3. PRESENT SITUATION AND ISSUES OF RURAL ELECTRIFICATION

3.1 OUTLINE OF POWER SUPPLY IN CAMBODIA

Electricity was introduced in Cambodia first in the year 1906. Up to the year 1958, electricity in Cambodia was supplied by the three (3) private companies, namely CEE, UNEDI and CFKE. At the time, CEE supplied electricity to Phnom Penh and its surrounding areas and UNEDI to all provinces except for Battambang, which was supplied by CFKE.

In 1958, the Government took over CEE and UNEDI and established a new state-own enterprise called as EdC. In 1958, total installed capacity in the country was approximately 30 MW, of which 16 MW was owned by EdC and others by private companies. In 1970, total installed capacity of EdC reached 61 MW, 68.5% of the total capacity of the country (79 MW).

During 1971 to 1979, the power sector in the country passed through two dangerous events: social disorder triggered by a coup d'etat (1971-1975) and turbulent history during the Pol Pot Regime (1975-1979). During this time, all kinds of generation, transmission and distribution facilities were destroyed not only in Phnom Penh but also in other areas.

After the liberation in 1979, the Government started to restore the electricity infrastructure in the capital town and main provincial towns of the country. At that time, the whole electricity supply in the country was under management of the Ministry of Industry. The Government re-established EdC with the task of electricity supply in Phnom Penh and established small enterprises in provinces with the responsibility to supply electricity in each province. Remarkable progress was made in power sector from 1991 resulting in restoration and development of electricity infrastructure and supply of electricity.

The present power supply in the country still consists of many isolated systems except for a system of provincial town of Kampong Speu which was connected since 2002 with the Phnom Penh system through a 115 kV single circuit transmission line from the Kirirom hydropower station (IPP CETIC) to Phnom Penh. Phnom Penh, almost of all the provincial towns and some small towns have their own power supply system isolated each other. EdC and REEs purchase electricity from neighboring countries for supplying to the small towns close to Cambodia-Vietnam border and Cambodia-Thailand border and other areas have their own generating facilities or purchase electricity from IPPs.

National electrification ratio with grid-quality electricity at the end of 2004 is estimated at about 15.3 %, which consists of 8.4% by EdC, 2.9 % (at the end of 2004) by other consolidated licensees of EAC and 4.0 % (Source: Team's questionnaire to DIME) by REEs with DIME's licenses or non-licenses. In addition to the electrification ratio with grid-quality electricity, the electrification ratio by rechargeable batteries is estimated about at 38.5 % (Source: Team's questionnaire to DIME)). The summary table of number of customers and electrification level by province is given in Table 3.1.1 attached hereto. As shown in the table, the electrification ratio of the country including domestic customers by batteries is estimated at 53.8 %.

Table 3.1.1 Electrification Level of Whole Country by Grids and Rechargeable Batteries

ID-	Province	Population Census (2004)			Supply by EDC (2004) *1				Supply by EAC's Licensees *2			Supply by Other Suppliers *3		Electrif. Ratio by Grid/Mini-grid		Electrification by Rechargeable Batteries *4		Electrif. Ratio inclu. Batteries	
		Population (2003)	Number of Family	Nos of Household	Nos. of Customer (2004) Domestic	Others	Total	Ratio (%)	Nos. Licensees	Nos. of Customer	Ratio (%)	Nos. of Customer	Ratio (%)	Nos. Customer	Ratio (%)	Estimated Customer	Ratio (%)	Total Customers	Ratio (%)
1	Banteay Meanchey	669,961	130,362	122,576					8	6,318	5.2	42,838	34.9	49,156	40.1	26,279	21.4	75,435	61.5
2	Battambang	918,173	179,574	170,507	15,073	415	15,488	8.8	8	3,439	2.0	n.a		18,512	10.9	1,117	0.7	19,629	11.5
3	Kampong Cham	1,717,769	355,800	315,558	8,099	186	8,285	2.6	13	5,825	1.8	17,698	5.6	31,622	10.0	226,590	71.8	258,212	81.8
4	Kampong Chhnang	430,962	88,675	83,559					5	5,136	6.1	1,149	1.4	6,285	7.5	42,348	50.7	48,633	58.2
5	Kampong Speu	675,932	129,333	124,977					7	3,220	2.6	2,075	1.7	5,295	4.2	n.a		5,295	4.2
6	Kampong Thom	616,370	120,693	111,059					7	7,198	6.5	758	0.7	7,956	7.2	86,064	77.5	94,020	84.7
7 & 23	Kampot/Krong Kep	599,006	118,527	115,359	6,317	0	6,317	5.5	4	1,450	1.3	n.a		7,767	6.7	n.a		7,767	6.7
8 & 12	Phnom Penh/Kandal	2,168,398	413,102	375,241	137,649	13,087	150,736	36.7	13	8,364	2.2	4,211	1.1	150,224	40.0	63,352	16.9	213,576	56.9
9	Koh Kong	126,595	24,867	24,381					3	4,416	18.1	1,201	4.9	5,617	23.0	6,049	24.8	11,666	47.8
10	Kracheh	280,521	55,770	49,691					1	2,642	5.3	115	0.2	2,757	5.5	33,842	68.1	36,599	73.7
11	Mondol Kiri	43,067	9,455	7,923								430	5.4	430	5.4	982	12.4	1,412	17.8
13	Preah Vihear	137,002	27,548	24,994					1	550	2.2	200	0.8	750	3.0	n.a		750	3.0
14	Prey Veng	1,050,743	221,990	196,919	2,587	0	2,587	1.3	5	3,950	2.0	3,800	1.9	10,337	5.2	148,004	75.2	158,341	80.4
15	Pursat	378,572	73,280	71,569					5	5,964	8.3	1,361	1.9	7,325	10.2	29,310	41.0	36,635	51.2
16	Ratana Kiri	114,451	23,435	19,195	2,098	94	2,192	10.9			0.0	43	0.2	2,141	11.2	137	0.7	2,278	11.9
17	Siem Reap	762,816	139,035	135,311	9,883	818	10,701	7.3	3	940	0.7	1,827	1.4	12,650	9.3	4,390	3.2	17,040	12.6
18	Sihanoukvill	164,364	31,212	29,646	7,376	805	8,181	24.9	3	2,180	7.4	n.a		9,556	32.2	n.a		9,556	32.2
19	Stung Treng	77,372	14,960	13,429								2,376	17.7	2,376	17.7	1,711	12.7	4,087	30.4
20	Svay Rieng	526,904	109,264	103,012	1,426	3	1,429	1.4				4,830	4.7	6,256	6.1	30,807	29.9	37,063	36.0
21	Takeo	862,342	167,750	160,730	2,147	408	2,555	1.3	8	2,008	1.2	5,953	3.7	10,108	6.3	157,981	98.3	168,089	104.6
22	Oddar Meanchey	136,358	26,752	25,210					2	1,097	4.4	539	2.1	1,636	6.5	12,630	50.1	14,266	56.6
24	Krong Pailin	45,723	10,450	9,406					1	1,589	16.9	n.a		1,589	16.9	10,311	109.6	11,900	126.5
		12,503,401	2,471,834	2,290,252	192,655	15,816	208,471	8.4	80	66,286	2.9	91,404	4.0	350,345	15.3	881,904	38.5	1,232,249	53.8

