and EAC decided to provide concessions to private enterprises to invest on mini-grids using diesel generators to supply electricity to rural areas. The electricity tariffs in these areas depend on the variation in the fuel price and at present, it is in the range of 2,600 Riels to 3,600 Riels/kWh. With the gradual expansion of national grid, the supply from diesel generators is being replaced by supply from national grid, thereby lowering the electricity tariff to the range of 1,100-1,250 Riels/kWh. In the absence of any subsidy mechanism, this tariff is still higher than the affordability limit of many. However, since it is yet lower than the present tariff, it should facilitate the rural electrification development.



Source: Strategy and Plan for development of Rural Electrification in the Kingdom of Cambodia, 2011

Figure 2-45 Map showing planned National Grid and Substations

b. Goals of RGC's upcoming actions

Fundamental goals of rural electrification are all villages to have access to electricity and all households to have access to electricity through the power supply system. In order to achieve these goals, the electricity infrastructure for rural electrification is needed.

After the placement of the electricity infrastructure, whether a household can be connected to the distribution network and the ability to pay the electricity tariff would be questioned. In addition to the difficulties with the connection to the distribution network and the purchasing power, the cost of electricity supply per household will be high in rural poverty areas, since demands are spread out compared to metropolitan areas.

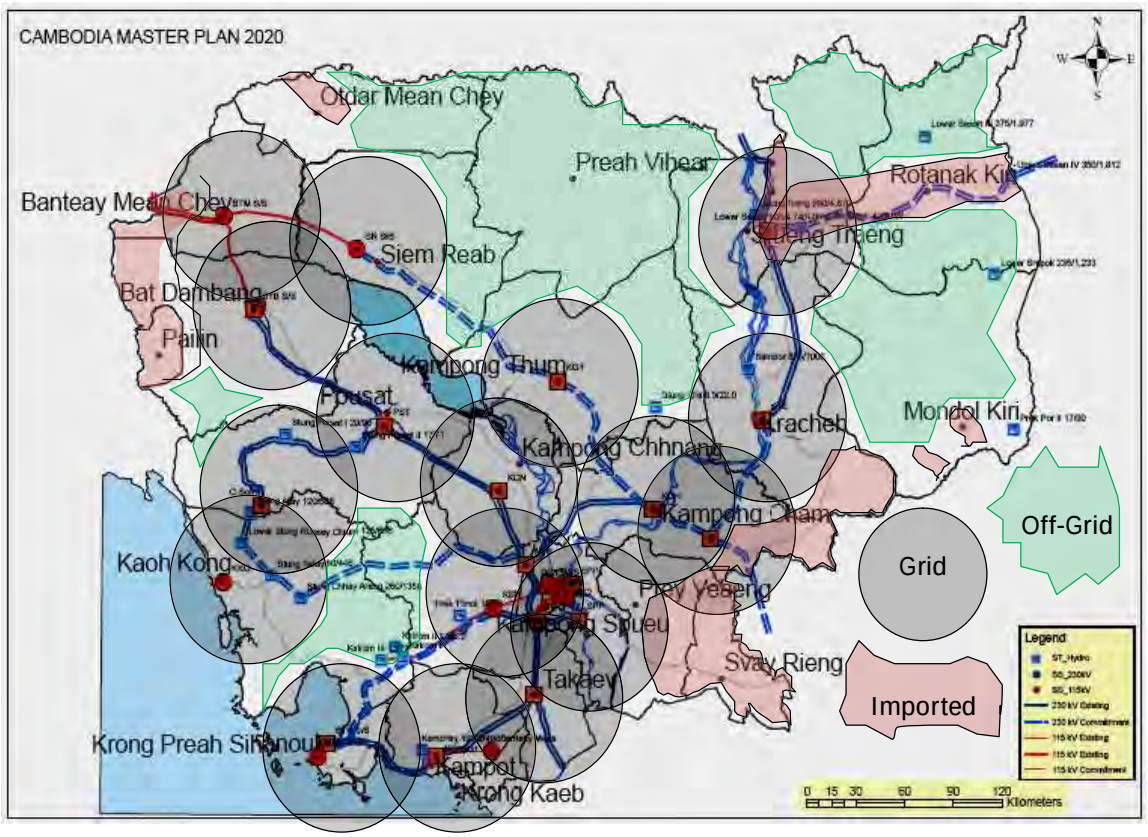
Electricity enterprises already exist in many rural areas due to executing projects previously, and the electricity tariffs are set up individually. When the electricity supply becomes available from the expansion of national grid in these areas, the electricity will be supplied via MV transmission lines of the existing enterprises and the cost for transmission and distribution will be added to the electricity tariffs. The cross subsidy mechanism will be necessary to make adjustment to keep the cost low in these areas.

c. Rural electrification strategy in Cambodia

(a) Electricity supply strategy for Villages

Electricity supplies for Villages are mainly classified as ① grid extension plan: within the range of the national grid expansion, ② mini grid plan: use of mini-grids in areas outside of the range of the national grid expansion, and ③ stand-alone systems plan: use of the stand-alone system in the areas where neither ① nor ② are applicable. The grid extension plan is to supply expansion through the extension of the national grid. The mini grid plan is to generate isolated power in small-scale systems not connected to the national grid. The stand-alone systems plan is to supply electricity directly to households through BCS and SHS.

In rural electrification, the grid extension plan that is most reliable and inexpensive is prioritized. Areas with the potential of supply by grid extension are called "grid extension areas" and the remaining areas are called "off-grid extension areas". "Grid extension area" is the area within the circle with diameter of 50 km around the grid substation. Figure 2-46 shows the projection of the areas in the year 2020.



Source: Strategy and Plan for development of Rural Electrification in the Kingdom of Cambodia, 2011

Figure 2-46 Map showing the Grid and Off-Grid areas in 2020

For supply of electricity to "off-grid extension areas", first step will be to examine the possibility of establishing a mini-grid which uses micro hydropower, biomass energy, wind energy, and solar energy. If supply is found to be non-feasible by any of the above sources, introduction of SHS or establishment of BCS will be examined. The examination shall be implemented by MIME in cooperation with EAC and REF.

(b) Responsibilities for the development of infrastructure for electricity supply in rural areas

For sub transmission projects MIME has already provided concession to some private companies, some have started supplying electricity to rural areas with the permission from EAC and others are under construction. EDC is the only entity responsible for operating the national grid and for purchasing and selling electricity on the national grid and capable to operate the cross subsidy mechanism to provide subsidy from urban areas to rural areas. Thus, the best strategy may be that EDC is made responsible for bulk sale of electricity from the grid substation and also from the sub transmission to all rural distribution areas throughout the country. This way, all areas will have the opportunity to receive bulk power at the same or similar bulk tariff and the concession holders are to be issued new licenses and allowed to make investment. However, EAC shall examine the future and allow the private enterprises to continue to operate the sub-transmission system only if the sub-transmission fee of these operators is equal or lower than sub transmission fees of EDC throughout the country. In such cases, these private enterprises can receive the sub transmission fees based on their investment. If the sub transmission fee of any private project is found to be higher than EDC's sub transmission fees, the private enterprise may be required to transfer or lease this sub transmission system to EDC. The purpose of such requirement is to include the cost of this sub transmission system in calculating the sub transmission fees of EDC on the basis of the average cost of sub-transmission.

Approval of new sub transmission licenses to the private sector will be limited to cases where

EDC does not have the technology to develop and EDC does not have the intention to develop it. MIME and EAC should examine before issuing any license whether the level of the sub transmission fees in future can be equal or lower than the sub transmission fees of EDC throughout the country. For smooth achievement of these goals, EDC should develop the sub transmission network from the grid substations according to the plan in a timely manner.

If part of the 22kV distribution line of the private sector is required to be used as the sub transmission network, EDC should approach the private enterprise to either transfer or give on hire this main 22kV network to EDC, so that the bulk sell management on the sub transmission network can be done. Term and conditions of transfer or hire of the network should be made as per business model and EAC's approval will be required. If neither transfer nor give on hire is possible, EDC may examine the viability to construct new network.

Strategies for the distribution network development in rural areas that MIME, EAC, and DIME should promote are as follows:

(1) Encourage existing licensed enterprises to expand the distribution network including the adjacent urban areas as well as low population density areas. (Distribution license to new licensee should not be issued for small areas and areas in between existing distribution areas.)
(2) Concession and distribution license is issued to new private enterprises only for the remote rural areas which cannot be supplied by network expansion of the existing licensees due to technical limitations and there is no possibility of expansion of NGD to that area.
(3) If electricity is not supplied in a grid extension area, EDC shall have the obligation to develop distribution infrastructures to supply electricity in that area.

(c) Responsibilities for the planning of the development of electricity supply infrastructure in rural areas

Table 2-55 shows fundamental roles associated with the electricity supply plan in rural areas.

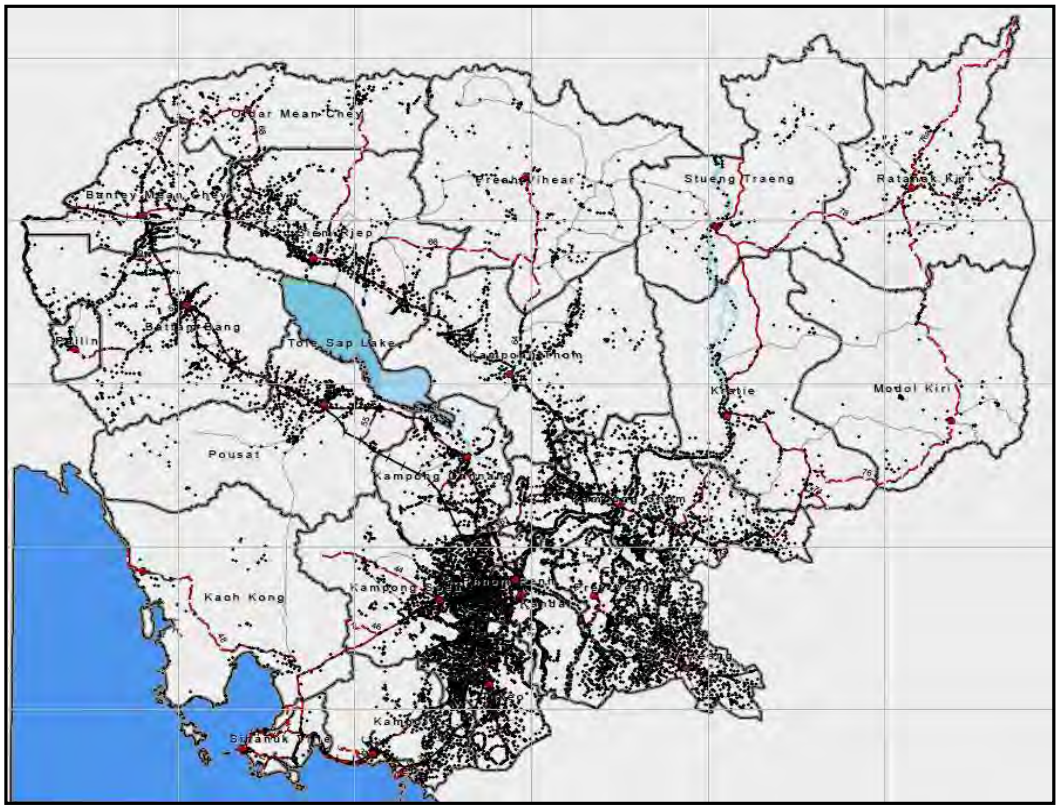
Table 2-55 Assignment to plan development of electricity supply infrastructure in rural areas

- Transmission development plan: duty of MIME in cooperation with EDC;
- Sub-transmission development plan: duty of EDC in cooperation with EAC;
- Plan for defining the direction of electricity supply development in off-grid areas: duty of MIME in cooperation with EAC and REF;
- Distribution network development plan in licensed areas: the duty of the respective distribution licensees in compliance with the conditions of the license issued by EAC; if the distribution area belongs to a private enterprise, this enterprise will prepare this plan; if the distribution area belongs to EDC, EDC will prepare this plan. This planning shall be in accordance with the agreement / commitment of the licensee with EAC.

Source: Strategy and Plan for development of Rural Electrification in the Kingdom of Cambodia, 2011

(d) Scenarios of rural electrification

In Cambodia, the number of Villages increased from 14,073 (2008) to 14,210 (2010) whereas the number of population and households increased from 13.4 million persons and 2,817,637 households (2008) to 14.1 million persons and 2,970,897 households (2010). As shown in Figure 2-47, Villages and population are concentrated around the Tonlé Sap Lake and the areas located along the Lower Mekong River. Such distribution and its growth every year has to be considered for planning the development of electricity supply. The plan should make it possible to achieve the target of rural electrification.

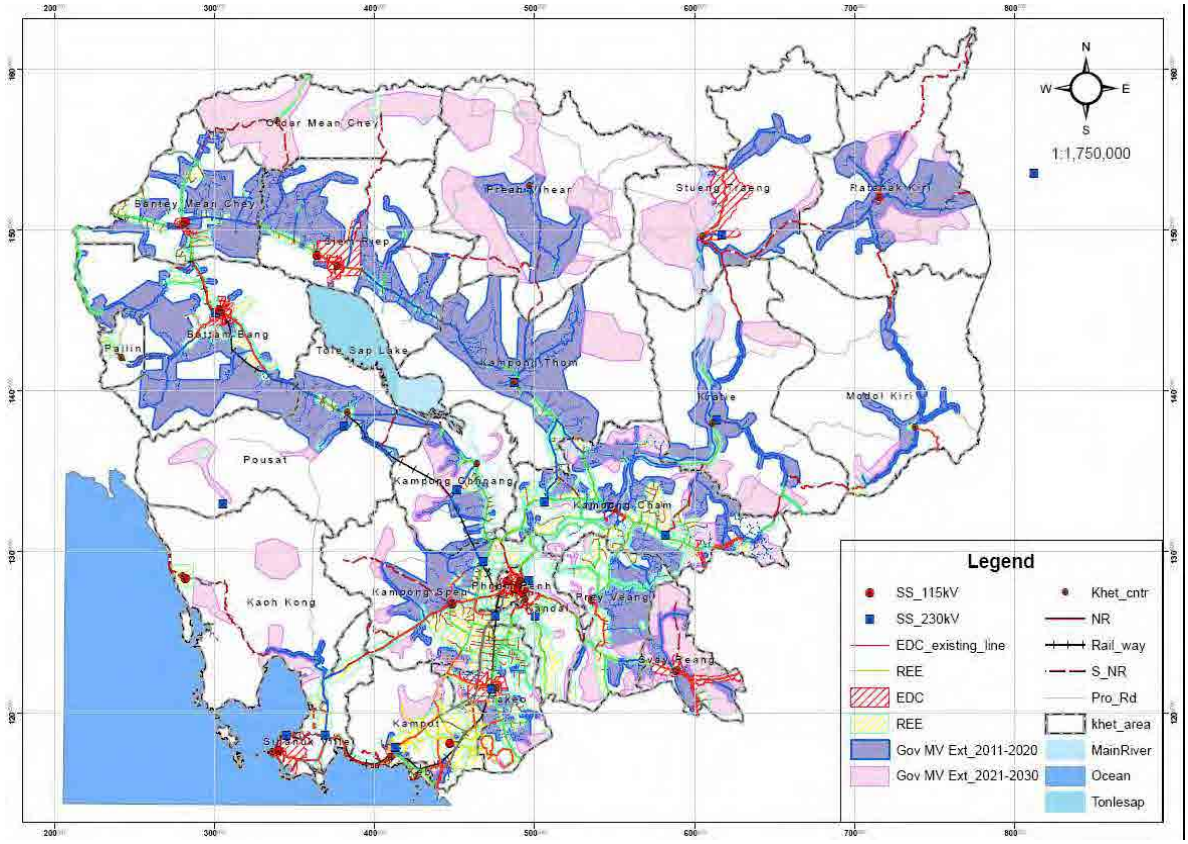


Source: Strategy and Plan for Development of Rural Electrification in the Kingdom of Cambodia, 2011

Figure 2-47 Location of villages in the Kingdom of Cambodia

The electricity supply from the national grid to rural areas was examined by EDC and EAC in relation to the grid extension which is considered the most effective option. When all required finance will be available as projected in the examination, it will be possible to cover about 80% of all villages by 2020 and 46% of households can have access to electricity from the national grid by 2020 and 70% of households by 2030. Figure 2-48 shows the grid extension project (2020 and 2030) generated as a result of the examination.