Remarks:
*1: Source: EDC. 2004, Electrification ratio is calculated on the basis of number of domestic customers.
*2: Source: EAC's annual report 2005 (actual data in 2004) except for Generation Licensees. Electrfication ratio is calculated against reported number of customers, because of no informations on customer groups.
*3: Source: Reply from DIME against questionnaire of JICA Study 2004-2005. The shaded column in the table means "not available" or "doutful". Number of other suppliers is subtracted number of licensed customers from reported total number of customers, becase the reported one is not devided by license group.
*4: Source: Reply from DIME aginst questionnaire of JICA Study 2004-2005. The shaded column in the table means "not available" or "doutful". For example, reported number of households electrified is bigger than total households of census.

3.2 POWER SUPPLY BY EDC

3.2.1 Power Supply Systems

EdC transferred to be under management of Phnom Penh Municipality from the Ministry of Industry in 1991 and re-named as Electricite de Phnom Penh (EDP). In 1992, EDP was re-named as Electricite du Cambodia (EdC) and attached to the Ministry of Energy. After election in 1993, EdC was restructured under the MIME and was responsible for development, management and operation of power supply facilities in Phnom Penh.

In March 1996, EdC became a wholly state-owned limited liability company to generate, transmit and distribute electric power throughout the country.

EdC has been granted a Consolidated License (No.001L) consisting of Generation, Distribution and Transmission Licenses as explained in Clause 3.3.1. The license gives EdC the right to provide transmission service for entire country and to provide distribution service in its licensed areas and to operate generating facilities at different locations. In 2004, EdC supplied electricity in its licensed areas of Phnom Penh/Kandal, eight (8) provincial towns (Sihanoukville, Siemreap, Battambang, Takeo, Kampong Cham, Prey Veng, Ratana Kiri (Banlung) and Kampot) and four (4) small isolated systems near the border with Vietnam (Ponhea Krek district of Kampong Cham, Memot district of Kampong Cham, Baveth commune of Svay Rieng and Kampong Trach of Kampot). In four (4) provincial towns of Kampong Speu, Banteay Meanchey, Stung Treng and Svay Rieng, its operation of power systems has taken over by EdC in 2004 from DIME or private enterprises, which distribution systems are under reconstruction and/or rehabilitation under the Provincial Power Supply Project (ADB).

3.2.2 Generating Facilities

Generating facilities for supplying electricity to the EdC's supply areas consist of diesel power plants owned by EdC and IPPs with hydropower and diesel power plants. Total installed capacity of EdC as of 2004 is 95.1 MW (available output: 77.2 MW), of which Phnom Penh system shared 68% of the total (65.0 MW, available output: 56.5 MW). For Siemreap, new diesel power plant with 3 x 3.5 MW capacity under the grant assistance of Japanese Government commenced its operation in April 2004. O Chum mini-hydro power plant with a capacity of 1,000 kW was transferred from MIME in 2004 to EdC for supplying electric power to the customers of provincial town of Ratnakiri which became a new licensed area of EdC.

In addition to the EdC's generating facilities, IPPs operated generating facilities as Generation Licenses with total installed capacity of 91.0 MW, of which 86.4 MW is supplied to EdC in accordance with power purchase agreements. The installed capacity of the EdC system is shown in Table 3.2.1. In these IPPs, only Kirirom power plant owned by CETIC is hydropower plant with two units of Pelton turbines.

Table 3.2.1 Installed Capacity (Name Plate) of Generating Plants

Unit : MW

	Plant	Owner	Kinds	Year in Service	Unit No.	Unit Cap.	Capacity
Phnom Penh	C2	EdC	Steam	1995	3	6	18.0
	C3	EdC	Diesel	1995	6	2.8/2.1	15.4
	C5	EdC	Diesel	1995	5	5.0/0.8	13.0
	C6	EdC	Diesel	1995	3	6.2	18.6
	EdC total						65.0
	IPP	CUPL	Diesel	1997	7	6.89	38.6
	IPP	Jupiter	Diesel	2000	17	2/0/1.06	24.9
	IPP	CETIC	Hydro	2002	2	6	12.0
	IPP Total						75.5
Sihanoukville		EdC	Diesel		8	1.3/0.4	9.2
Kampong Cham	IPP	GTS	Diesel		4	1.4/0.7	3.6
Battambang		EdC	Diesel		4	1.0/0.4	2.3
	IPP	Jupiter	Diesel		4	1	4.0
Takeo		EdC	Diesel		3	0.6/0.3	1.1

Source: EAC

In addition to the above existing generating facilities, five (5) diesel power plants with total installed capacity of 8.5 MW are under construction at provincial towns of Takeo, Stung Treng, Kampot, Banteay Meanchey and Prey Veng under the Provincial Power Supply Project and will come on stream in 2005.

3.2.3 Power Transmission and Distribution Facilities

Transmission and distribution line voltages of the countries are of 115 kV for the transmission system, 4.0 kV, 6.3 kV, 15 kV and 22 kV for the medium voltage distribution system and 380/220 Volt for the low voltage distribution system. The transmission line voltage of 110 kV was firstly introduced to Cambodia in 1970 for transmitting electric power generated at the Kirirom No.1 hydropower station to Phnom Penh via Prek Tnout, but completely destroyed during the turbulence started in 1971.

The present single circuit 115 kV transmission lines were constructed in 1999 between the grid substations in Phnom Penh (GS1, GS2 and GS3) for decreasing system losses and increasing system reliability. It was followed by another 115 kV line between the Kirirom hydropower station and Phnom Penh (GS1) via Kampong Speu substation for transmitting electric power from Kirirom to Phnom Penh (2001).

For the medium voltages of Phnom Penh system, three (3) kinds of voltages of 4.0 kV, 6.3 kV and 15 kV were used in the beginning of 1990s. The Government made its effort to change-over the 4.0 kV and 6.3 kV to 15 kV for increasing power carrying capacity of the lines and reducing its distribution losses. As a result of the effort, the 4.0 kV systems were completely changed over to 15 kV by 1998 and 6.3 kV by 2000. A new medium voltage of 22 kV was introduced to the Phnom Penh system in 2000 and the similar effort for changing over to 22 kV was further continued. By the end of 2003, total capacity of 15/0.4 kV distribution transformers were significantly decreased from 217 MVA in 2000 to 42 MVA in 2004.

For other provinces, the old distribution line voltages are still used. Under the Provincial Power Supply Project, those old distribution systems are reconstructed with a new 22 kV-380/220 V system in the selected provinces for transferring its management to EdC and for starting its operation in 2005. The trend of transmission and distribution line length by voltage and number of distribution transformers managed by EdC are given in Table 3.2.2.

Table 3.2.2 Transmission and Distribution Facilities of EdC

Unit: cct･km

	1998	1999	2000	2001	2002	2003	2004
High voltage line	-	22.7	22.7	128.7	128.7	128.7	128.7
Medium voltage	319.4	411.6	423.1	476.3	558.0	635.7	1,119.6
Over head line	141.1	189.0	186.6	225.0	289.3	311.6	632.7
UGC	178.3	222.6	236.5	251.3	268.5	324.1	486.9
Low voltage line	409.1	465.7	670.6	708.6	831.6	842.9	1,549.3
Nos. of transformers	679	712	705	617	602	585	658

Source: EdC

3.2.4 Power Generation, Purchase and Import

Generated, purchased and imported energy by EdC's supply area are given in Table 3.2.3. As shown in the table, total energy generated by EdC, purchased from IPPs and imported from neighboring countries was reached to the level of 761 GWh in 2004 with an increase rate of 20.3 % against last year, which consists of 309 GWh by own generation, 439 GWh purchased from IPPs and 13 GWh imported from Vietnam.

Table 3.2.3 Generated, Purchased and Imported Energy in 2004

Unit : GWh

No.	Distribution Area	Generation	Purchase	Import	Total
1	Phnom Penh	231.5	421.8	-	653.7
2	Siemreap	36.4		-	36.4
3	Kampong Cham	-	7.9	-	7.9
4	Battambang	16.6		-	16.6
5	Sihanoukville	22.8	1.8	-	24.6
6	Takeo	-	2.3	-	2.3
7	Prey Veng	-	1.1	-	1.1
8	Kampot	-	2.3	-	2.3
9	Banlung (Ratanakiri)	1.4	1.6	-	3.0
10	Ponhea Kraek (Kp.Cham)	-		4.0	4.0
11	Memot (Kp. Cham)	-		3.6	3.6
12	Baveth (Svay Rieng)	-		4.9	4.9
13	Kampong Trach (Kampot)	-		0.7	0.7
	Total	308.7	438.8	13.2	760.7

Source: EdC

As explained in Clause 3.2.1, power import from Vietnam by EdC is limited to 4 places and its scale of import is still in small through 22 kV distribution lines.

Typical generating costs per kWh of the plants in Phnom Penh are given in Table 3.2.4.

Table 3.2.4 Generating and Fuel Cost per kWh (2004)

	C2/Steam	C3/Diesel	C5/Diesel	C6/Diesel
1. Rated output (kW)	18,000	15,400	10,000	18,600
2. Kind of fuel	HFO	DO	DO	DO/HFO
3. Annual energy product (MWh)	32,371.2	29,944.3	20,883.1	68,736.0
4. Plant factor (%)	20.5	22.2	23.8	42.2
5. Station use (MWh)	3,444.6	683.2	581.5	3,806.0
6. Sent-out energy (MWh)	28,956.9	29,261.1	20,301.6	65,650.0
7. Annual cost (Million Riel)	14,810.63	15,056.40	14,009.54	24,470.18
(Fuel cost)	(12,777.58)	(10,983.12)	(7,831.59)	(16,250.22)
8. Generating cost (Riel/kWh)	511	515	690	373
(Fuel cost, Riel/kWh)	(441)	(375)	(385)	(248)

Source: EdC

Averaged electricity price per kWh purchased from IPPs and its fluctuation due to imported oil price are summarized in Table 3.2.5. As shown in the table 3.2.4 and 3.2.5, unit price of purchased energy is higher than that of EdC's generating cost except for energy from the Kirirom hydropower station, taking its plant factor into consideration. Among under mentioned IPPs, Jupiter (Poursat) and Santepheap (Takeo) have been closed in May and August of 2004, respectively, and J.P.N has newly started its operation in September 2004.

Table 3.2.5 Averaged Electricity Tariff of IPPs in 2004

Name of IPP	Location	Price (US Cents/(Riel))	Tariff Range
CETIC	Kirirom	7.00 (280)	Flat
CUPL	Phnom Penh	12.41 (496)	11.54- 13.55
Jupiter	Phnom Penh	15.35 (614)	13.54 – 17.33
Jupiter	Pursat	18.61 (744)	17.88 – 19.06
Jupiter	Kamp. Chhnang	19.78 (791)	17.88 – 21.96
GTS	Kamp. Cham	17.50 (700)	15.76 – 19.54
GPS	Prey Veng	17.14 (686)	16.00 – 19.36
Santepheap Inv.	Takeo	15.78 (631)	14.62 – 16.70
J.P.N	Takeo	17.56 (706)	16.97 – 18.30

Source: Report on Power Sector of the Kingdom of Cambodia for the Year 2004 (EAC)

The import of electric power from Vietnam and Thailand by EdC and private companies in accordance with the power purchase agreement is made through the 22 kV lines. The contracted capacity and purchased energy in 2003 are given in Table 3.2.6.

Table 3.2.6 Contracted Capacity and Purchased Energy in 2004

Name of licensee	Service Area		Capacity (kW)	Energy (kWh)
I. Imported from Thailand				
Fransie Imp/Exp Co.	Kamrieng	Battambang	1,000	2,518,464
	Phnom Preuk	Battambang	1,000	626,928
	Sampeou Loun	Battambang	1,000	806,532
M.S.P Develop. Co	Phum Phsar Prum	Pailin	2,500	4,301,200
Anco Brothers Co.	Ochraov District	Battambang	5,000	20,086,720
Duty Free Shop Co.	P. Town of Koh Kong	Koh Kong	2,000	12,564,240
	Osmarch Town	O. Meanchey	2,000	5114,440
II. Import from Vietnam				
EdC	Ponhea Krek Distict	Kamp. Cham	700	3,967,300
	Memot District	Kamp. Cham	1,750	3,872,700
	Baveth coomune	Svay Rieng	800	4,928,100
	Kampong Trach	Kampot	1,000	700,500
III. Total			18,750	59,487,124

Source: EAC

Averaged electricity price per kWh purchased in 2003 from neighboring countries and its fluctuation by private companies and EdC are summarized in Table 3.2.7. Price of energy imported from neighboring countries is much cheaper than that of purchased energy from IPPs in the country.