The study performed by the RGC with the aid of French government (the consultant was IED) evaluated the validity of these results for the possibility of achieving the rural electrification target. It has been concluded that the scenario with a slight change added to the results of this study should be effective in achieving the final goal of "at least 70 % of all households have access to grid quality electricity by the year 2030."



(Areas shown in Blue will be covered during 2011 to 2020 whereas Areas shown in Red will be covered during 2021 to 2030.)

Source: Strategy and Plan for development of Rural Electrification in the Kingdom of Cambodia, 2011

Figure 2-48 Extent of electricity supply from national grid in 2020 and 2030

d. Rural electrification plans in Cambodia

(a) Fundamental rural electrification plan

The scenario referred above has been recognized as the fundamental rural electrification plan for 2011-2030. MIME with the corporation of related organization is to review this plan every 2 years so that the rural electrification target can be achieved. Details of the fundamental plan are as follows:

- ✓ 80% of all Villages will receive electricity supply from the national grid or from neighboring countries between 2011 and 2020. The remaining 20% of Villages shall have access to electricity supplied from other sources, such as micro hydropower, biomass energy, diesel generation, SHS, and BCS installed within these Villages.
- ✓ 95% of all Villages will receive electricity supply from the national grid or from neighboring countries between 2021 and 2030. The remaining 5% shall have access to the grid quality electricity (24 hour supply) through mini-grids.

In achievement of these goals, the rural electrification plan of Cambodia consists of (1) grid extension project, (2) mini-grid development plan, and (3) stand-alone system development plan.

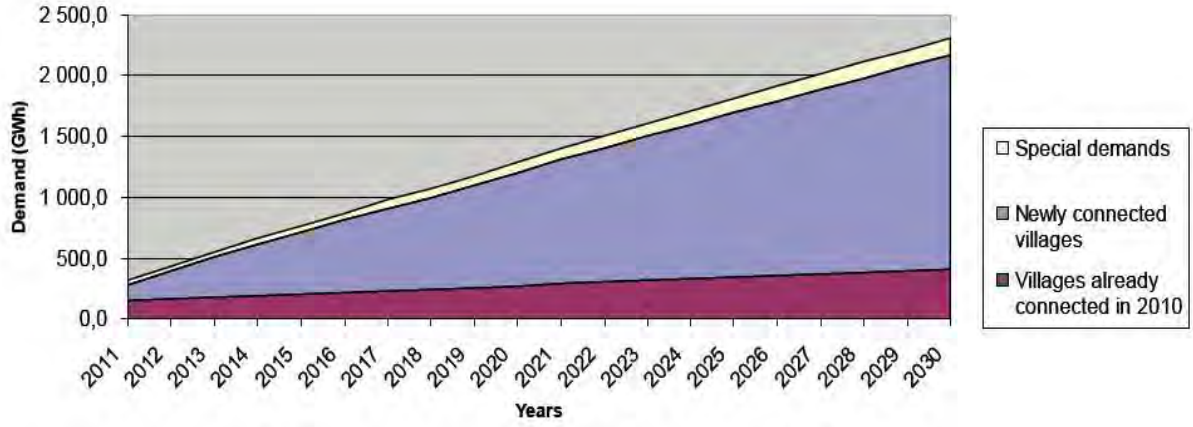
(b) Grid extension project

The grid extension project, the power demands from the national grid to rural areas, and the peak power demands are shown in Table 2-56, Figure 2-49, and Figure 2-50, respectively. The power demand in rural area will be approximately 2,310 GWh and the peak power demand approximately 800 MW in 2030.

Table 2-56 Progress of Electricity Supply Development to Rural Areas to Be Achieved

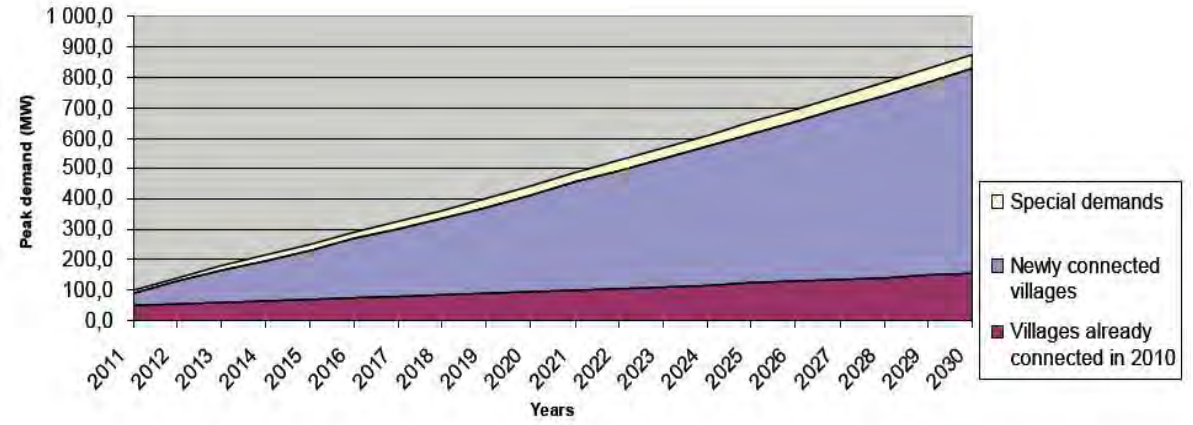
Rural areas	2010	2015	2020	2030
Connection to residences	6.9%	29.1%	47.4%	66.2%
Supply to village	10.9%	46.1%	78.3%	94.8%

Source: The study of IED for baseline scenario



Source: The study of IED for baseline scenario

Figure 2-49 The Electricity Demand for Rural Areas with Target Progress



Source: The study of IED for baseline scenario

Figure 2-50 Peak Demand for Rural Areas with Target Progress

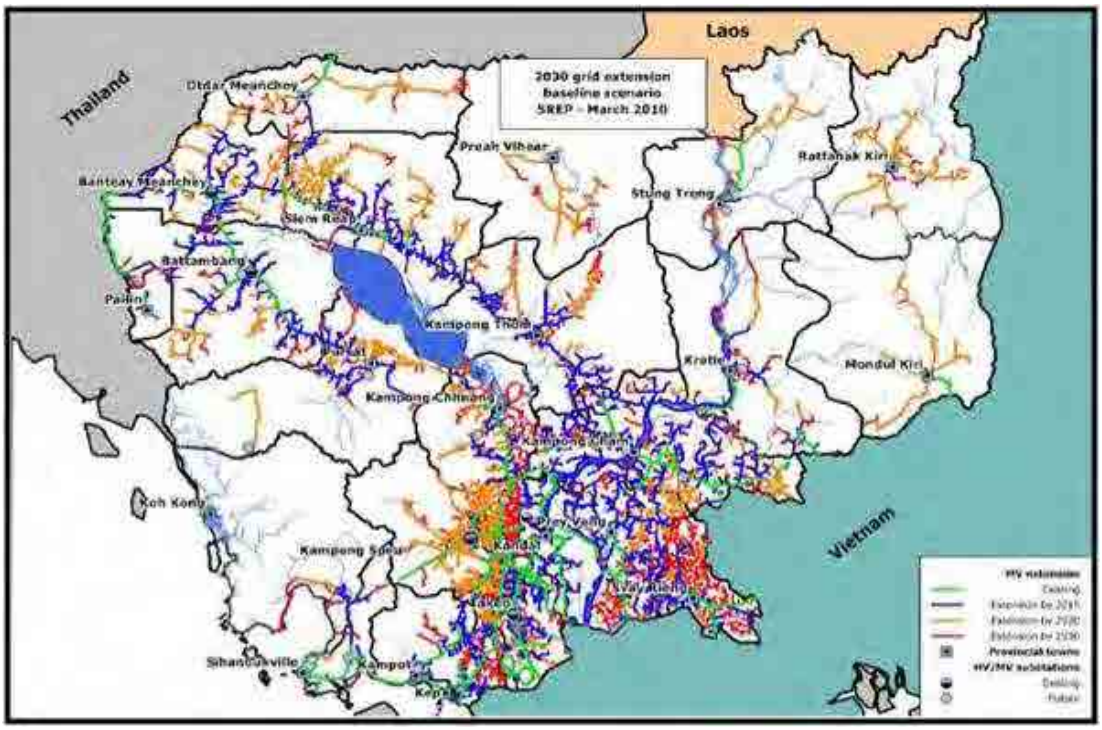
Table 2-57 summarizes the numbers of Villages to be electrified and amount of investment costs in relation to the grid extension project. In 20 years from 2011, 17,246km of MV transmission lines shall to be developed and the total extension and necessary investment costs will be 7,171 km and 143.4MUSD in 2011-2015, 5,910 km and 118.2MUSD in 2016-2020, and 4,164 km and 83.3MUSD in 2021-2030.

Table 2-57 Infrastructure And Investment Required for Different Phases

Phase	Number of village to be electrified	Number of HH to be electrified x 1000	MV length (km)	Amount to be invested on MV network (MUS$)	Amount to be invested on Distr. (MUS$)	Total investment cost (MUS$)	Investment cost per village (USD)	Investment per HH (USD)
2011-2015	4,431	570	7,171	143.4	183.5	327	73,776	575
2016-2020	4,054	539	5,910	118.2	158.7	277	68,303	514
2021-2030	2,087	729	4,164	83.3	203.5	287	137,422	393
2011-2030	10,572	1,838	17,246	344.9	545.8	891	84,250	485

Source: The study of IED for baseline scenario

MV transmission network included in the plan is shown in Figure 2-51.



(Green color is the existing MV network in 2010, blue color is the MV network needed to be developed in 2011-2015, yellow color is the MV network needed to be developed in 2016-2020, red color is the MV network needed to be developed in 2021-2030)
Source: the study of IED for baseline scenario
Source: The study of IED for baseline scenario

Figure 2-51 Plan for development of MV network

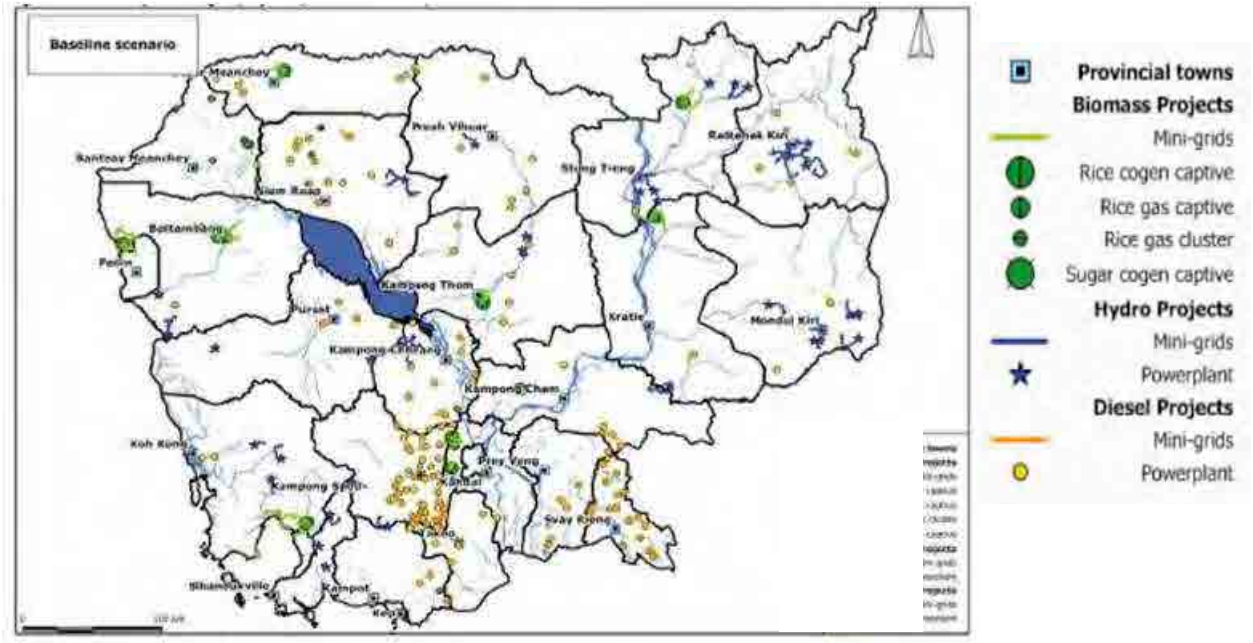
(c) Mini-grid development plan

Proportion of areas covered by the mini-grid plan is shown in Table 2-58. Locations for mini grid development planned between 2011 and 2030 and investment costs required are shown in Figure 2-52 and Table 2-59, respectively.

Table 2-58 Mini-grid Development to Be Planned to Cover the Supply in Rural Areas

Extent of Coverage of rural areas by the year		2010	2015	2020	2030
Supply to HH	Hydro mini-grid	0.0%	0.6%	0.3%	0.1%
	Biomass mini-grid	0.0%	0.4%	0.3%	0.0%
	Existing diesel mini-grid	4.4%	1.9%	1.4%	0.6%
	New diesel mini-grid	0.0%	1.9%	1.2%	0.1%
	Total percentage of HH to be supplied	**4.4%**	**4.7%**	**3.2%**	**0.7%**
Supply to Village	Hydro mini-grid	0.0%	1.5%	0.6%	0.2%
	Biomass mini-grid	0.0%	1.2%	0.7%	0.1%
	Existing diesel mini-grid	11.9%	5.4%	2.7%	0.9%
	New diesel mini-grid	0.0%	5.1%	1.9%	0.1%
	Total percentage of HH to be supplied	**11.9%**	**13.3%**	**5.9%**	**1.3%**

Source: The study of IED for baseline scenario



Source: The study of IED for baseline scenario

Figure 2-52 Mini grid Plan by 2030

Table 2-59 Investment Required for the Development in Accordance with the plan

Investment required ('000 USD)	2011-2015	2016-2020	2021-2030
Hydro mini-grid	31,492	861	233
Biomass mini-grid	16,363	581	171
New diesel mini-grid	23,906	2,382	392
Total mini-grid projects	**71,761**	**3,824**	**796**

Source: The study of IED for baseline scenario

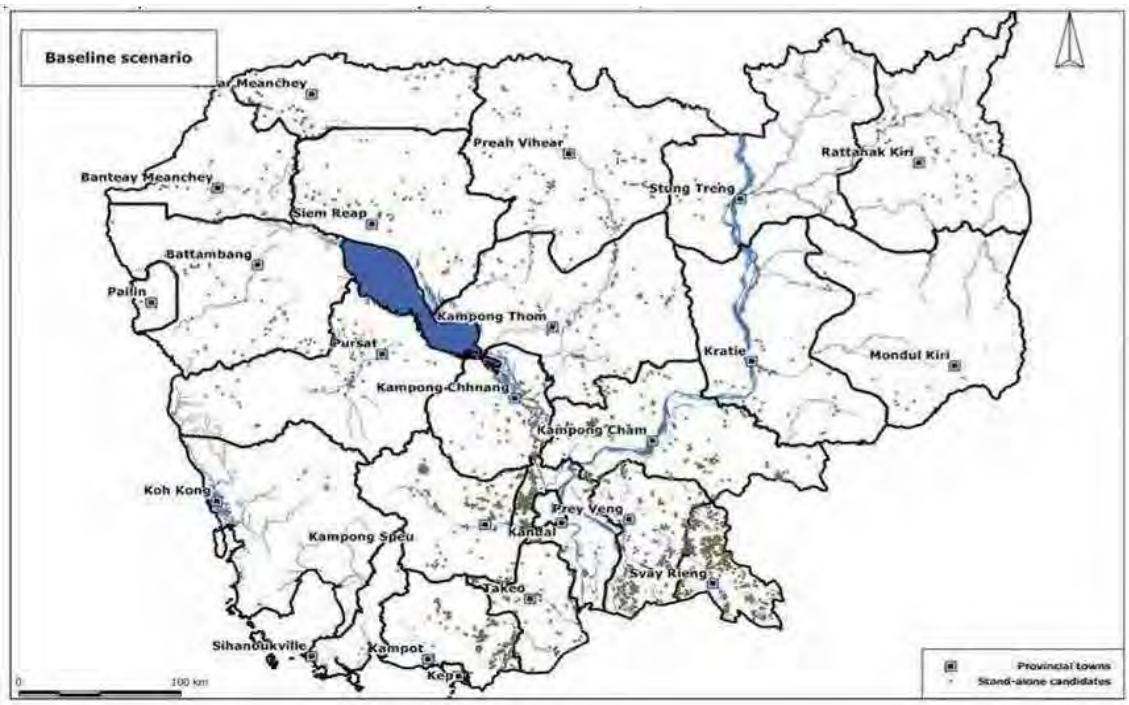
(d) Stand-alone systems development plan

The stand-alone system plan is shown in Table 2-60. Locations for the development between 2011 and 2030 and required investment costs are shown in Figure 2-53 and Table 2-61.