Table 3.2.7 Averaged Price of Imported Energy in 2003

Name of licensee	Service Area	Unit	Averaged (Riel)	Fluctuation
I. Imported from Thailand				
Fransie Imp/Exp Co.	Kamrieng	Baht	2.66 (266)	2.54 – 2.78
	Phnom Preuk	Baht	2.96 (296)	2.82 – 3.07
	Sampeou Loun	Baht	2.85 (285)	2.69 – 3.14
Anco Brothers Co.	P. Phsar Prum	Baht	2.86 (286)	2.55 – 2.93
M.S.P Develop. Co.	Ochraov, Pilin	Baht	2.70 (270)	2.59 – 2.83

Duty Free Shop Co.	P. T. of Koh Kong	Baht	2.62 (262)	2.44 – 2.75
	Osmarch Town	Baht	2.66 (266)	2.50 – 2.78
II. Import from Vietnam				
EdC	Ponhea Krek	US cents	6.90 (276)	Flat
	Memot	US cents	6.90 (276)	Flat
	Bavit	US cents	6.90 (276)	Flat
	Kampong Trach	US cents	6.90 (276)	Flat

Source: Report on Power Sector of the Kingdom of Cambodia for the Year 2004

3.2.5 Power Demand

(1) Electricity Tariff and its Category

EdC's electricity tariff have been divided into six categories, i.e. 1) Residential, 2) Industrial and Handicraft, 3) Commercial and Service Sector, 4) Hotel and Guest House, 5) Embassy, Foreigners' House, NGO, 6) Government Institutions, and further divided into 55 small items for actual billing. However, tariff schedule of only Phnom Penh and Sihanoukville systems follows the above criterion of tariff. For Siemreap system, tariffs based on the consumed energy are commonly applied to all demand groups. For the remaining systems only single fixed rate is applied to all customers. The detailed tariff schedule by system in 2004 is given in Table 3.2.8.

For statistic data on demand of EdC, however, customers are divided in 5 demand groups, 1) Residential, 2) Industrial and Handicraft, 3) Commercial and Service Sector, 4) Government Institutions and 5) Rehabilitations. The group of commercial and service sector is for all commercial activities including hotel, guest house, etc. and the group of rehabilitation is explained as tariff group for retail providers who extend distribution lines from the EdC's end pole of low voltage line for supplying electricity to outside the EdC's service areas through energy meters.

(2) Number of Customers

Number of customers had increased from 50,517 in 1998 to 208,471 in 2004 with very high averaged increase rate of 26.7% (from 1998 to 2004) due to high increase rate of Phnom Penh system and extension of its service areas to other provinces. Increase rate of 2004 against the last year amounted to 12.7%, even three new service areas (Kampot, Prey Veng and Ratanakiri) were newly transferred to the management of EdC in 2004. The detailed number of customers in 2003 and 2004 by its distribution area are given in Table 3.2.9.

Number of customers in 2004 by demand group and by its distribution area are given in Table 3.2.10. Number of residential customers of Phnom Penh accounted for 71% of the total residential customers in the country.

Table 3.2.8 Tariff Schedule

System/Tariff Category			Riel/kWh	Effective Date
Phnom Penh	Residential	less than 50 kWh	350	
		51 - 100 kWh	550	
		more than 100 kWh	650	
	Industrial and Handicraft	less than 45,000 kWh	600	
		45,000 - 80,000 kWh	550	
		80,000 - 130,000 kWh	550	
		more than 130,000 kWh	500	
		Medium Voltage	480	
	Commercial and Service Sector	less than 45,000 kWh	650	
		45,000 - 80,000 kWh	600	August 2000
		80,000 - 130,000 kWh	600	
		more than 130,000 kWh	500	
		Medium Voltage	480	
	Hotel and Guest Houses	less than 45,000 kWh	650	
		45,000 - 80,000 kWh	600	
		80,000 - 130,000 kWh	600	
		more than 130,000 kWh	500	
		Medium Voltage	480	
	Embassy, Foreigners' House, NGO, OI		800	
	Government Institutions		700	
Siemreap	Overall Sectors	less than 20,000 kWh	780	
		20,000 - 50,000 kWh	750	2004
		50,000 - 110,000 kWh	650	
		more than 110,000 kWh	600	
Sihanoukville	Residencial		500	
	Industrial and Handicraft	less than 20,000 kWh	686	
		20,000 - 50,000 kWh	690	
		50,000 - 110,000 kWh	568	
		more than 130,000 kWh	529	
	Commercial and Service Sector	less than 20,000 kWh	764	
		20,000 - 50,000 kWh	706	February - July
		50,000 - 110,000 kWh	643	1999
		more than 130,000 kWh	588	
	Hotel and Houses for Foreiners	less than 20,000 kWh	784	
		20,000 - 50,000 kWh	721	
		50,000 - 110,000 kWh	666	
		more than 130,000 kWh	627	
	Embassy, Government Institutions		760	
Kampong Cham	One Rate		850	1997
Takeo	One Rate		960	1999
Battambang	One Rate		900	Jun-00
Others: Baveth, Menut, Ponhea Krek and Kampong Trach	Low Voltage		650	
	Medium Voltage		500	

Source: EdC

Table 3.2.9 Number of Customers by Area in 2003 and 2004

No.	Distribution Area	2003	2004	Inc. Rate(%)
1	Phnom Phen	140,611	150,736	7.2
2	Siemreap	9,580	10,701	11.7
3	Kampong Cham	4,999	5,081	1.6
4	Battambang	14,116	15,488	9.7
5	Sihanoukvill	7,841	8,181	4.3
6	Takeo	2,483	2,555	9.7
7	Prey Veng		2,587	
8	Kampot		4,674	
9	Banlung (Ratanakiri)		2,192	
10	Ponhea Kraek	983	1,208	22.9
11	Memot	1,768	1,996	12.9
12	Baveth	1,204	1,429	18.7
13	Kampong Trach	1,333	1,643	23.2
	Total	184,918	208,471	12.7

Source: EdC

Table 3.2.10 Number of Customers by Demand Group (2004)

No.	Distribution Area	Resident	Indust	Comm	Govern	Rehabi	Total
1	Phnom Phen	137,649	701	11,444	695	247	150,736
2	Siemreap	9,883		710	108		10,701
3	Kampong Cham	4,906	5	14	156		5,081
4	Battambang	15,073		276	139		15,488
5	Sihanoukvill	7,376	100	659	46		8,181
6	Takeo	2,147	20	349	39		2,555
7	Prey Veng	2,587					2,587
8	Kampot	4,674					4,674
9	Banlung (Ratanakiri)	2,098		48	46		2,192
10	Ponhea Kraek	1,202	6				1,208
11	Memot	1,991	5				1,996
12	Baveth	1,426		3			1,429
13	Kampong Trach	1,643					1,643
	Total	192,655	837	13,503	1,229	247	208,471

Source: EdC

(3) Sold Energy

Sold energy by EdC in the country had increased from 540.6 GWh in 2003 to 643.7 GWh in 2004 with an increase rate of 19.1%. The detailed sold energy in 2003 and 2004 by the distribution area are given in Table 3.2.11. Sold energy in the Phnom Penh distribution area accounted for 88% of the total sold energy in the country. Sold energy by demand group by distribution area is given in Table 3.2.12.

Table 3.2.11 Sold Energy (MWh) by Area in 2003 and 2004

No.	Distribution Area	2003	2004	Inc. Rate(%)
1	Phnom Phen	478,180	557,770	16.6
2	Siemreap	19,130	28,019	46.5
3	Kampong Cham	5,470	6,205	13.4
4	Battambang	10,200	12,982	27.3
5	Sihanoukvill	18,450	20,070	8.8
6	Takeo	1,850	2,049	10.8
7	Prey Veng		666	
8	Kampot		2,382	
9	Banlung (Ratanakiri)		957	
10	Ponhea Kraek	1,690	3,679	117.7
11	Memot	2,260	3,558	57.4
12	Baveth	3,450	4,704	36.3
13	Kampong Trach	150	626	317.3
	Total	540,550	643,668	19.1

Source: EdC

Table 3.2.12 Sold Energy (MWh) by Demand Group (2004)

No.	Distribution Area	Resident	Indust	Comm	Govern	Rehab	Total
1	Phnom Phen	252,710	82,300	138,460	71,950	12,350	557,770
2	Siemreap	15,351		11,275	1,393		28,019
3	Kampong Cham	4,994	44	0	1,166		6,205
4	Battambang	8,896		3,050	1,036		12,982
5	Sihanoukvill	11,087	1,736	6,133	1,114		20,070
6	Takeo	1,123	32	555	339		2,049
7	Prey Veng	412			254		666
8	Kampot	1,948			434		2,382
9	Banlung (Ratanakiri)	604	8	158	187		957
10	Ponhea Kraek	713	2,966				3,679
11	Memot	1,024	2,534				3,558
12	Baveth	953	9	3,741			4,704
13	Kampong Trach	626					626
	Total	300,442	89,629	163,373	77,438	12,350	643,668

Source: EdC

(4) Annual Unit Energy Consumption by Customer

Unit annual energy consumption per customer is calculated from Tables 3.2.10 and 3.2.11 as given in Table 3.2.13. For residential customers, unit annual energy consumption of Phnom Penh area is the highest at 1,836 kWh per customer and the second is 1,553 kWh of Siemreap. For Kampot, Prey Veng and Rtanakiri areas which was transferred to EdC management in 2004, unit annual energy consumption is not reliable since power supply by EdC to the customers have not been made through out one year.

Table 3.2.13 Unit Annual Energy Consumption by Demand Group (2004)

Unit: kWh per customer

No.	Distribution Area	Resident	Indust	Comm	Govern	Rehab	Total
1	Phnom Phen	1,836	117,404	12,099	103,525	50,000	3,700
2	Siemreap	1,553		15,880	12,898		2,618
3	Kampong Cham	1,018	8,822	0	7,477		1,221
4	Battambang	590		11,051	7,455		838
5	Sihanoukvill	1,503	17,359	9,307	24,217		2,453
6	Takeo	523	1,587	1,590	8,700		802
7	Prey Veng	159					258
8	Kampot	417					510
9	Banlung (Ratanakiri)	288		3,298	4,057		437
10	Ponhea Kraek	593	494,351				3,046
11	Memot	514	506,804				1,783
12	Baveth	668		1,247,106			3,292
13	Kampong Trach	381					381
	Total	1,560	107,084	12,099	63,364	50,000	3,088

Source: EdC

(5) Averaged Tariff by Demand Group in 2004

Revenue of energy sales by EdC in the country had increased from 328,760 million Riel in 2003 to 392,548 million Riel in 2004 with an increase rate of 19.2 %. The detailed revenue in 2004 by the distribution area and demand group are given in Table 3.2.14. Revenue in the Phnom Penh distribution area accounted for 83% of the total revenue in the country.

Averaged unit price of energy by demand group is calculated from Table 3.2.12 and Table 3.2.13 as given in Table 3.2.15. For residential customers, averaged unit price of energy of Kampong Trach of Kampot area is the highest at 1,214 Riel per kWh and the second is 1,100 Riel per kWh of Prey Veng. Averaged unit price in the country is Riel 597 per kWh for residential customers and Riel 610 per kWh for all customers. The different among the averaged unit prices of sale, unit generating cost of EdC and unit price of energy purchased from IPP are small.

Table 3.2.14 Revenue by Service Area and Demand Group in 2004

Unit: Million Riel

No.	Distribution Area	Resident	Indust	Comm	Govern	Rehab	Total
1	Phnom Phen	141,393	44,005	85,744	50,380	5,303	326,825
2	Siemreap	13,242		9,373	1,196		23,811
3	Kampong Cham	4,219	37		991		5,248
4	Battambang	8,803		2,933	1,026		12,761
5	Sihanoukvill	5,544	1,051	4,038	847		11,480
6	Takeo	992	29	499	305		1,825
7	Prey Veng	453			280		733
8	Kampot	1,943			521		2,464
9	Banlung (Ratanakiri)	344	4	92	72		511
10	Ponhea Kraek	464	1,421				1,885
11	Memot	666	1,213				1,879
12	Baveth	620		1,746			2,366
13	Kampong Trach	760					760
	Total	179,441	47,761	104,425	55,618	5,303	392,548

Source: EdC

Table 3.2.15 Unit Annual Energy Consumption by Demand Group (2004)

Unit: kWh

No.	Distribution Area	Resident	Indust	Comm	Govern	Rehab	Average
1	Phnom Phen	560	535	619	700	429	586
2	Siemreap	863		831	859		850
3	Kampong Cham	845	850		850		846
4	Battambang	990		962	990		983
5	Sihanoukvill	500	606	658	760		572
6	Takeo	883	902	900	900		891
7	Prey Veng	1,100			1,100		1,100
8	Kampot	997			1,200		1,034
9	Banlung (Ratanakiri)	569	474	581	387		535
10	Ponhea Kraek	650	479				512
11	Memot	650	479				528
12	Baveth	650	0	467			503
13	Kampong Trach	1,214					1,214
	Total	597	533	639	714	429	610

Source: EdC

(6) Transmission and Distribution Losses

The detailed transmission and distribution losses in 2004 by the distribution area are given in Table 3.2.16. As for the area basis, Baveth area is the lowest (3.8%) and following Memot (7.1%), the both areas are served by electric energy imported from Vietnam. Losses of Ratanakiri area is the highest (47.2%) and following Prey Veng (38.2%). In general, losses of the areas imported energy from Vietnam are lower than the other areas.