Table 2-60 Stand-alone System Plan

Stand-alone Systems Plan	Unit	2011-2015	2016-2020
Plan for providing SHS householdwise	HH	16,744	20,679
Plan for providing Solarsystems commu itywise	vi dgd	997	997
Plan for establ shment of B GS	vi dgd	569	455

Source: The study of IED for baseline scenario



Source: The study of IED for baseline scenario

Figure 2-53 Stand-alone Systems Plan 2020

Table 2-61 Investment Required for the Development of the plan

Investment required	Unit	2011-2015	2016-2020
Plan for providing SHS householdwise	**USD**	6,698,000	8,272,000
Plan for providing Solar systems communitywise	**USD**	2,190,000	2,190,000
Plan for establishment of BCS	**USD**	10,368,000	10,564,000
Total investment cost needed	**USD**	**19,256,000**	**21,026,000**

Source: The study of IED for baseline scenario

(e) Plan for rural electrification development throughout Cambodia

The extent of coverage throughout Cambodia is shown in Table 2-62 by power source. Investment costs required from 2011-2015 is shown in Table 2-63 by provinces. Investment costs required for rural electrification throughout Cambodia from 2011-2030 is shown in Table 2-64.

Table 2-62 Plan for Rural Electrification Development 2011-2030

Extent of Coverage of rural area by the year		2010	2015	2020	2030
Electrified HH	Grid extension	6.9%	29.1%	47.4%	66.2%
	Hydro mini-grid	0.0%	0.6%	0.3%	0.1%
	Biomass mini-grid	0.0%	0.4%	0.3%	0.0%
	Existing diesel mini-grid	4.4%	1.9%	1.4%	0.6%
	New diesel mini-grid	0.0%	1.9%	1.2%	0.1%
	SHS	0.0%	0.7%	1.4%	0.2%
	Total percentage of HH received electricity supply	**11%**	**34%**	**52%**	**67%**
villages received electricity supply	grid extension	10.9%	46.1%	78.3%	94.8%
	Hydro mini-grid	0.0%	1.5%	0.6%	0.2%
	Biomass mini-grid	0.0%	1.2%	0.7%	0.1%
	Existing diesel mini-grid	11.9%	5.4%	2.7%	0.9%
	New diesel mini-grid	0.0%	5.1%	1.9%	0.1%
	Existing BCS	34.7%	14.3%	6.8%	1.3%
	New BCS	0.0%	4.5%	9.0%	2.6%
	Total percentage of villages received electricity supply	**57%**	**78%**	**100%**	**100%**

Source: The study of IED for baseline scenario

Table 2-63 Province-wise finance required for development of rural electrification by different technologies during initial 5 years from 2011-2015

Name of Province	Finance required for different rmtete hnology in '000$US								Total
	National Grid		Hydro Mini-Grid	Biomass Mini-Grid	New diesel Mini-Grid	SHS	Commu-nity PV	Solar BCS	
	MV	Trans, LV, Meters							
Banteay Mean Chey	8,845	8,886	0	899	113	111	47	133	**19,034**
Battambang	10,479	15,767	1,381	2,761	113	198	72	242	**31,014**
Kampong Cham	27,533	35,840	1,031	998	661	705	186	1,119	**68,071**
Kampong Chhnang	4,610	5,414	3,054	262	2,344	349	134	377	**16,543**
Kampong Speu	1,889	3,279	1,570	59	6,336	297	109	699	**14,238**
Kampong Thom	11,299	13,395	2,074	1,107	851	325	129	635	**19,815**
Kampot	8,053	10,778	0	237	947	633	124	854	**21,626**
Kandal	9,906	17,885	0	2,142	0	561	154	933	**31,581**
Kep	392	578	0	0	0	0	0	0	**970**
Koh Kong	594	905	1,925	2,147	291	33	19	76	**5,989**
Kratie	5,237	5,855	172	199	345	172	84	270	**12,333**
Mondukiri	0	30	4,931	0	220	26	25	45	**5,276**
Oddor Mean Chey	740	1,163	0	1,837	1,192	174	80	307	**5,494**
Pailin	581	681	455	312	0	12	6	23	**2,069**
Sihanouk	988	1,794	1,152	0	0	12	2	0	**3,949**
Preah Vihear	220	221	543	0	699	286	182	390	**2,541**
Prey Veng	17,963	21,859	0	0	1,208	946	237	1,308	**43,521**
Pursat	5,902	5,220	1,860	0	1,245	218	89	301	**14,834**
Ratanakiri	105	152	5,677	0	746	102	51	382	**7,214**
Siem Reap	11,657	11269	2,933	969	1,931	212	68	264	**29,303**
Steung Treng	404	303	2,736	2,434	57	94	70	235	**6,332**
Svay Rieng	5,243	5,859	0	0	3,763	983	249	1,341	**17,438**
Takeo	10,789	16,409	0	0	846	249	74	434	**28,801**
Total	143,429	183,542	31,492	16,363	23,906	6,698	2,190	10,368	**417,986**

Source: The study of IED for baseline scenario

Table 2-64 The finance required for development of rural electrification throughout the country

Different Technologies	Amount of investment required in '000 $US		
	2011-2015	2016-2020	2021-2030
Sub transmission (MV network)	143,429	118,203	83,282
Distribution network (transformer, LV network, meter)	183,542	158,735	203,490
Total Grid Extension Projects	**326,971**	**276,938**	**286,772**
Hydropower with mini-grid	31,492	861	233
Biomass with mini grid	16,363	581	171
Diesel with mini grid	23,906	2,382	392
Total Mini-Grid Projects	**71,761**	**3,824**	**796**
Equip SHS	6,698	8,272	0
Solar system community wise	2,190	2,190	0
BCS	10,368	10,564	0
Total Stand-alone Systems Projects	**19,255**	**21,025**	**0**
Grand Total	**417,986**	**301,787**	**287,568**

Source: The study of IED for baseline scenario

e.Participation of EDC and use of funds for rural electrification

EDC's participation is required in rural electrification to achieve the rural electrification targets for the following reasons;

(1) EDC is the only entity that can execute the projects funded by grants and loans provided to RGC, for extension of electricity supply from national grid to rural areas;
(2) EDC is the most suitable and effective entity to be in charge of bulk sale to distribution enterprises at a uniform tariff throughout the country. EDC is also the only entity that can invest for the installation of the sub-transmission system and perform bulk sell of energy to the rural distribution network; and
(3) EDC is the only entity that can implement the cross subsidy mechanism to rectify the tariff difference between metropolitan and rural areas.

To urge participation of EDC, action plans, such as EDC's participation of rural electrification projects and terms and conditions for investment support, are specified and RGC and EDC in cooperation will undertake the following tasks;

(1) Prepare the plan for the sub-transmission development throughout Cambodia
(2) Act as the agency for implementation of projects for development of sub-transmission throughout the country. Implement projects for development of distribution network using funds provided to RGC, in the areas not being developed by the private sector
(3) Operate the sub-transmission network and also the distribution network in its authorized areas
(4) Manage the subsidy allocated to rural areas

Additionally, management of funds for rural electrification (e.g., treatment of conditions for electricity tariffs in rural electrification funds) is also mentioned. Rural electrification with renewable energy sources supported by development banks will be managed by MIME and REF.

f. Consideration

Among the plans in SPRDE, the cross subsidy mechanism is significantly useful as a basic system to supply stable and inexpensive electricity to rural area. Reducing electricity tariff in an area of comparatively higher costs enables a household of low income to start paying an electricity tariff, and helps to remove a sense of unfairness, which serves as an incentive for rural households to connect to the system.

EDC's consolidation approach to the power transmission and distribution network is quite effective not only in the sense of energy security but also in the sense of secure implementation of the framework. Obviously, once the power transmission network has been prepared, more households gain the opportunities to connect to the system, which positively facilitates the electrification.

It is estimated that the main energy source should basically depend on large-sized hydropower, fire power, and imported electricity; from the increasing energy demand in the Phnom Pnh system and the Senmonorom system, and from the power source mainly consisted of the hydropower, however,

sudden expansion of the power transmission and distribution network may easily cause electricity shortage of the entire NGD, especially in the dry season. This naturally requires a secure, continuous supply. The current choice in which the power source completely depends on IPP and import is not necessarily beneficial in the energy security point of view, yet it should be one of effective options in the process of promoting the electrification.
From the above, the direction to preferentially consolidating the transmission and distribution network should be regarded as reasonable.
The power transmission and distribution network of NGD is planned to be developed preferentially in the area around Tonle Sap Lake to the southwest area where the population concentrates. In the areas of small population, the priority of transmission network is relatively low. Such areas are also low in the population density in most cases, which deteriorates the economic efficiency of power distribution network, resulting in a wide range of off-grid area. Practically speaking, electrification of such areas should depend not only on the NGD network but also on a mini-grid or BS. Especially, rural electrification by a mini-grid using renewable energy promises the effect of minimizing the influence on supply and demand, since the power generation can continue even when the mini-grid is connected to NGD in the future. In the consideration by RGC, economical micro hydropower points, where available, are to be utilized as the mini-grid power source; this direction should have no problem.

2.11.2 Trends in support from other donors

We have mentioned support from other donors in 2.10 but for the grid extension project of northeastern provinces supported by other donors, hardly any information is available. Though considering the policy, plans, and previous results of rural electricity support, the possibility for other donors to electrify northeastern provinces through small hydropower is extremely low. The power source of choice may be solar energy due to little restriction on the location of installation and electrification through hydropower is unlikely to happen.

2.11.3 Significance of rural electrification in northeastern area using micro hydropower

(1) Current status of rural electrification through micro hydropower

According to MIME, the hydropower potential in Cambodia is approximately 10,000MW (300MW of which is micro hydropower generation) including the main stream of Mekong River and the development of hydropower stations is an important strategy for achieving electrification enhancement goals in Cambodia. EAC Annual Report 2009 and information obtained from MIME have indicated that micro hydropower stations currently in operation are as shown in Table 2-65. Further, stations at the planning stage are shown in Table 2-66. Small hydropower stations that shall contribute to rural electrification following the provision of political goals of rural electrification include O'Romis and O'Moleng which commenced operation in 2008. Additionally, construction of two other stations, the Anlong Cherey station (maximum output: 130kW) and the Krapeu Truon station (maximum output: 30kW), are near completion as of January 2012. (Development of these stations is part of the Krong Ponley Water Resources Development Project supported by loans from Korea, led by MOWRAM, an irrigation project.) That is to say that the development of micro hydropower is not progressing as planned from the standpoint of the RGC, which recently proposed "rural electrification by the private sector.

Table 2-65 Micro Hydropower Stations under Construction / in Operation in Cambodia

No.	Name of Hydropower Station	Province	Output (kW)	Operating Entities	Remarks
1	O Chum II	Ratanak Kiri	960	EDC	EDC
2	O'Romis	Mondul Kiri	185	EDC	Granted by JICA
3	O'Moleng	Mondul Kiri	185	EDC	Granted by JICA
4	O Romis Restaurant	Mondul Kiri	2	Private	
5	Ta Ang	Ratanak Kiri	2	Private	
6	Ou Pon Mong	Stung Treng	37	Private	
7	Khum Koh Sampeay	Stung Treng	56	Private	
8	Toeuk Char	Kompong Cham	40	Private	Not in operation
9	Pailin	Pailin	15	Private	
10	Ta Tai	Koh Kong	5	Private	
11	Anlong Chrey	Kampon Chhnang	170	MOWRAM	Under construction
12	Krapeu Truom	Kampon Chhnang	30	MOWRAM	Under construction

Source: Interview with MIME and Information Collection by JICA Team

Table 2-66 Micro Hydropower Project under Study in Cambodia

No.	Name	Province	Output (kW)	Output (kW) in MP2006*
1	O Turou Trao	Kampot	1.1	** 129
2	Stoeng Sva Slap	Kaoh Kong / Kampong Speu	3.8	56
3	Upper St. Siem Reap	Siem Reap	0.6	73
4	Lower St. Siem Reap	Siem Reap	1.5	348
5	Upper O Sla	Koh Kong	2	126
6	Lower O Sla	Koh Kong	4.5	283
7	Upper Phum Tunsang	Koh Kong	3.2	** 3,143
8	Lower Phum Tunsang	Koh Kong	3	** 3,002
9	Upper Prek Dakdeur	Mondul Kiri	110	** 113
10	Sare Chaeng (St. Daunpe)	Kampot	126	6
11	Sangke (O Samrel)	Pursat	33	*** 180
12	Ta Taok (O Chum)	Battambang	38	29
13	Kampong Lpov (O Doeum Chek)	Battambang	32	14
14	Busra (O Por)	Mondul Kiri	56	70
15	Prek Dakdeur / O Romis	Mondul Kiri	200	123
16	O Pramoie	Pursat	36	31
17	Ta Ang (O Cheng)	Ratanak Kiri	10	12
18	O Katieng	Ratanak Kiri	330	32
19	O Kachanh	Ratanak Kiri	220	40
20	Bay Srok (O Sien Ler)	Ratanak Kiri	130	66
21	O'Chum Redevelopment	Ratanak Kiri	300～1,000	

*MHP identified thorough Map Study in MP2006
** MHP Identified in Past Study
*** Pre F/S in MP2006

Source: Interview with MIME, Final Report of MP2006

(2) Challenges in promoting rural electrification through micro hydropower

For rural electrification, much progress has been observed in transmission line expansion and introduction of SHS; however, the goal of the involvement of private sector in the development of micro hydropower seems to have been less attended. We have interviewed MIME and came to believe that the following challenges may be the reasons behind this problem.

Challenges associated with restrictions on location of installation

a. Since hydropower stations utilize the stream flow and drop, the location of installation is determined by geographical features. However, most of the times these locations are far from the location with power demand. Connection would require long transmission lines and therefore, the initial investment cost and the maintenance cost increase. Thus, the development of rural electrification through hydropower is unattractive to private investors.
b. In mountainous regions where micro hydropower stations can be installed, houses are decentralized and long distribution lines are required. As with above, the initial investment cost and the maintenance cost increase. Thus, the development of rural electrification through hydropower is unattractive to private investors.
c. Areas where micro hydropower stations can be installed have low absolute population and the priority of rural electrification is low.
d. Access to areas chosen for rural electrification is not good and availability of repair parts can be a problem. Thus, the revenue is unstable.

Challenges associated with technology

a. Technology foreign to everyday life is required but hardly any hydropower engineers are in Cambodia.
b. Hydropower stations require large initial investment cost.

(3) Sharing roles between EDC and private enterprises in rural electrification

Over the entire country, private enterprises operating the large-sized power station currently in construction are responsible for power generation and transmission from the station to GS, and are supposed to operate the system basically by the approval of EDC in the annual, weekly, and daily operation pattern. Currently it is EDC that is mainly responsible for the transmission from GS to SS, and from the SS to customers, private enterprises other than EDC are participated. In SPDRE, a direction is given in which EDC is responsible for total power transmission and distribution network from GS to customers in the future, in which EDC takes a role of an organization to supply electricity using fund in the off-grid area out of the range of NGD expansion, and in which MIME and REF handle the development of renewable energy in this area. In summary, this direction shows a basic policy where EDC takes a role of organization which practically manages the domestic power transmission and distribution network, private enterprises handle a large-sized power source, and the government and private enterprises take charge of a small-sized power source.

The electricity transaction cost between the private power enterprises and EDC is specified in the PPA entered into through negotiation between the concerned parties of power sector in Cambodia such as MIME, EDC, EAC and REF, and the private enterprises. In the current situation, about the half of electricity tariff is occupied by the electricity transaction cost from IPP, i.e., the generation cost, and gives a most decisive influence on electricity tariff. The transaction cost needs to be evaluated by fully considering the supply characteristics (such as seasonal fluctuation or hourly fluctuation). EDC that manages the transmission and distribution network is furthermore expected to maintain the capability on network administration as well as on the power generation planning or operation, to control power quality and cost.