Table 3.2.16 Transmission and Distribution Losses by Area

No	Distribution Area	Sentout Energy (GWh)	Sold Energy (GWh)	Loss Energy (GWh)	Losses in %
1	Phnom Phen	641.53	557.77	83.77	13.1
2	Siemreap	33.23	28.20	5.03	15.1
3	Kampong Cham	7.87	6.23	1.64	20.8
4	Battambang	15.88	12.98	2.90	18.3
5	Sihanoukvill	23.23	20.17	3.06	13.2
6	Takeo	2.33	2.05	0.28	11.9
7	Prey Veng	1.08	0.67	0.41	38.2
8	Kampot	2.30	1.49	0.81	35.1
9	Banlung (Ratanakiri)	1.56	0.82	0.74	47.2
10	Ponhea Kraek	3.97	3.69	0.28	7.1
11	Memot	3.87	3.57	0.31	7.9
12	Baveth	4.93	4.74	0.19	3.8
13	Kampong Trach	0.70	0.63	0.07	10.6
	Total	742.47	643.00	99.48	13.4

Sources : EdC

3.2.6 Issues of Power Supply by EdC

Major issues of power supply by EdC are explained hereunder:

(1) Power Supply Systems

At present (2004) EdC supplies electricity to their customers in 13 service areas which are licensed by EAC. However, total service area is much limited in 10 provincial towns and 4 district towns with its surrounding small areas except for the Phnom Penh system. Almost of all the supply systems are isolated each other. EdC operates small scaled diesel generators or purchases from IPPs or imports from Vietnam for supplying electricity for respective service areas. This means that power supply situation of these systems is not stable and reliable without providing reserve capacity.

(2) High Generating and Purchasing Costs of Energy

As explained in item (5) of Clause 3.2.4, most of the energy is generated by small scaled diesel generators owned not only by EdC but also by IPPs except for energy generated by the Kirirom hydropower plant. Unit generating cost of these power plants is much higher than that of neighboring country. In addition to this situation, energy sources are heavily concentrated on single source of imported oil transported through the Mekong river.

(3) Shortage of Supply Capabilities

There is huge latent power demand in the country. It is very clear that many REEs are established in the recent years due to the Electricity Law and licensed by EAC, but electricity tariff of these licensees is much higher than that of EdC, in the range between Riel 950 per kWh (Kampong Thom) and Riel 3,200 per kWh (Banteay Meanchey, Battambang, etc.). However, interconnection of major demand centers with transmission lines seems rather difficult due to not only economic point of view but also shortage of generation capacity of EdC with cheaper generating cost.

(4) Shortage of Financial Resources for Rural Electrification

For promoting rural electrification, extension of power transmission facilities to the rural areas where power demand is sparse is essentially needed with huge amount of fund resources, which is normally subsidized from the benefits in urban areas or by the Government. As explained above, however, there is little allowance in urban areas for creating cross subsidy under the present situation of generating cost of electricity and electricity tariff level.

3.3 POWER SUPPLY BY LICENSEES OF EAC

3.3.1 Type of Licenses

As per the provisions of Electricity Law, each electricity service provider is required to have license issued by EAC and to abide by the provisions of Electricity Law and those of its license, and regulations and procedures of EAC. License for providing electric power services is an authorized document conforming to the provisions of the Electricity Law, which EAC decides to grant to any individual or legal entity to give it the right for providing electric services as per the provisions defined in the license.

Types of licenses to be issued and regulated by EAC are defined in eight (8) categories as indicated hereunder in the Electricity Law:

1) **Generation License:** grants the right to generate electric power from specially identified power generating facilities. The Generation Licensee right in this law is to own, operate and manage or control the generation facilities for generating electricity for sale and not solely for own consumption.

2) **Transmission License:** grants the right to provide the electric power transmission service. The transmission licensee right in this law is to own operate and manage the power transmission facilities for transferring and delivering or selling the electricity in bulk. There are two (2) types of this license, i.e. National Transmission License and Special Purpose Transmission License.

   National Transmission License: can be issued only to the state power transmission company, under the Government control, to have the right to provide the transmission service for delivering the electric power to the distribution companies and bulk power consumers throughout Cambodia.

   Special Purpose Transmission License: grants the right to construct, own and operate the specifically fixed and identified transmission facilities in Cambodia that have the specified purpose and ensure the public interest. The principles and conditions for issuing the Special Purpose Transmission Licenses shall be determined by the government

3) **Electricity Distribution License:** grants the right to provide the electricity distribution services in a determined contiguous territory. The right to provide the electricity distribution services under this law is the right of ownership, operation and managing or controlling the distribution facilities for supplying and selling the electricity to the customers. The ownership, operation and managing or controlling the distribution facilities in private territory for their own use is not considered as the provision of distribution service.

4) **Consolidated License:** is a license, which may be the combination of some or all types of licenses. The consolidated license can be issued to EdC and to the private providers having the isolated systems to grant to generate, purchase, transmit, dispatch, distribute and sell the electricity to the consumers in a determined contiguous territory. If a consolidated licensee intends to add new generation facilities, then he must apply for generation license for each new generation facility.

5) **Electricity Dispatch License:** grants the right to control, manage and operate the dispatch facilities for facilitating the delivery and receiving the electricity from the generation, transmission and distribution systems. Electricity Dispatch License shall prescribe the regulation to ensure that the operation of generation, transmission and distribution systems under its dispatch control is in the safe, reliable and efficient condition.