(4) Significance of micro hydropower

Although the small hydropower, especially micro hydropower, is expected to take a certain role in rural electrification in Cambodia, there has been, and unfortunately will be, quite a few development results by overseas donors. Because the initial investment for micro hydropower energy is comparatively larger than the other power source, and because there are almost no technical engineer in hydropower in Cambodia, new entry from private enterprises into this field is hopeless. In this

situation, two power generations, O'Moleng and O'Romis, started the operation in Mondul Kiri Province in 2008, and have been successfully supplying electricity as a rural mini-grid power source. This successful example shows the following key factors for sustainable rural electrification by micro hydropower in Cambodia:

① If launched as a free project, the micro hydropower plan needs minimized initial investment, contributing to finance the operation and maintenance cost, and the cost problem among the limits in the installation site can be more or less solved.

② By an integrated assistance to the backup after starting the operation, an engineer in the micro hydropower field can be trained, realizing the framework in which the achievement in ① remains effective.

In Cambodia where almost no hydropower engineer is available, the small hydropower energy can play its role of realizing the rural electrification target only by the total, continuous assistance not only limited to the initial investment but also to the subsequent maintenance and management. Especially in Ratanak Kiri Province, where the population has been increasing contrary to a low electrification rate, has a large potential of small hydropower. Promoting rural electrification in this area by small hydropower means much.

As separately described, an opportunity to be involved in hydropower operation, such as negotiation with private enterprises that are under development of large-sized hydropower, is very significant in Cambodia where almost no hydropower engineer is currently available.

In considering development of small hydropower, rural electrification in Mondul Kiri Province serves as a useful reference. From the local residents, improuvent of safety and atmosphere of the city as well as convenience by electricity are reported. On the other hand, small hydropower does not have high cost conpetitiveness even in the case of just development of power plant because it does not have advantage of scale. Besides, the development of rural electrification with hydropower has additional facilities such as distribution line etc. and seems to have more cost varier even with loan assistance.

As of now, many irrigation systems are being (re) developed in Cambodia. As shown in after-mentiones potential study on the hydrpoower on the irrigation system, the scale of the sites is small and the sites are located in the non-electrified area. The investment cost on the small hydrpower in much less than that on the irrigation system. The study on the hydropower development with irrigation development may give fresh market.

2.12 Micro hydropower generation using agricultural canal

2.12.1 Outline of agricultural project in Cambodia

Potential locations described in both "Master Plan Study for Rural Electrification by Renewable Energy (JICA, MP2006)" and the study conducted by NEDO for the "Master Plan on Renewable Energy" included micro hydropower stations using existing agricultural facilities. However, agricultural facilities in these areas have been intensly damaged by civil war and the majority of them cannot be used for the development of hydropower stations. Agricultural facility repair is a main policy of the RGC for the next few years and many irrigation-related projects aided by domestic and internal funds are being performed. Japan also participates in the irrigation projects of Cambodia through both support and loans. Projects, such as the "Kandal Province Irrigation Facilities Improvement Plan," the "Kandal Steng Irrigation Facilities Rehabilitation Plan," and the "Trapeang Thmor Irrigation Facilities Rehabilitation Plan to the North of Tonle Sap" have already been completed and the "Tonle Sap Western Basin Irrigation Facilities Rehabilitation Project" is underway.
According to the MOWRAM's "Irrigation Development of Cambodia by MOWRAM - Status of March 2011 (Supported by JICA)," the number of irrigation works in Cambodia was 2,403 (small scale: 1,415, medium scale: 955, large scale: 33) in 2004.
Recent status of irrigation development and redevelopment projects are shown in Table 2-67 to Table 2-70.

Table 2-67 Irrigation works with National Budget

Completed in 2004-2008
Rehabilitaion/Construction of irrigation systems for 382,305 ha.
Repair of 794 small pond (reservor) with dike length 0f 377 km by farmer participation.
Repair of 1,266 canals with total length of 2,256 km by farmer participation.
Rehabilitaion of 270 gates, 377 culverts, 90 check structures, 29 spillways.
Installation of new 12 pumping station and repair of 78 pumping machines.
On-going
Rehabilitation of 29 irrigation systems (MOWRAM code 7.22) (US$ 21.9 million)
Rehabilitation of 19 irrigation systems (MOWRAM code 8.20) (US$ 12.4 million)
Rehabilitation/Construction of 26 irrigation systems (US$ 24.9 million)

Source: Ministry of Water Resources and Meteorology, Irrigation Development in Cambodia, Status as of March 2011, Supported by JICA

Table 2-68 Completed Irrigation Projects with Foreign Buddet

IPP No.	Project Name/Title	Donor	Remarks
16-1	Colmatage Irrigation Rehabilitation Project (2,112 ha)	Japan	Completed in 2002
17-1	Stung Chinit Irrigation and Rural Infrastructure Project (3,000 ha)	ADB+AFD	Completed in 2008
24-1	Integrated Development in Batambang Province (1,950 ha)	FAO	Completed in 2008
25-1	Batheay Irrigation Construction Project (8,000 ha)	Korea	Completed in 2010
25-2	Tamouk Reservoir Dike Rehabilitation Project (4,051 ha)	Korea	Completed in 2004
27-1	Bassac Dam Rehabilitation Project in Battambang Province (20,000 ha)	Japan	Completed in 2006
34-1	Rehabilitation of the Kandal Stung Irrigation System in the Lower Prek Thnot Basin (1,950 ha)	Japan	Completed in 2007
N-9	Grant Assistance for Grass-Roots Human Security Project (11sub-projects,11 River basin, 12,200 ha)	Japan	Completed in 2005-2009
MP-1	Study on Comprehensive Agricultual Development of Prek Thnot River Basin (River Basin No.24)	Japan	Completed in 2005
MP-2	River Basin and Water Use Study for Northwest Irrigation Sector Project (River basin No.24)	ADB+AFD	Completed in 2006
MP-3*	Master Plan on Water Resources Development in Cambodia (All 42 river basins)	Korea	Completed in 2008
MP-4	The Basin-Wide Basic irrigation and Drainage Master Plan Study in the Kingdom of Cambodia (River basin No.26,27,28,29)	Japan	Completed in 2009

Note: IPP No. = Irrigation Project Profile number
16-1 = Project in Single river basin: Code number is given as < River basin no + serial no of order to start construction in each river basin>
MP-1 = Master plan study <order of implementation date>
* = not appeared in the location map

Source: Ministry of Water Resources and Meteorology, Irrigation Development in Cambodia, Status as of March 2011, Supported by JICA

Table 2-69 Ongoing Irrigation Projects with Foreign Buddet

IPP No.	Project Name/Title	Extemal Support		Implementation Period		Total Project Cost (USD '000)	Fund Resource (USD '000)		Project Status as of 15 March 2011
		Donor Name	Kind of Fund	from	to		External	Local	
N1	Northwest Irrigation Sector Project (4 Provinces)	ADB +AFD	Loan +Grant	2005	2011	30,870	21,740	9,130	On-going
N2*	Eastern Rural Irrigation Development Project (7 Provinces)	IMF	MDRI	2007	2011	33,380	32,763	617	On-going
N3	Krang Ponley Multipurpose Water Resource Project (3 Provinces)	Korea	Loan	2008	2012	29,505	26,098	3,407	On-going
N4*	Tonle Sap Lowlands Rural Development Project (3 Provinces)	ADB	Loan +Grant	2008	2015	24,000	20,000	4,000	On-going
N6*	Water Resources Management (Sector) Project	ADB +OPEC +AFD	Loan +Grant	2011	2018	31,900	24,800	7,100	On-going
13-1	Kampong Trabek River Flood Control Project (Prey Veng)	China	Loan	2010	2014	31,010	31,010	0	On-going
22-1	Stung Sreng Irrigation Development Project (Siemreap)	China	Loan	2011	2015	65,000	54,780	10,220	Loan processing
24-2	Mongkol Borey Dam Development Project (Battambang)	Korea	Loan	2009	2013	24,301	18,700	5,601	On-going
26-1	Kong Hort Irrigation Development Project (Battambang)	China	Loan	2010	2014	61,000	49,900	11,100	On-going
27-2	Dauntri Multipurpose Dam Development Project (Battambang)	Korea	Loan	2009	2013	45,958	40,283	5,675	Loan processing
28-1	Stung Pursat Dam No.3 and No.5 Development Project (Pursat)	China	Loan	2011	2014	80,000	66,460	13,540	On-going
34-3	Stung Tasal Storage Resevoir Development Poject (Kg.Speu)	India	Loan	2011	2013	19,000	19,000	0	On-going
38-1	Surrounfing Bayong Kouv Reservoir Improvement Project (Takao)	Korea	Grant	2010	2013	3,012	3,012	0	Committed
39-1	Prek Stung Kev Water Resources Development Project (Kampot)	China	Loan	2011	2015	52,000	42,620	9,380	On-going

Note: IPP No. = Irrigation Project Profile number

N1 = Project in Multi-river basin: Code number is given as < N+ serial no of order to start construction >

22-1 = Project in Single river basin: Code number is given as < River basin no + serial no of order to start construction in each river basin>

* = not appeared in the location map

Source: Ministry of Water Resources and Meteorology, Irrigation Development in Cambodia, Status as of March 2011, Supported by JICA

Table 2-70 Committed / Promotion Projects by Foreign Donors

IPP No.	Project Name/Title	Extemal Support		Implementation Period		Total Project Cost (USD '000)	Fund Resource (USD '000)		Project Status as of 15 March 2011
		Donor Name	Kind of Fund	from	to		External	Local	
N5	West Tonle Sap Irrigation and Drainage Rehabilitation Project (6 sub-projects)	Japan	Loan	2011	2016	54,500	47,200	7,300	Loan processing
N7	Vaico Irrigation Development Project (Kampong Cham,Prey Veng & Svay Rieng)	China	Loan	2011	2015	130,000	100,000	30,000	Loan processing
N8	Small Scale Irrigation System Improvement Project (84 sub-projects in 23 provinces)	seek fund	Loan	2013	2017	71,500	71,500	0	Promotion
N10*	Rural Irrigation and Agriculture Productivity Improvement Project (7 Provinces)	IMF	MDRI	2011	2014	10,980	10,980	0	Processing
N11	Damnak Choeukrom Flood and Drought Project (Battambang,Pursat)	ADB	Loan	2011	2016	24,100	24,100	0	Loan processing
N12	Vacio Irrigation Development Project Phase II (Kampong Cham,Prey Veng & Svay Rieng)	China	Grant	2013	2015	130,000	100,000	30,000	Loan processing
19-1	Stung Sen Multipurpose Development Feasibility Study (Kg,Thom)	Kwait	Loan	2009	2010	1,000	1,000	0	FS on-going
20-1	Stung Staung Water Resources Development Project (Kg.Thom)	China	Loan	2012	2015	52,000	50,000	2,000	FS on-going
21-1	Stung Chikreng Water Resources Development Project (Siemreap)	China	Loan	2014	2018	90,000	85,000	5,000	Loan processing
22-2	Northem Water Resouces Development Project Phase I (Oddar Meanchey,Preah Vihear)	China	Loan	2015	2018	60,000	60,000	0	Promotion
26-2	Battambang Multipurpose Dam Development Project (Battambang)	China	Loan	2012	2016	120,000	100,000	20,000	Reviewing FS
26-3	Kong Hort Irrigation Development Project Phase II (Battambang)	China	Loan	2011	2015	31,000	30,000	1,000	Loan processing
28-2	Pursat River Basin Water Resouces Development Project (Pursat)	Korea	Loan+ Private	2011	2015	126,900	121,160	5,740	FS completed
28-3	Stung Pursat Dam No.3 and No.5 Development Project Pase II (Pursat)	China	Loan	2014	2017	55,000	55,000	0	Promotion
34-2	Roleang Chrey Headworks Rehabilitation Project (Kampong Speu)	seek fund	Loan	2012	2017	21,050	21,050	0	Promotion
34-4	Northem Upstream of Prek Thnot River Basin Water Resources Development Project (kampong Speu)	Korea	Loan	2011	2013	60,000	50,000	10,000	FS completed
34-5	Kandal Stung-Bati Irrigation System Rehabilitation Project (Kandal,Takeo)	seek fund	Loan	2012	2017	23,950	21,850	2,100	Promotion
38-2	Upper Slakou Irrigation System Rehabilitation Project (Takeo)	seek fund	Loan	2013	2018	25,000	25,000	0	Promotion

Note: IPP No. = Irrigation Project Profile number

N1 = Project in Multi-river basin: Code number is given as < N+ serial no of order to start construction >

22-1 = Project in Single river basin: Code number is given as < River basin no + serial no of order to start construction in each river basin>

* = not appeared in the location map

Source: Ministry of Water Resources and Meteorology, Irrigation Development in Cambodia, Status as of March 2011, Supported by JICA

2.12.2 Possibility of hydropower development using agricultural canals

The Toeuk Char hydropower station (Kampong Cham province, 40kW, "Experimental Study on Decentralized System Using NEDO Solar and Other Type of Energies" [solar energy + micro hydropower]) constructed with the aid of Japan is the only hydropower station in Cambodia that uses agricultural canals.

According to the interview with MOWRAM, no other hydropower stations use the agricultural canals and with respect to multi-purpose dam including power generation, use of agricultural canals has not been widely adopted in Cambodia. In actuality, however, MOWRAM has been conducting a similar development with loans from Korea using a multi-purpose dam-like setup. This irrigation project is

named “Kran Ponley Water Resources Development Project” and is located in the west of the Kampong Chhnang province. In this project, irrigation water is controlled by dams in 3 locations and 3 water gate facilities. Two power stations called the An Long Chrey hydropower station (maximum output: 170kW) and the Krapeu Truom hydropower station (maximum output: 30kW) are scheduled to be installed at 2 of the 3 dams (commencement of operation is scheduled at the beginning of 2012). The main purpose of installing hydropower stations is to obtain power source from dam gates and to supply excess electricity to the nearby unelectrified Villages. Aside from this project, a consultant company from India has suggested MOWRAM to develop small hydropower stations using agricultural dams.

Since agriculture-related projects are progressing with the support of various countries and most of these projects do not involve hydropower development at the potential sites, locations for micro hydropower development seem to be gradually consolidating.

2.13 Human resource development

2.13.1 Human resource development-related projects

Outcome and challenges involved with the human resource development supported by Japan for the power sector of Cambodia are summarized in Table 2-71.

Table 2-71 Human Resources Development-Related Projects

Project Name	Summary	C/P	Issues	Implementation Period
Study for Plan of Establishing Electric Power Technical Standards and Guidelines (JICA) (Development Study)	• Formulation of electric power technical standards	MIME EAC EDC	• Formulation of detailed electric power technical standards	2002 - 2004
Technical Cooperation Project for Power Sector Development (JICA) (Technical Cooperation Project)	• Formulation of detailed electric power technical standards (covering thermal power generation, transmission and distribution) • Strengthening the operational capabilities of the distribution system	MIME EAC EDC	• Implementation of training in line with the detailed electric power technical standards • Strengthening technical capabilities in the transmission and substation field	2004 - 2007
Human Resource Development for ASEAN Countries（JEPIC）	• Cooperation for electricity utilities in ASEAN countries.	EDC EDC(Laos)	• Financial management (2006), Human resource development (2007), Electric power quality improvement(2008), Environment management for hydropower (2009), Improvement of reliability of distribution facilities(2010)	2006-
Basic Training Program for Micro Hydropower Generation Development (joint project by Chugoku EPCO and AOTS)	• Training in basic techniques relating to micro hydropower generation development study, planning, and design	MIME EAC EDC Local consultants	• To provide technical training relating to practical aspects of micro hydropower generation development • With few examples of successful development up until now, there is a lack of experience that needs to be overcome	2008
Follow-up Survey on Study for Plan of Establishing Electric Power Technical Standards and Guidelines (JICA, Development Study)	• Formulation of detailed electric power technical standards (covering hydropower)	MIME EAC EDC	• Establishment of guidelines covering the procedures for every stage from hydropower station development studies through to operation and maintenance	2008 - 2009
The Project of Operation, Maintenance and Management of the Rural Electrification Plan using Micro-hydropower in Mondulkiri Province (JICA, Technical Cooperation Project)	• To develop the capabilities to execute electric industry	EDC (formerly Electricity Unit Mondul Kiri Province (EUMP))	• Strengthening of back-up systems for maintenance operations • Maintenance and management of suitable power equipment	2008 - 2011
Capacity Building for High Voltage Transmission System (Chugoku EPCO) (Yen-denominated loan)	• Education and training relating to electricity transmission, substation, supply, control, and relay	EDC	• Establishment of training programs aimed at enhancing power system operation and transmission and substation facilities management capabilities	2008 - 2009

Source: Survey Team

In 2009, Chugoku Electric Power provided a transmission and transformation training (CBHV) in 6 disciplines of substation, transmission lines, load dispatching, SCADA, protective relay, and safety and new technology. Two major challenges faced during the training have been reported to EDC. At present, majority of these challenges still remain with EDC.

① Upgraded maintenance of transmission system
Data management (Analysis of inspection data etc.),
Speedy restoration when in failure,
Accurate and reliable setting of protective relays,
Drawing management, Safety management,
Some internal rules related above

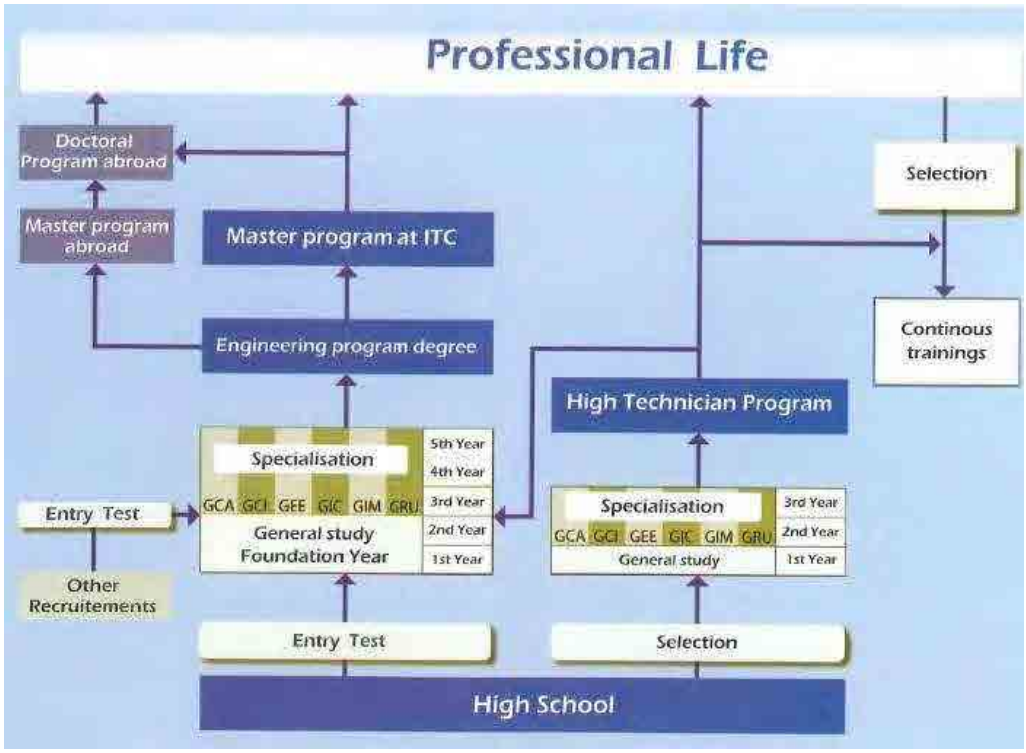
② For reliable and economical system operation (Preparation for NCC operation)
Rules for Power System Operation, Training for Operators,
OJT for Operators after NCC Operation Starting

2.13.2 Institute of Technology of Cambodia

Institute of Technology of Cambodia (ITC) was founded in 1964 with the aid of the former USSR and has been supported by France since 1993. ITC has 6 departments: civil engineering; rural engineering; electrical and energy engineering; information and communication engineering; industrial and mechanical engineering; and food technology and chemical engineering. The numbers of students per academic year are as follows

- Civil engineering: approx. 70
- Rural engineering: approx. 70
- Electrical and energy engineering: approx. 80
- Information and communication engineering: approx. 40
- Industrial and mechanical engineering: approx. 40
- Food technology and chemical engineering: approx. 40

Durations of programs are based on the French education system, i.e., high technician programs are 3 years and engineering programs are 5 years. After completing the 1 year (high technician course) or the 2 year (engineering course) liberal arts courses, students will be assigned to a department. Approximately half the alumni proceed into affiliated graduate programs abroad (e.g., civil engineer alumni to Chulalongkorn University, Thailand) through the scholarship system



Source: ITC

Figure 2-54 Education flow at ITC

The rural engineering program started providing the hydropower generation course since approximately 3 years ago. Government organizations such as MIME are short of civil engineers at present and according to ITC, this stems from hydropower not being a main power source and human resources not being developed that hydropower-related courses have not been available in the past. Previous civil engineering alumni have found employment at MOWRAM and private enterprises.

2.14 Electricity tariffs

2.14.1 Calculation of electricity tariffs

Electricity tariffs in Cambodia are determined and amended by EAC in accordance with Title 7 "Electricity Tariff" of the Electricity Law. EAC reviews electricity tariffs using provisions in the "Regulations on General Principles for Regulating Electricity Tariffs in the Kingdom of Cambodia (2007)" and "Procedures for Data monitoring, Application, Review and Determination of Electricity Tariff (2007)."

In Cambodia, electricity is supplied through the transmission and distribution system connected with neighboring countries and isolated distribution systems. EDC supplies electricity to Phnom Penh and other major cities, and there are a few hundred rural electricity enterprises, some of which unlicensed, also supplying electricity. Electricity tariffs of electricity enterprises that hold the business license are, with approval from EAC, determined on the basis of the initial costs of the areas so that both consumers and the enterprises will be treated fairly. Thus, electricity tariffs of different areas vary even if the electricity supplier is the same EDC. Further, amendment of electricity tariffs usually requires public consultation, but the fuel cost adjustment mechanism is in place to be able to reflect fuel cost fluctuations without public consultation. However, the fuel cost adjustment mechanism is not applicable to electricity enterprises that accommodate electricity from Vietnam or Thailand or those that are not impacted by the fuel cost.

2.14.2 Electricity tariffs

(1) Electricity tariffs of EDC

Electricity tariffs of areas where electricity is supplied by EDC are determined by EAC that reviews and approves the tariffs suggested by EDC. Since tariffs are calculated based on the initial cost of each system, they vary depending on areas. Naturally, the tariffs of areas that import electricity from a neighboring country are relatively inexpensive and that of areas where the electricity is generated by small-scale systems with diesel fuel tend to be expensive. Though both areas have no base charge and electricity tariffs are setup on a pay-as-you-go basis.

a. Electricity tariffs for wholesalers, rural electricity enterprises, and bulk customers located outside of the EDC supply areas

   Electricity tariffs of wholesalers outside of EDC supply areas, rural electricity enterprises, and bulk customers outside of the EDC supply areas (HV and MV connections) from NGD are shown in Table 2-72.

Table 2-72 Tariff of EDC for supply at HV and MV from National Grid

Type of Connection	Condition	Electricity Tariff, US cents/kWh
Grid Tariff for bulk sale outside the distribution area of EDC	Connection at High Voltage from Grid Substation	12.05
	Connection at Medium Voltage from Grid Substation	12.25
Connection by Licensee from MV feeder of EDC getting supply from National Grid	Licensee having MV line to supply points at a distance of more than 20 kM	13.05
	Licensee having MV line to supply points at a distance of more than 15 kM	13.55
	Licensee having MV line to supply points at a distance of more than 8 kM	14.05
	For other Licensee not in the above categories	14.55
Connection by Consumers from MV feeder of EDC getting supply from National Grid outside the area of Distribution of EDC	MV consumers outside the distribution area of EDC but connected to the internal supply system for a city or provincial town	Tariff for MV consumer of that city or town
	MV consumers outside the distribution area of EDC and not connected to the internal supply system for a city or provincial town	16.05

Source: EAC Annual Report, 2011

b. Phnom Penh, Kandal, and Kampong Speu

Electricity tariffs of Phnom Penh, Kandal, and Kampong Speu are shown in Table 2-73. For the electricity tarrifs approved by Riel currency, prices are also represented by US cent converted by the exchange rate as of November 31, 2010 (1US$ = 4,047.5Riel).

Table 2-73 Tariff of EDC for Phnom Penh, Kandal and Kampong Speu Province

Category of Consumer	Electricity Tariff, Riels/kWh	Condition
Domestic in Phnom Penh and Takhmao Town of Kandal Province	610 (15.07 US cents)	All kWh if monthly consumption does not exceed 50 kWh
	720 (17.79 US cents)	All kWh if monthly consumption exceeds 50 kWh
Domestic in Ch. Bamon City of Kampong Speu Province	720 (17.79 US cents)	All Domestic Consumers
Embassy, NGO and Foreign Residents and Institutions	820 (20.26 US cents)	
Customer paying by Government budget, Commercial (business) and Industrial customers	Tariff rate = average cost of total electricity purchased in previous month + 3.6 US Cents/kWh	For small commercial and Industrial customers
	Tariff rate = average cost of total electricity purchased in previous month + 2.8 US Cents/kWh	For medium commercial and Industrial customers
	Tariff rate = average cost of total electricity purchased in previous month + 2.4 US Cents/kWh	For big commercial and Industrial customers
	Tariff rate = average cost of total electricity purchased in previous month + 2.0 US Cents/kWh	For commercial and Industrial Customer who is directly connected to MV

Source: EAC Annual Report, 2011

c. Other areas

Electricity tariffs as of December 2010 used by EDC local offices are shown in Table 2-74 to Table 2-79. For the electricity tarrifs approved by Riel currency, prices are also represented by US cent converted by the exchange rate as of November 31, 2010 (1US$ = 4,047.5Riel).

Table 2-74 Electricity Tariff of EDC for Provincial Town of Takeo and Ang Tasom

Category of Consumer	Electricity Tariff
Small consumer	920 Riels/kWh (22.73 US cents)
Medium consumer	18.25 Cents/kWh
Big consumer	17.30 Cents/kWh
MV Customer	16.55 Cents/kWh

Source: EAC Annual Report, 2011

Table 2-75 Electricity Tariff of EDC for Sihanoukville

Consumer	Category	Electricity Tariff per kWh
Domestic	all	720 Riels (17.79 US cents)
Customer paid by Government budget	all	820 Riels (20.26 US cents)
i. Administration, Commercial, Industrial not paid by Government Budget ii. Embassy, NGO and Foreigner's Residence iii. Licensee connected outside the low voltage distribution system	Small	Energy Charge = Average cost of energy received by EDC Sihanoukville during the previous month +4.6 US cents/kWh
	Medium	Energy Charge = Average cost of energy received by EDC Sihanoukville during the previous month +3.8 US cents/kWh
	Big	Energy Charge = Average cost of energy received by EDC Sihanoukville during the previous month +3.4 US cents/kWh
	MV Consumer 275 kVA to 500 kVA	Energy Charge = Average cost of energy received by EDC Sihanoukville during the previous month +2.5 US cents/kWh
	MV Consumer 501 kVA to 1000 kVA	Energy Charge = Average cost of energy received by EDC Sihanoukville during the previous month +2.2 US cents/kWh
	MV Consumer 1001 kVA to 3000 kVA	Energy Charge = Average cost of energy received by EDC Sihanoukville during the previous month +1.8 US cents/kWh
	MV Consumer More than 3000 kVA	Energy Charge = Average cost of energy received by EDC Sihanoukville during the previous month +1.5 US cents/kWh

Source: EAC Annual Report, 2011

Table 2-76 Electricity Tariff of EDC for Provincial Town of Siem Reap

Category of Consumer	Electricity Tariff, Riels/kWh
Small consumer	820 (20.26 US cents)
Medium consumer	800 (19.77 US cents)
Big consumer	750 (18.53 US cents)
MV Customer	700 (18.40 US cents)
Licensees	600 (14.82 US cents)

Source: EAC Annual Report, 2011

Table 2-77 Electricity Tariff of EDC for Provincial Towns of Battambang and Banteay Meanchey and Monkol Borey District Town

Category of Consumer	Electricity Tariff, Riels/kWh
Small consumer	1,000 (24.71 US cents)
Medium consumer	900 (22.24 US cents)
Big consumer	850 (21.00 US cents)
MV Customer	750 (18.53 US cents)
Licensees	600 (14.82 US cents)

Source: EAC Annual Report, 2011

Table 2-78 Electricity Tariff of EDC for Kampong Cham

Consumer	Category	Electricity Tariff per kWh
Domestic	all	940 Riels (23.22 US cents)
Customer paid by Government budget	all	940 Riels (23.22 US cents)
i. Administration, Commercial, Industrial not paid by Government Budget ii. Embassy, NGO and Foreigner's Residence iii. Licensee connected outside the low voltage distribution system	Small	Energy Charge = Average cost of energy received by EDC Sihanoukville during the previous month +4.6 US cents/kWh
	Medium	Energy Charge = Average cost of energy received by EDC Sihanoukville during the previous month +3.8 US cents/kWh
	Big	Energy Charge = Average cost of energy received by EDC Sihanoukville during the previous month +3.4 US cents/kWh
	MV Consumer 275 kVA to 500 kVA	Energy Charge = Average cost of energy received by EDC Sihanoukville during the previous month +2.5 US cents/kWh
	MV Consumer 501 kVA to 1000 kVA	Energy Charge = Average cost of energy received by EDC Sihanoukville during the previous month +2.2 US cents/kWh
	MV Consumer 1001 kVA to 3000 kVA	Energy Charge = Average cost of energy received by EDC Sihanoukville during the previous month +1.8 US cents/kWh
	MV Consumer More than 3000 kVA	Energy Charge = Average cost of energy received by EDC Sihanoukville during the previous month +1.5 US cents/kWh

Source: EAC Annual Report, 2011

Table 2-79 Electricity Tariff of EDC for other Provincial Towns and Town Centers

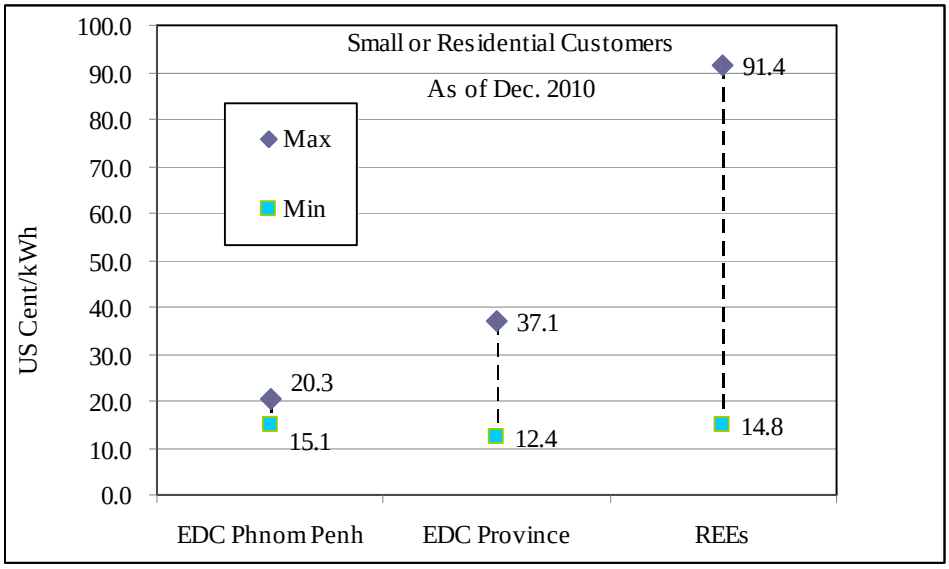
Distribution Areas of EDC	Electricity Tariff per kWh	Condition
Provincial Town of Steung Treng	1,220 Riels (30.14 US cents)	all consumer
Provincial Town of Rattanakiri	670 Riels (16.55 US cents)	all consumer
Provincial Town of Mondul Kiri	1,500 Riels (37.06 US cents)	Household
	1,700 Riels (42.00 US cents)	Hotel&Guest House
Keosema	650 Riels (16.06 US cents)	Small
	11.5 US Cents	Medium
Provincial Town of Kampot	1,100 Riels (27.18 US cents)	all consumer
Provincial Town of Prey Veng	1,220 Riels (30.14 US cents)	all consumer
Memot	500 Riels (12.35 US cents)	Bun Rany Hun Sen Primary and High School
	650 Riels (16.06 US cents)	Small Consumers
	12.5 US Cents	Medium Consumers
	11.5 US Cents	Medium Voltage
Pohnea Krek and Bavet	650 Riels (16.06 US cents)	Small Consumers
	12.5 US Cents	Medium Consumers
	11.5 US Cents	Medium Voltage
Kampong Trach	650 Riels (16.06 US cents)	Small and medium consumers
	11.5 US Cents	Big consumers
Svay Rieng, Kampong Row, Svay Teap	650 Riels (16.06 US cents)	all consumers