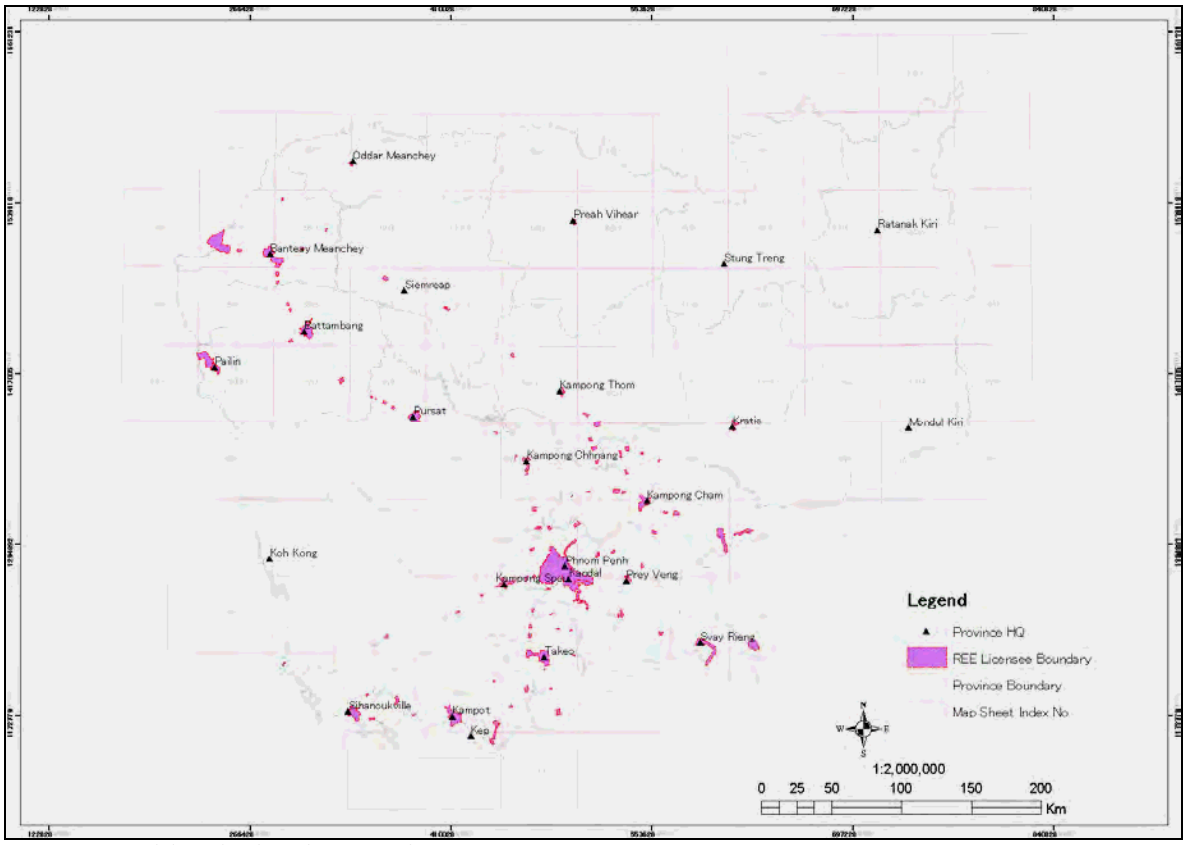
6) **Bulk Sale License:** grants the right to buy the electricity from any Generation Licensees or from the power systems of neighboring country for sale to Distribution Licensees or to the large customers in one connected power system. The bulk market under this law is a market where the producers can sell electricity to many buyers and where the transmission service has been separated from the generation services.

7) **Retail License:** grants the right to engage in the sale of electric power to consumers. Each retail license shall apply to a contiguous service territory. Retail licensee own facility needed for sale of power to the customers, i.e. meter equipment, but not own facilities for supplying power, i.e. distribution lines. The electricity sold to consumers by retail licensee shall be purchased from a licensed electric utility to supply in the applicable geographic territory, until such time when the EAC permits to purchase from other suppliers of electric power consistent with national energy policy.

8) **Subcontract License:** grants the right to supply of electric power services according to the subcontract agreement with existing licensee. Subcontract license under this law shall include all applicable conditions, and such additional license conditions as EAC may consider in the public interest.

EAC issued 107 licenses including EdC in total up to the end of 2004. The licensees except for EdC consist of 11 generation licenses, 87 consolidated licenses and 8 distribution licenses. Of these licenses, the validity period of 3 generation licenses were not extended and become invalid in 2004.

The licensed distribution area of consolidated and distribution licensees are given in GIS map developed by the Study Team (Figure 3.3.1).



Source: Team elaboration based on EAC data

Figure 3.3.1 Distribution and Command Areas of REE Licensees

As shown on the map, the licensed areas account for mainly urban areas and are very small area in total against the area of the country.

The expenditure of EAC for its operation is to be bone by all the electric service providers in the form of paying the license fees in accordance to the provisions of the Electricity Law. EAC has determined the license fees to be paid by licensees vide Notification No. 001SR-03-EAC dated January 23, 2003. The license fees are determined as follows:

(1) Generation or power purchased from any other country: 1.60 Riels per kWh of power generated or purchased.

(2) Transmission: 0.60 Riels per kWh of per transmitted.

(3) Distribution and sale: 1.10 Riels per kWh of power sold.

(4) Retail: 0.50 Riels per kWh of power sold.

(5) Other licenses: license fee shall be 0.1% of the service fee.

3.3.2 Size of Generating Facilities of Licensees

Eight (8) generation licensees sell electricity generating at their own plants not only to EdC but also to distribution licensees (private companies) at 10 locations as given in Table 3.3.1. Their total installed capacity is 98.8 MW, which consist of 95.4 MW for supplying to EdC and 3.4 MW for other licensees.

Table 3.3.1 Power Supply by Generation Licensees

Unit: Sold energy in MWh

No.	Provider	Location	Capacity(kW)	Purchaser	Sold Energy
1	CUPL	Phnom Penh	37,100	EDC	247,125
2	Jupiter-1	Phnom Penh	24,951	EDC	11,603
3	CETIC	Phnom Penh	12,000	EDC	40,509
4	GTS	Kp. Cham	3,280	EDC	6,845
5	J.P.N	Takeo	660	EDC	861
6	U.V.A	Battambang	6,320	EDC	4,087
7	Jupiter-2	Pursat	1,000	Private	2,732
8	Jupiter-3	Kp. Chhnang	750	Private	2,567
9	G.P.S	Prey Veng	980	Private	1,617
10	Edward E.S	Pursat	1,880	Private	1,873

Source: EAC

In addition to the above-mentioned generating facilities, the consolidated licensees operate their own generating machines of 17.5 MW in total. The biggest generating capacity of the providers with consolidated license is 2,072 kW (No. 017L, Prey Veng) and the smallest is 24 kW (No. 084L, Takeo). Generating capacity of licensed providers is distributed by capacity as given in Table 3.3.2.

Table 3.3.2 Size of Consolidated Licensees

No.	Capacity Range	Nos. of Providers	Providers in%
1	More than 500 kW	6	7.0%
2	250 kW to 500 kW	11	12.8%
3	100 kW to 250 kW	6	7.0%
4	50 kW to 100 kW	54	62.8%
5	Less than 50 kW	9	10.5%

Source: EAC's report for the year 2004 (analyzed by the Team)

As indicated in the table above, majority of the consolidated licensees is small scale ones with generating capacity less than 100 kW.

Unit capacity of generators owned by providers is distributed between 8 kW to 800 kW. The distribution of unit capacity of generators is given in Table 3.3.3. Generator units of nearly half are smaller than 50 kW.

In addition to the size of generators, according to the site inspection made during the site visit in Cambodia, most of the generators are used ones and seem to be over their life time, and many generators have not name plates to indicate detail specifications including manufacturing year. Those consume much diesel oil with the range from 0.3 to 0.5 litter per kWh which is much higher than that of EdC.

Table 3.3.3 Unit Capacity of Generator

No.	Capacity Range	Nos. of Generators	Generators in%
1	More than 500 kW	1	0.1%
2	250 kW to 500 kW	2	0.1%
3	100 kW to 250 kW	34	18.1%
4	50 kW to 100 kW	61	32.4%
5	Less than 50 kW	90	47.9%

Source: EAC's report for the year 2004 (analyzed by the Team)

3.3.3 Demand

(1) Supply Areas

As explained in Clause 3.1, 87 consolidated licensees and 8 distribution licensees (11 supply areas) have supplied electricity to their customers in 2004. However, Mondol Kiri, Ratanakiri, Stung Treng and Svay Rieng provinces have no provider with licenses of EAC as shown in Table 3.1.1. The provincial town areas of Ratanakiri, Svay Rieng and Stung Treng are transferred to EdC's management in 2004. As of the year 2004, 95 power providers supplied electricity to 98 their service areas in total. Of these service areas, 8 areas were served by imported electric energy from Thailand (Battambang: 3, Manteay Meanchey: 1, Koh Kong: 1, Oddar Meanchey: 1, Pailin: 2).