Source: EAC Annual Report, 2011

(2) REE

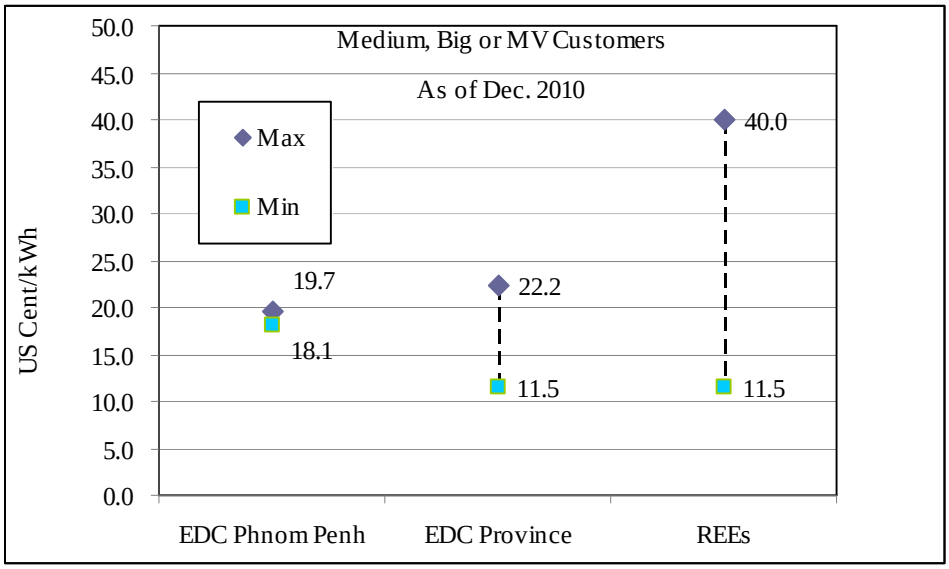
REE electricity tariffs as of December 2010 and comparisons of REE with the EDC Phnom Penh systems / the EDC local offices are described here. Figure 2-55 is a comparison of REE and EDC electricity tariffs for residential and small customers. In Figure 2-56, REE and EDC electricity tariffs of large customers and customers receiving MV supplies are compared. The electricity tarrifs approved by Riel currency, prices are also represented in US cents converted by the exchange rate as of December 31, 2010 (1US$ = 4,047.5Riel).

REE electricity tariffs have a wide range. Tariffs in areas where electricity is supplied directly from the Cambodia-Vietnam or Cambodia-Thailand border are relatively inexpensive, but those of areas where small-scale diesel generators are used for small numbers of customers are quite expensive.



Source: EAC Annual Report, 2011
1US$=4,047.5Riel

Figure 2-55 Electricity tariffs for small and residential customers (December 2010)

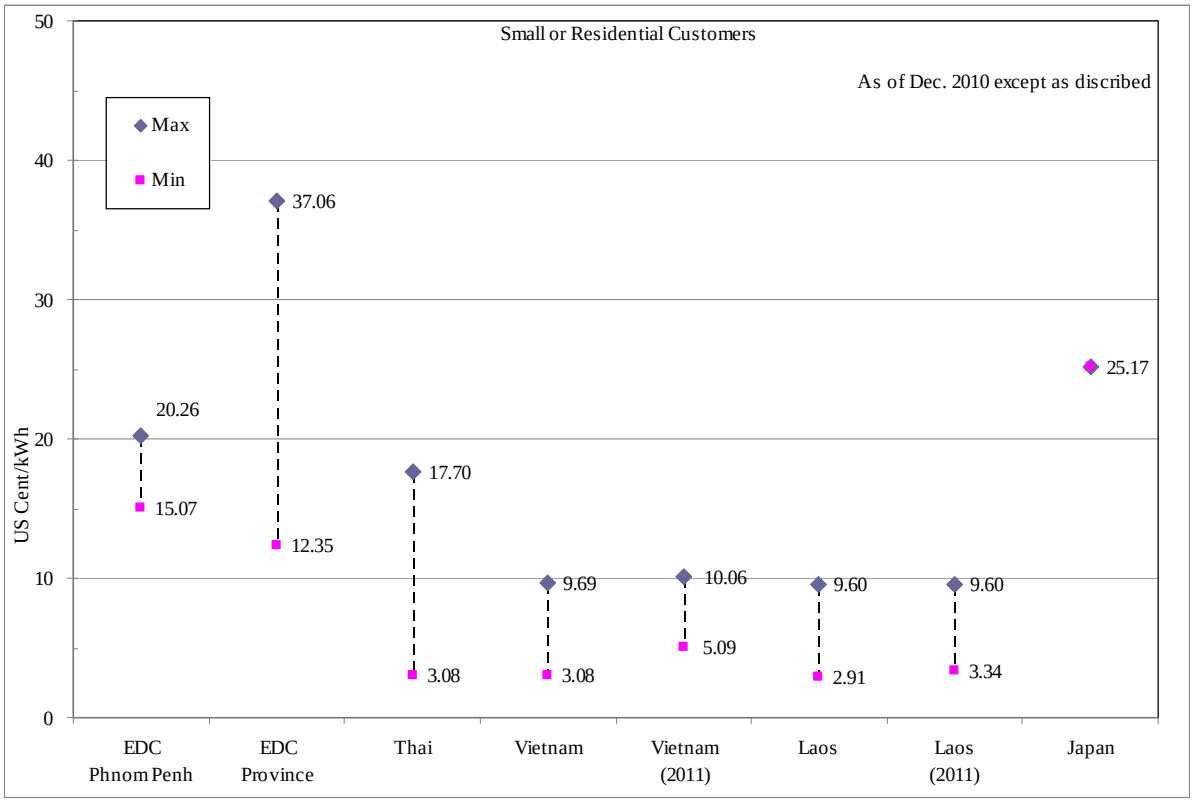


Source:EAC Annual Report, 2011
1US$=4,047.5Riel

Figure 2-56 Electricity tariffs for large or medium customers (December 2010)

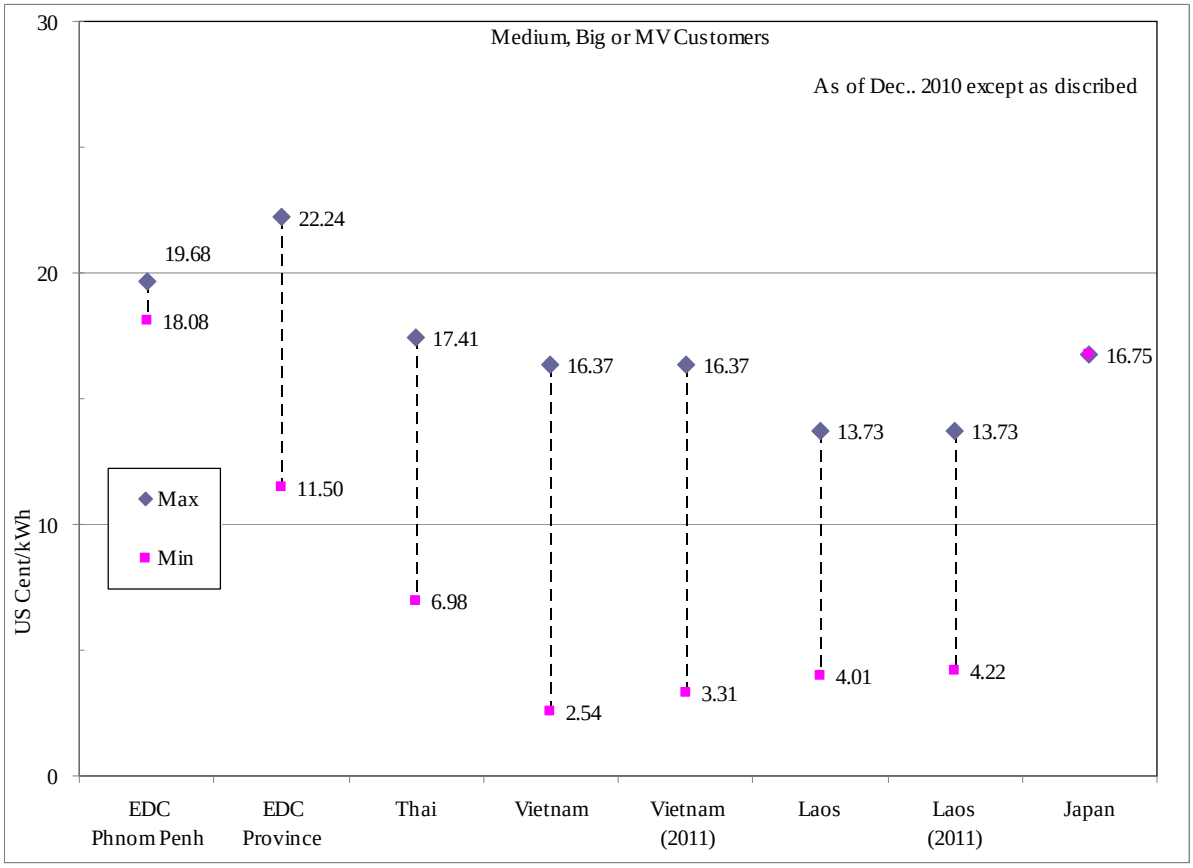
2.14.3 Comparison with neighboring countries

Cambodian electricity tariffs are characterized as (1) high unit price for electricity generation and (2) being influenced greatly by fuel cost, since majority of domestic power rely on small-scale diesel generators. Thus, Cambodian electricity tariffs are quite expensive compared to those of neighboring countries. A comparison of those per 1kWh in 2010 is shown in Figure 2-57 and Figure 2-58.



Source:EAC Annual Report, 2011
Homepage of MEA, PEA, EVN, EDL
Energy Prices and Taxes, IEA, 2011
1US$=4,047.5Riel=30.07THB=19,505VND=8053.8LAK=80.915JPY

Figure 2-57 Comparison of tariffs for residential and small customers (December 2010)



Source:EAC Annual Report, 2011
Homepage of MEA, PEA, EVN, EDL
Enegy Prices and Taxes, IEA, 2011
1US$=4,047.5Riel=30.07THB=19,505VND=8053.8LAK=80.915JPY

Figure 2-58 Comparison of tariffs for large and medium customers (December 2010)

Compared to the neighboring countries, tariffs of residential, large, and medium size electricity of Cambodia are high. The minimum tariffs of residences are cheaper than the unit price for electricity generation in all countries studied, indicating inclusion of subsidies for poverty. Electricity tariffs have been raised twice in Vietnam in 2011, and in Laos, they are raised 1% every year. In Vietnam, average unit price for electricity generation was 1,320VND and electricity sale 1,077VND, i.e., a negative spread.

To reduce electricity tariffs that involve systems connected to transmission lines, MIME promotes the development of large-scale domestic hydropower stations, which have more stable costs, as well as relatively inexpensive coal fire stations. The promotion starts with the Kamchay hydropower station that is scheduled for March 2012 and (other stations) are also expected to commence operations. To lower REE electricity tariffs that are more expensive than tariffs of metropolitan areas, consolidation of the transmission and transformation network will be facilitated to shift from small-scale diesel generators to grid electricity.

2.14.4 Licensing fees

Licensing fees paid by electricity enterprises to EAC are determined every year based on the maximum licensing fee as provided by law. Licensing fees from 2008 to 2010 are shown in Table 2-80.

Table 2-80 Licensing fees

Type	Riel per kWh		
	Year 2008	Year 2009	Year 2010
Generated or Power Purchased from any other Country	1.40	1.30	1.30
Transmission	0.50	0.50	0.50
Distribution and Sale	0.70	0.60	0.60
Retail	0.40	0.30	0.30
Other services license fee	0.1%	0.1%	0.1%

Source: EAC Annual Report, 2011

2.15 Financial statuses of related organizations

2.15.1 Financial status of EAC

The financial EAC is shown in Table 2-81. Licensing fees account for a large proportion of revenue, indicating a stand-alone based system in place. As for expenses, employment costs account for 1/3 of the total expenses.

Table 2-81 Financial status of EAC

[Riel]

	2007	2008	2009
Revenues			
License Fees	2,938,314,797	3,260,934,800	3,962,755,200
Applicaion Fees	8,900,000	11,400,000	5,400,000
Adjustment License Fees	227,700	181,700	134,231,950
Other Revenue	516,903	0	0
Transfer fund from Project	0	0	0
Total Revenues	2,947,959,400	3,272,516,500	4,102,387,150
Expenses			
Fixed Assets	586,726,595	856,390,510	829,904,110
Salary	1,029,564,965	1,181,434,500	1,372,799,400
Transfer fund from Project	1,230,638,674	1,438,847,528	1,536,432,857
Total Expenses	2,846,930,234	3,476,672,538	3,739,136,367
Opening Balance	683,592,345	784,621,512	568,472,086
Income	2,947,959,400	3,272,516,500	4,102,387,150
Expenditure	2,846,930,234	3,476,672,538	3,739,136,367
Surplus / Deficit (Income - Expenditure)	101,029,167	▲ 204,156,038	363,250,783
Closing Balance	784,621,512	580,465,474	931,722,869

Source: EAC Annual Report

2.15.2 Financial status of EDC

Table 2-82 shows balance sheet of EDC from 2002 to 2010. Current ratios, which is used an index for evaluating short-term safety, deteriorated from 2002 to 2008, but has started improving since 2009. Capital ratios, an index that is used to evaluate long-term safety, showed a similar trend.

Table 2-82 Balance Sheet

(unit: 1,000 Riels)

Items	2002	2003	2004	2005	2006	2007	2008	2009	2010
Assets	687,753,261	667,144,307	740,468,273	846,617,646	974,158,618	904,851,713	1,065,255,733	1,377,817,340	1,757,763,688
Long-term assets	494,026,177	473,565,097	510,666,518	539,338,097	625,450,726	567,080,343	671,103,095	791,072,614	970,353,074
Property, Plant and equipment	485,418,785	466,929,191	510,631,674	539,318,695	563,234,083	566,903,776	670,965,708	790,960,747	969,951,942
Intangible	8,607,392	6,635,906	34,844	19,402	50,044	176,567	137,387	111,867	401,132
Recievable from MEF	-	-	-	-	62,166,599	-	-		
Current assets	193,727,084	193,579,210	229,801,755	307,279,549	348,707,892	337,771,370	394,152,638	586,744,726	787,410,614
Cash and cash equivalents	20,964,005	34,460,057	23,558,474	41,667,975	43,071,197	60,999,351	45,798,220	153,350,951	289,457,512
Trade and other receivable	90,927,224	55,388,999	78,352,918	90,452,227	102,207,917	86,536,313	137,623,747	150,873,266	174,691,472
Inventories	33,744,075	34,523,599	43,395,450	43,695,072	51,863,932	58,009,813	66,123,313	79,074,471	117,391,960
Other assets	48,091,780	69,206,555	84,494,913	131,464,275	151,564,846	132,225,893	144,607,358	203,446,038	205,869,670
Liabilities and owner's equity	687,753,261	667,144,307	740,468,273	846,617,646	974,158,618	904,851,713	1,065,255,733	1,377,817,340	1,757,763,688
Non current liabilities	134,304,800	142,464,251	133,382,847	180,273,288	255,963,735	192,359,250	294,428,754	391,288,665	432,139,130
Borrowings	111,448,070	117,187,474	105,174,116	148,298,288	154,675,159	145,601,398	239,975,006	330,724,570	361,525,204
Customer deposits	22,856,730	25,276,777	28,208,731	31,975,000	38,646,042	46,255,959	53,787,756	59,898,913	68,164,789
Payable to Tax Department	-	-	-	-	62,166,599	-	-	-	1,585,002
Provision for retirement benefit	-	-	-	-	475,935	501,893	665,992	665,182	864,135
Current liabilities	136,498,304	118,974,521	190,926,112	299,787,738	314,065,990	294,141,293	317,808,940	395,479,335	503,458,446
Trade and other payables	49,749,583	54,865,277	73,053,754	130,319,719	120,021,248	182,252,205	213,665,252	234,557,571	272,301,325
Borrowings	21,524,881	10,115,348	42,481,752	55,645,923	64,478,533	81,353,377	78,092,672	94,906,670	138,279,382
Interest payable	22,127,872	28,180,007	34,441,452	41,668,732	49,254,101	29,188,459	22,410,380	42,701,150	61,969,026
Current income tax liabilities	43,095,968	25,813,889	40,949,154	72,153,364	80,312,108	1,347,252	3,640,636	23,313,944	30,908,713
Owner's equity	416,950,157	405,705,535	416,159,314	366,556,620	404,128,893	418,351,170	453,018,039	591,049,340	822,166,112
Capital	511,994,849	512,192,242	568,275,518	573,771,280	597,073,404	599,852,950	605,698,016	614,393,127	662,390,444
Accumulated losses	(95,044,692)	(106,486,707)	(152,116,204)	(207,214,660)	(192,944,511)	(181,501,780)	(152,679,977)	(23,343,787)	159,775,668
Current ratio	142%	163%	120%	102%	111%	115%	124%	148%	156%
Capital ratio	61%	61%	56%	43%	41%	46%	43%	43%	47%

Source: EDC Annual Report

The income statements of EDC from 2002 to 2010 are shown in Table 2-83. EDC's sales rapidly grew with the power demand increase, e.g., the sales increase in 2010 was 545% compared to 2002. Meanwhile, operating expenses increased similarly, e.g., the increase in 2010 was 461% compared to 2002. The net profit has been in the red until 2005 but turned into the black in 2006.
Regarding uncollected balance from government organizations, EAC said that the Prime minister issued an order of payment normalization in 2011 and it will be solved soon.

Table 2-83 Income Statements

(unit: 1,000 Riels)

Items	2002	2003	2004	2005	2006	2007	2008	2009	2010
Operation income	293,061,919	336,332,001	400,134,917	527,093,532	733,428,428	924,952,838	1,302,204,274	1,231,327,270	1,598,138,626
Electricity sales	286,305,991	330,092,888	394,396,785	517,685,044	719,042,874	900,026,129	1,206,179,617	1,215,763,623	1,577,667,850
Connetion fees	5,918,709	5,441,240	4,873,640	7,185,446	10,922,201	12,134,765	12,401,745	10,574,579	12,866,750
Grant income from RGC	-	-	-	-	-	-	79,595,200	-	-
Other income	837,219	797,873	864,492	2,223,042	3,463,353	12,791,944	4,027,712	4,989,068	7,604,026
Operating expenses	290,571,123	335,837,198	431,320,666	563,782,416	704,310,742	898,914,084	1,242,149,827	1,047,906,569	1,339,733,438
Purchased power	162,292,413	192,342,404	230,893,090	360,502,165	500,357,575	690,342,369	1,008,753,238	875,453,346	1,144,613,037
Fuel costs	48,456,656	68,423,998	111,695,943	114,559,510	114,957,751	113,066,222	131,107,946	61,018,894	32,782,648
Import duty	5,401,899	5,251,139	7,687,802	7,296,857	5,582,079	6,619,234	12,233,008	10,596,794	31,262,376
Salaries and staff costs	10,059,450	10,308,366	11,670,937	12,523,776	15,601,724	19,509,664	24,633,947	29,764,019	47,764,116
Other operating expenses	31,387,565	24,387,657	26,151,649	30,012,308	29,380,152	33,537,872	30,540,803	34,410,007	43,199,471
Depreciation	27,033,581	27,602,409	36,620,183	38,854,882	38,421,062	35,820,632	34,841,705	36,663,509	40,111,790
Amortisation	5,939,559	7,521,225	6,601,062	32,918	10,399	18,091	39,180	-	-
Operating profit	2,490,796	494,803	(31,185,749)	(36,688,884)	29,117,686	26,038,754	60,054,447	183,420,701	258,405,188
Finance costs (net)	(10,898,965)	(7,840,475)	(9,890,248)	(13,009,085)	(6,400,139)	(5,230,267)	(19,009,403)	(19,768,955)	(30,670,516)
Profit before income tax	(8,408,169)	(7,345,672)	(41,075,997)	(49,697,969)	22,717,547	20,808,487	41,045,044	163,651,746	227,734,672
Income tax expense	(5,049,575)	(4,096,343)	(4,705,742)	(5,123,493)	(8,447,398)	(9,365,756)	(12,223,241)	(34,315,556)	(44,615,217)
Net profit for the year	(13,457,744)	(11,442,015)	(45,781,739)	(54,821,462)	14,270,149	11,442,731	28,821,803	129,336,190	183,119,455

Source: EDC Annual Report

Table 2-84 shows EDC's cash flow from 2002 to 2010. The cash flow was in the red in 2008 but it improved from 2009 and at the end of year 2010, the balance was 289.5 billion Riel.
According to the comments of EAC that is checking the financial status of REEs, EDC has ability to extend distribution lines in its supply area and construct sub-transmission lines to REEs by own budget. The government has a policy that the private companies will invest large-scale power plant and transmission system by BOT scheme and EDC should use own budget for the field where the private sector does not want to invest.

Table 2-84 Cash Flow

(unit: 1,000 Riels)

Items	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cash flows from operating activities	4,060,755	41,871,879	3,820,371	28,047,426	12,558,448	43,514,068	34,221,473	115,721,969	216,382,520
Cash generated from operations	4,277,718	62,481,794	8,034,664	32,277,324	26,277,385	82,221,071	62,698,541	130,229,827	257,239,702
Interest paid	-	-	-	(720,014)	(1,475,470)	(28,492,124)	(18,547,212)	-	(5,421,736)
Taxes paid	(216,963)	(20,609,915)	(4,214,293)	(3,509,884)	(12,243,467)	(10,214,879)	(9,929,856)	(14,507,858)	(35,435,446)
Cash used in investing activities	(4,889,861)	(20,493,992)	(78,419,449)	(28,200,444)	(7,650,641)	(25,508,900)	(37,208,083)	(15,098,547)	(87,804,709)
Purchases of property, plant and equipment	(4,965,733)	(20,525,072)	(78,733,080)	(28,425,686)	(9,239,704)	(25,774,548)	(38,225,583)	(15,435,505)	(92,213,377)
Purchases of software	-	-	-	(17,476)	(41,041)	(144,614)	-	(20,950)	(357,010)
Proceeds from sale of property, plant and equipment	75,872	31,080	313,631	242,718	1,630,104	410,262	1,017,500	357,908	4,765,678
Cash flows from financing activities	2,972,912	(7,881,835)	63,697,495	18,262,519	(3,504,585)	(77,014)	(12,214,521)	6,929,309	7,528,750
Borrowing during the year	15,282,685	4,212,610	65,607,854	24,859,192	4,098,468	4,792,032	6,681,473	6,872,146	6,235,352
Repayment of borrowing	(12,309,773)	(12,094,445)	(6,206,604)	(6,596,673)	(7,603,053)	(4,869,046)	(20,050,794)	(181,088)	(10,694)
Grants, Interest received	-	-	4,296,245	-	-	-	1,154,800	238,251	1,304,092
Increase in cash and cash equivalents	2,143,806	13,496,052	(10,901,583)	18,109,501	1,403,222	17,928,154	(15,201,131)	107,552,731	136,106,561
Cash and cash equivalents at beginning of year	18,820,199	20,964,005	34,460,057	23,558,474	41,667,975	43,071,197	60,999,351	45,798,220	153,350,951
Cash and cash equivalents at end of year	20,964,005	34,460,057	23,558,474	41,667,975	43,071,197	60,999,351	45,798,220	153,350,951	289,457,512

Source: EDC Annual Report

2.16 System stabilization and quality of electricity

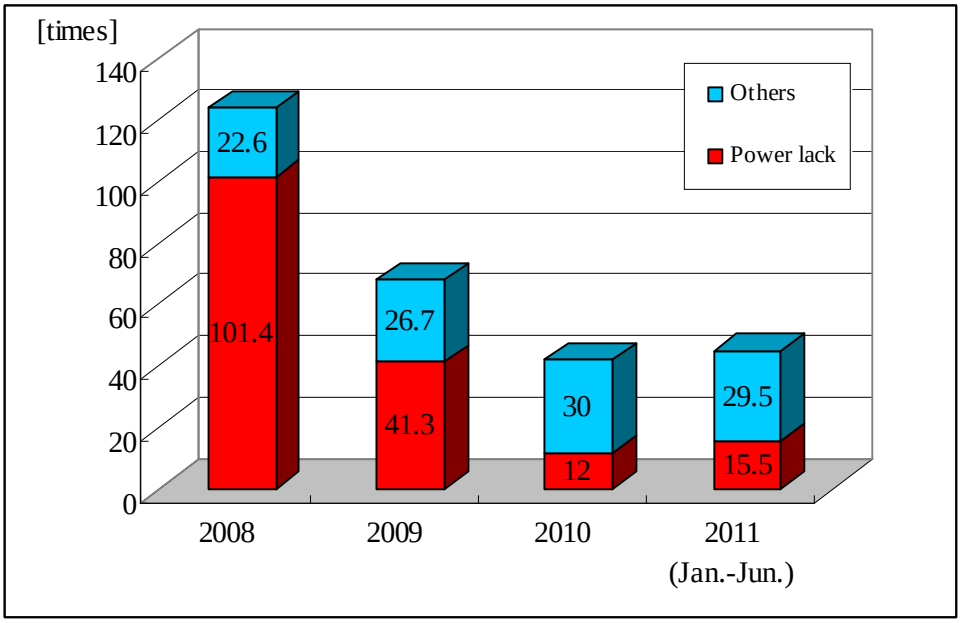
2.16.1 Power failure

Power failure incidences from 2008 to 2011 are shown in Table 2-85, Figure 2-59 and Figure 2-60. Table 2-85 indicates the numbers of power failure incidences and durations of power failure by causes and total figures can be found at the bottom row. Records before June 2011 show that 1/3 of power failure incidences and 1/2 of the duration of power failure were due to supply capacity shortage. The power supply shortage observed in 2008 improved in 2009 and 2010 following procurement of electricity from Vietnam. However, since the upper limit is set for the amount of electricity that can be procured from Vietnam, the increased demand caused increased power failure incidences and durations of power failure in 2011, which eventually became similar to those of 2010. Fore a reference, power failure incidences and durations of power failure per household in Japan in 2007 were 0.14 and 16 min, respectively, which were <1/100 of those in Cambodia.

Table 2-85 Power failure incidences and duration by cause

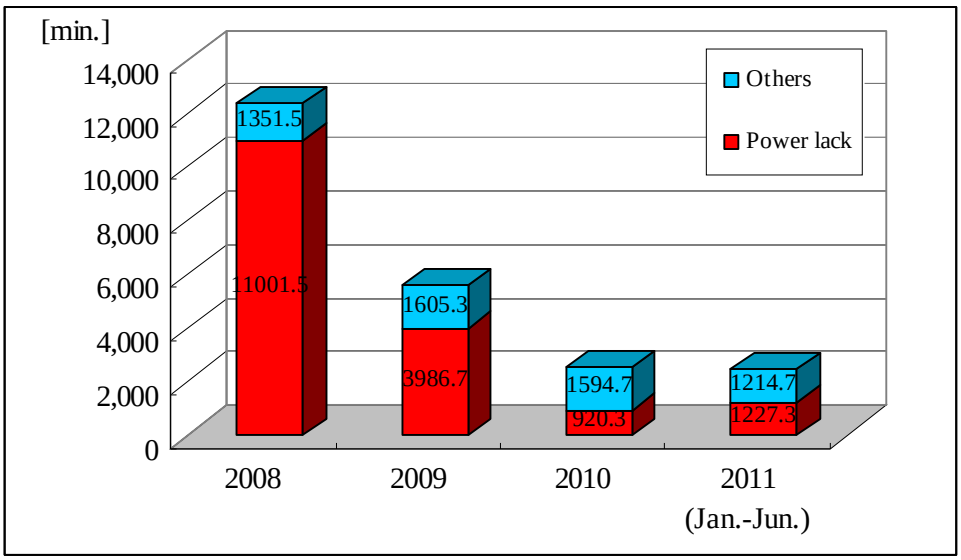
	Cause Description	2008		2009		2010		2011(Data by June)	
		SAIFI	SAIDI	SAIFI	SAIDI	SAIFI	SAIDI	SAIFI	SAIDI
		Times	Minutes	Times	Minutes	Times	Minutes	Times	Minutes
BO	Generator fault	1.0	205.0						
	Unstable Frequency Fluctuation								
	Other	1.0	267.0	5.0	485.5	1.0	30.0		
	Total	2.0	472.0	5.0	485.5	1.0	30.0	0.0	0.0
CUT	Generator	2.1	64.0	1.3	34.1	0.3	9.2	0.1	2.8
	Power lack	101.4	11001.5	41.3	3986.7	12.0	920.3	15.5	1227.3
	Install new power network	0.2	28.7	0.6	136.0	0.8	112.2	1.0	124.2
	Install electrical equipment	0.2	32.5	0.2	28.6	0.5	62.3	0.1	20.5
	Repair network	1.4	240.0	0.9	208.7	2.1	452.6	1.8	308.2
	Repair electrical equipment	0.1	12.2	0.3	44.6	0.9	116.8	0.3	18.5
	Other incidents	0.1	16.7	0.9	130.1	1.2	109.5	2.2	202.1
	Maintenance electrical	0.1	2.3	0.1	2.3	1.1	65.9	0.5	54.2
	Trip CB	1.6	57.6						
	Trip11.1,11.2	0.7	19.1						
	Total	107.8	11474.7	45.5	4571.1	19.0	1848.8	21.7	1957.9
Trip	Generator fault	1.2	30.2	0.5	4.8				
	Wave of Frequency			0.3	1.8	0.1	0.4		
	Power lack	0.4	14.7	0.0	0.3				
	Over load	0.6	7.4	0.7	2.3	2.4	19.3	0.9	5.1
	Network Fault							11.2	239.3
	Over head line,Cablefault	1.4	105.2	0.6	54.1	1.6	159.5	0.7	65.4
	Electrical equipment fault	0.5	24.6	1.2	143.0	1.4	107.6	0.4	9.2
	Cause by other feeder have a fault	0.2	3.7	0.3	3.9	0.1	4.2	0.0	0.1
	Unknown fault	7.4	149.4	11.2	251.4	12.8	199.0	8.3	87.4
	Digging	0.1	9.4	0.1	8.3	0.2	22.1	0.1	7.8
	Bird	0.0	0.0	0.0	0.9	0.0	2.7	0.1	1.8
	Tree or Something	0.2	9.3	0.4	25.2	1.2	58.9	0.6	19.6
	Lightning	0.0	3.7			0.0	10.9	0.4	18.8
	rain,wind	1.5	23.3	1.9	32.8	1.8	32.7	0.3	4.8
	Other fault	0.8	25.3	0.3	6.9	0.5	19.1	0.3	24.2
	Total	14.2	406.4	17.6	535.6	22.2	636.5	23.2	483.8
Grand Total		124	12353	68	5592	42	2515	45	2442

Note: SAIFI = power failure incidence per household, SAIDI = duration of power failure per household
Source: EDC



Source: EDC

Figure 2-59 SAIFI



Source: EDC

Figure 2-60 SAIDI

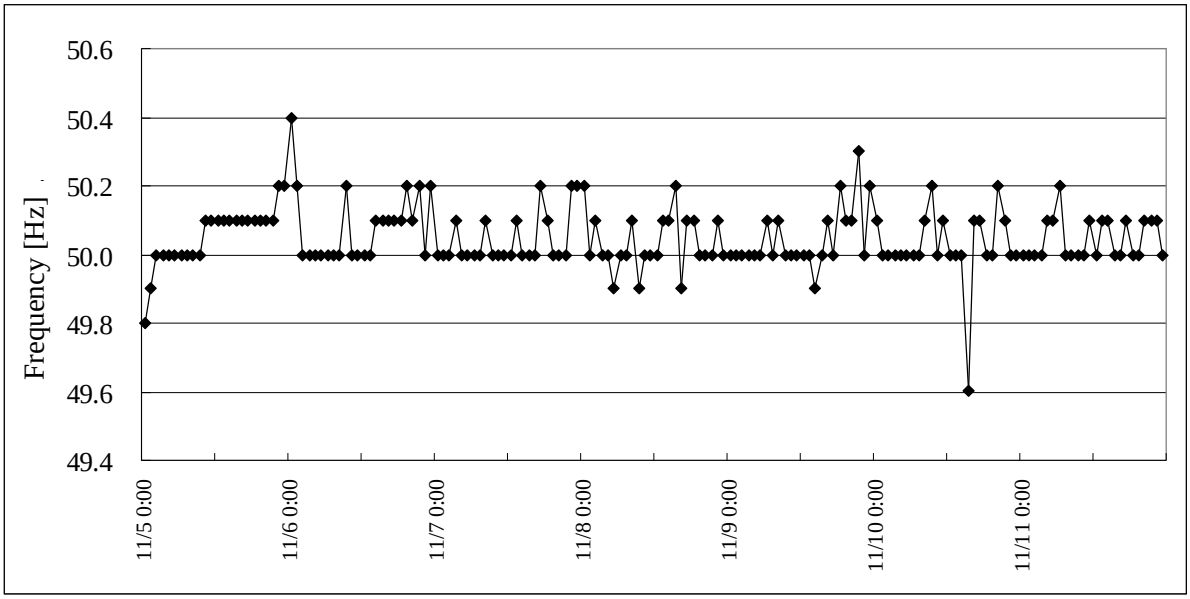
2.16.2 Voltage and frequency

With respect to the quality of electricity, Cambodia specifies to maintain 50 ± 0.5[Hz] for frequencies and the reference voltage ± 10% for voltages. However, since the frequency of the joint system on the Vietnam side is overwhelmingly larger, adjustment of the Phnom Penh system depends on Vietnam by necessity. That means, that even if the frequency decreases, the specified frequency may not be maintained despite Cambodian endeavors to adjust generator output or intercept loads.

Figure 2-61 to Figure 2-64 show frequencies and voltages recorded for the Phnom Penh system. Voltage graphs originate from the GS4 substation on the day the maximum output was recorded in 2011. The specified voltage of the reference voltage ± 10% was maintained and for 22kV and 115kV, it was mostly within the reference voltage ± 5%. As for 230kV, it fluctuated at a lower range, since the reference voltages are 230kV in Cambodia and 220kV in Vietnam.

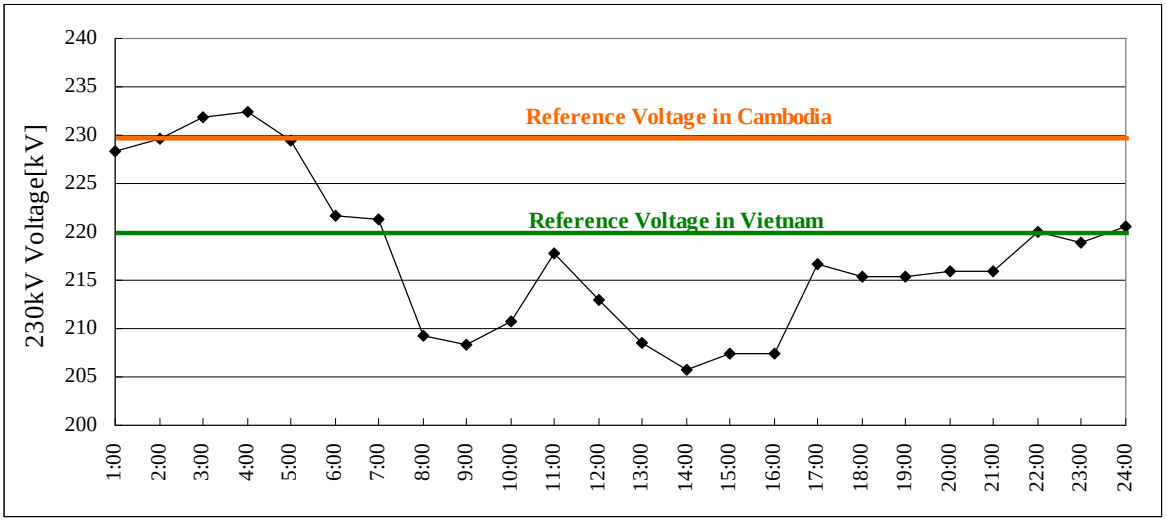
For a reference, target frequencies in Japan are specified and operated as 60 ± 0.2[Hz] or 50 ± 0.2[Hz] (50 ± 0.3[Hz] in Hokkaido) by electricity enterprises. Voltages in Japan are specified by the national

law to maintain 101 ± 6[V] for the reference voltage 100V circuit and 202 ± 12[V] for the 200V circuit at locations of electricity supply. Voltages for other systems are determined and operated individually by enterprises.



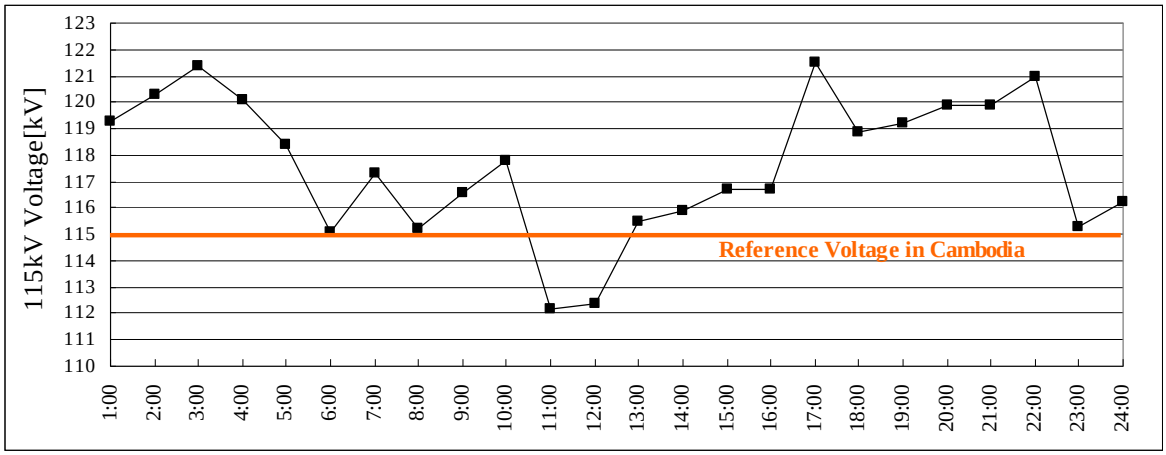
Source: EDC

Figure 2-61 Status of frequencies (2011/11/5-11)



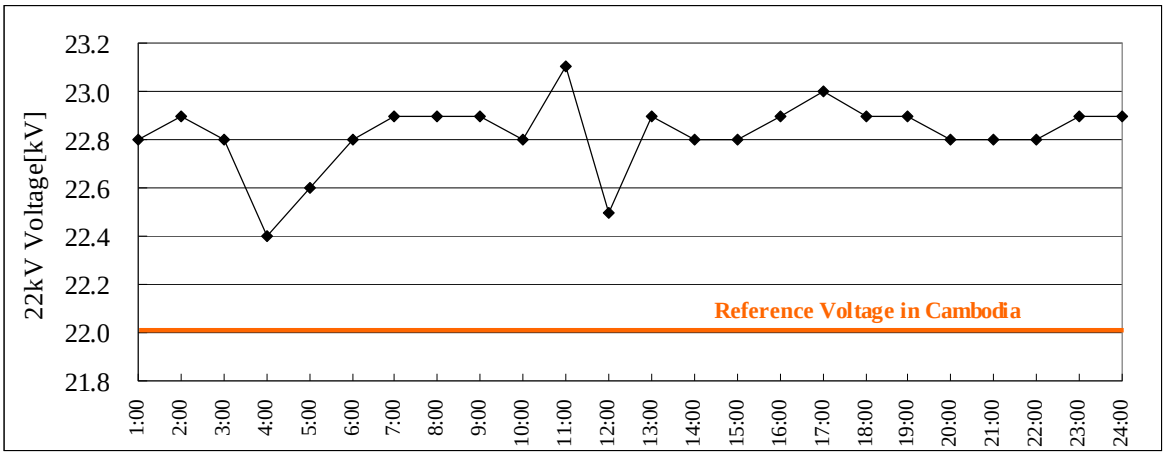
Source: EDC

Figure 2-62 Status of voltage of the 230kV system (2011/10/24, GS4)



Source: EDC

Figure 2-63 Status of voltage of the 115kV system (2011/10/24, GS4)



Source: EDC

Figure 2-64 Status of voltage of the 22kV system (2011/10/24, GS4)

2.16.3 System stabilization

At present, stable electricity supply is at high risk, since the proportion of electricity procured from Vietnam is large, i.e., if a tie line with Vietnam is intercepted as a result of accident, etc., frequencies of the Phnom Penh systems decrease and all systems in Phnom Penh are highly likely to fail. In actuality, power failure was experienced in all systems of Phnom Penh in 2010. The reading of the current in the tie lines was wrong and (the operator) thought there still was a leeway before reaching the maximum current volume of the tie lines. However, Vietnam suddenly shut down the transmission and the supply capacity became insufficient. Cambodia discussed with Vietnam thereafter to contact Cambodia before shutting down the electricity transmission when the maximum current for the tie lines is exceeded and it has been operated as such from them on.

2.17 Opinions of Japanese companies

Members of the Japanese Business Association of Cambodia were surveyed through JICA and JETRO. The objective of this survey was to obtain basic information that would help in creating contributive cases for Japanese companies launched or plan to launch in Cambodia. Answers were collected from 11 companies.

2.17.1 Quality of electricity

Answers related to quality of electricity are shown in Table 2-86. Relatively few answered that the current quality is intolerable. Results showed that quality improvement can promote Japanese companies such as manufacturers to launch in Cambodia.

Table 2-86 Results of Questionnaire (11 companies)

Question	Answer	
	YES	NO
Can you tolerate instantaneous voltage decreases caused by thunderbolts?	5 companies	5 companies
Can you tolerate frequency fluctuations? If No, how much fluctuation can you tolerate?	6 companies	5 companies 5～10%
Can you tolerate voltage fluctuations? If No, how much fluctuation can you tolerate?	4 companies	6 companies 5～10%
Up to how many minutes can you tolerate a continuous power failure?	0 min: 2 companies 1 min: 1 company 5 min: 2 companies 10 min: 2 companies 12 min: 1 company	
Do you think improvement in electricity quality can promote Japanese companies to launch in Cambodia?	8 companies	1 company

Note: Unanswered questions are not included in this Table
Source: Survey Team

(Answers and requests)

- Must be difficult to have the quality of the Japanese standard right away. Development of a business model and a cost structure that do not depend on electricity tariffs or quality may be a challenge. (Food manufacturing industry)
- For the manufacturing industry that uses production machinery, voltage fluctuations can cause equipment malfunction and want to avoid (power outages). Quality has been not so bad. However, hope you can do something about occasional unplanned power outages. (Architectural equipment industry)
- A large-scale generator that will be able to satisfy increased demand should be constructed for the future. (Architectural equipment industry)
- Voltage decreases suddenly before power outage. This is very bad for electronic equipment. (Construction industry)
- Instantaneous power outages also cause production loss. In any event, stable supply is wanted. (Manufacturing industry)
- Fire has broken out from a transformer. If electricity of stable quality is available, we can use electric appliances without worries. (Agricultural production and sales)
- Wish the number of power outages will be reduced. (Automobile sales)
- Current quality of electricity is not a major problem if office management and buying and selling activity are the only concern. However, low quality of electricity will be a major problem if competitive production cost for goods produced in Cambodia or investment for Cambodian manufacturers are involved. (General trading company)
- Sudden power outages accompanied by continuous power outages of <1 hour interfered with the continuous production at out factory. (Food manufacturing industry)

- Power outage by thunderbolts during the rainy season is the worst headache. (Company from the special economic zone)
- Power is out for 1-4 hours almost every day depending on the season, interfering with scheduled production. Equipment emergently stops due to power outage and equipment failure is now concerned. (Manufacturing industry)

2.17.2 Electricity tariffs

Answers related to electricity tariffs are as follows. Many companies feel that electricity tariffs are high despite low quality.

Question: What is your opinion/wish on electricity tariffs in Cambodia?
(Answers)

- May not have a choice other than charging higher tariffs than resource-rich countries, since no particular resources or industries exist and availability of raw fuel depend on import. (Food manufacturing industry)
- Life of Cambodian people can change if electricity tariffs are reduced further. (Tourist industry)
- High compared to neighboring countries. Will be great if it becomes about half the current price. (Agricultural production and sales)
- Can't understand why electricity tariffs are high despite frequency power outages. (Construction industry)
- Will be nice if the RGC releases specific goals to show the extent of reduction in 3, 5, and 10 years. (Company from the special economic zone)
- Electric tariff that is nearly 2-3 times higher than that of neighboring countries interfere with foreign investment to Cambodia and also affects export pricing of agricultural products, which is supposed to be more competitive. For instance, rice is the main agricultural export product, but power consumption cost for milling of rice is approximately US$10/mt higher than that of Vietnam (on a polished rice basis). High electricity tariffs are unavoidable due to the geographical reason, but this is a major setback in the economic development. (General trading company)
- To maintain competitiveness with neighboring countries, electricity tariffs should be similar. (Manufacturing industry)

2.17.3 Obstacles for Japanese companies launching in Cambodia

Regarding obstacles for Japanese companies to launch in Cambodia, some answered electricity tariffs but the biggest issues were infrastructure consolidation, human resources of the RGC, difficulty in finding good employees, and difficulty in keeping employees.

Question: What is the biggest obstacle for a Japanese company to launch in Cambodia?
(Answers)

- Not many middle-management level Cambodians are available. Employment is difficult and maintenance of employment is laborious. (Food manufacturing industry)
- Government and people. Lack of information. (Tourist industry)
- Not only electricity, but consolidation of other infrastructure is highly needed. (Architectural equipment industry)
- Problems of governance and lack of experienced personnel. Construction engineers and field supervisors hardly have experiences. (Construction industry)
- Costs other than the employment cost are expensive. (Manufacturing industry)
- Impression of Cambodia is yet not good. (Agricultural production and sales)
- Governance problems. Low population. Low GDP. (Automobile sales)
- In a case of the manufacturing industry, it really is the high electricity tariffs. (Company from the special economic zone)
- High transportation cost, high cost associated with competition principle not working, lack of basic training of employees, high electricity tariffs, etc. (General trading company)

- Surrounding industries for raw materials and parts are not available. (Manufacturing industry)

2.17.4 EDC's customer service

For the question on EDC's customer service in case of power outages, most answered that nothing was done (no prior notice or follow-up explanation). Causes of power outages were unknown and nothing could have been done other than waiting for restoration.

Question: What is your opinion on EDC's customer service in case of power outages?
(Answers)

- Slow restoration. It can take 3 days in Siem Reap. (Tourist industry)
- Usually, EDC does not do anything in case of power outages. (Architectural equipment industry)
- Type and location of customer service is unknown. Cannot make a complaint. (Construction industry)
- Wish to know when and where power will be out. Wish planned power outages will be publicized. Not aware of EDC's customer service in case of power outages. (Agricultural production and sales)
- I understand that no customer service is provided in particular. Just wait to be restored. I have no expectation. (Automobile sales)
- In order to avoid damages to equipment associated with sudden power outage, we have sent a request to EDC to notify us beforehand (20 min before is acceptable), but this request was not accepted. (Manufacturing industry)

2.17.5 Questionnaire results for overall Cambodian electric power

A question on electricity in general was asked. Japanese companies wish to have construction of relatively inexpensive thermal power plants because of the insufficient supply capacity at present. Japanese companies may be willing to go to Cambodia with respect to construction and operation of highly-efficient coal-fired power stations, since Japan has high technology in these areas.

Question: Tell us about electric power in Cambodia.
(Answers)

- Power stations should be constructed as soon as possible, since procurement of electricity from Vietnam and Thailand may not be available in the future. (Architectural equipment industry)
- China is constructing hydropower stations in a few locations, but electricity supply will be reduced during the dry season due to lack of water. It is apparent that thermal power stations will be necessary as an alternative. Locations where a Japanese business company, etc., are interested in investing should be searched immediately. (Construction industry)
- Since the aim is ambiguous in this country, industrial policies and energy plans to be followed are also unclear. Cambodia as a nation needs to be more specific on what their aim is and what industries are to be developed, as well as for the achievement, when electricity should be supplied, how much electricity should be supplied, and what type of quality the electricity should have. (Food manufacturing industry)