(2) Number of Customers

Number of customers of these licensees had reached 66,288 by the end of 2004, which shared 2.9 % of total households of the country and corresponded to about one third of the customers of EdC. Averaged number of customers of the consolidated licensees ia of 523 and the distribution of number of customers ia given in Table 3.3.4.

Table 3.3.4 Number of Customers of Consolidated Licensees

No.	Capacity Range	Nos. of Providers	Providers in %
1	More than 2,000	3	3.4
2	1,000 to 2,000	4	4.6
3	800 to 1,000	7	8.0
4	600 to 800	10	11.5
5	400 to 600	17	19.5
6	200 to 400	30	34.5
7	Less than 200	17	19.5

Source: EAC's report for the year 2004 (analyzed by the Team)

As for the distribution licensees, the averaged number of customer is 1,892 with the range from 240 (No. 008L, Poursat) to 5,204 (No. 008L, Battambang)

(3) Averaged Monthly Consumed Energy

Total sold energy by 87 consolidated licensees in 2004 was 13.32 GWh and its averaged monthly sold energy by customer was 24 kWh per month. The distribution of average monthly sold energy of providers is given in Table 3.3.5. As shown in the table, providers with customers of which consumed energy is less than 10 kWh per month shared 18.4 % of the total and 50.6 % within the rage from 10 kWh per month to 20 kWh per month. This means that about 70 % of the consolidated licensees consist of customers of nearly 100 W. The average monthly consumed energy is worked out from annual sold energy, number of customers and 12 months.

Table 3.3.5 Average Monthly Energy Consumption of Customers

No.	Capacity Range	Nos. of Providers	Providers in %
1	More than 50 kWh/month	3	3.4
2	40 to 50 kWh/month	1	1.1
3	30 to 40 kWh/month	7	8.0
4	20 to 30 kWh/month	16	18.8
5	10 to 20 kWh/month	44	50.6
6	Less than 10 kWh/month	16	18.4

Source: EAC's report for the year 2004 (analyzed by the Team)

Total sold energy of 8 distribution licensees was 47.27 GWh and its averaged monthly energy consumption per customer was 189 kWh per month.

(4) Electricity Tariff

The distribution of domestic tariff of the consolidated licensees is given in Table 3.3.6. The domestic tariff adopted for the analysis is electric tariff per kWh for the customers of the smallest consumption. The highest electric tariff per kWh was Riel 3,200 (No.078L, Banteay Meanchey) and the lowest was Riel 950 (No.012, Kampong Thom). As shown in the table, the providers with electric tariff of the range from Riel 2,000 to 2,500 per kWh are the biggest, 37 % of the total.

Table 3.3.6 Electric Tariff per kWh for Domestic Customers

No.	Capacity Range	Nos. of Providers	Providers in %
1	More than Riel 3,000/kWh	7	8.0
2	Riel 2,500 to 3,000/ kWh	19	21.8
3	Riel 2,000 to 2,500/ kWh	32	36.8
4	Riel 1,500 to 2,000/ kWh	22	25.3
5	Riel 1,000 to 1,500/ kWh	6	6.9
6	Less than Riel 1,000/ kWh	1	1.1

Source: EAC's report for the year 2004 (analyzed by the Team)

The electricity tariff of domestic customers of the distribution licensees is much smaller than that of the consolidated licensees in the range from Riel 500/kWh to Riel 1,100/kWh.

The distribution of the averaged monthly electric charge paid by the domestic customers of the consolidated licensees, which was worked out from the figures indicated in the Table 3.3.5 and 3.3.6, is given in Table 3.3.7. It is noted, however, that the annual report of EAC indicates only electricity tariff of demand groups, but no number of customers and sold energy by demand group. Therefore, the figures in the table are for reference only. The averaged maximum monthly electric charge of the distribution licensees was US$167.6 per month and minimum US$2.9 per month.

Table 3.3.7 Monthly Electric Charge for Domestic Customers

No.	Capacity Range	Nos. of Providers	Providers in %
1	More than US$ 15/month	7	8.0
2	US$ 10 to 15/month	20	23.0
3	US$ 5 to 10/month	51	58.6
4	Less than US$ 5/month	9	10.3

Source: EAC's report for the year 2004 (analyzed by the Team)

(5) Losses

Annual energy production and sold energy by the consolidated licensees were 19.37 GWh and 13.32 GWh respectively. Then, energy loss rate including station uses was recorded as 31.3 %. The distribution of energy loss rates is given in Table 3.3.8 and the maximum loss rate was 62.9 % (No. 068L, Battambang) and minimum 12.3 % (No.020L, Takeo).

Table 3.3.8 Energy Losses

No.	Capacity Range	Nos. of Providers	Providers in %
1	More than 50 %	4	4.6
2	40 to 50 %	14	16.1
3	30 to 40 %	41	47.1
4	20 to 30 %	20	23.0
5	Less than 20 %	8	9.2

Source: EAC's report for the year 2004 (analyzed by the Team)

The averaged energy loss rate of the distribution licensees was 10.9 %, and distributed in the rage from 29.2 % (No.052L, Poursat) to 6.5 % (No.009L, Pailin).

The extremely high loss rate of the consolidated licensees in comparison with ones of distribution licensees is seemed to be caused by not only poor distribution system, but also the following non-technical losses.

(a) For the distribution licensees, the reported purchased energy value may be correct, because the purchased energy reported by the licensee is easily cross checked by the information reported by other licensee or neighboring countries. However, it is very difficult to check exactly on the basis of the information on consumed fuel oil, efficiency for generation, etc. reported by the same licensee. In addition to the above, it was observed during site survey that some energy meters for measuring generated energy were under out of order or not equipped.

(b) Energy generated by the consolidated licensee is also served for their own use, but not clearly indicated in the report. The electric charge for own use shall be considered as income of the REE.

(6) Plant Factor of Generating Facilities

Almost of all distribution licensees serve electricity to their customers for 24 hours. However, the duration of power supply to the customers of the consolidated licensees are scattered from 3.5 hours (No.084L, Takeo and others) to 24 hours. The distribution of plant factor of licensees, which were worked out on the basis of registered plant capacity and reported annual generated energy, is given in Table 3.3.9. The table show that the plant factor of about 80 % of the consolidated licensees is less than 15 %. The plant factor is rather low even considering decreasing capability of energy generation and its efficiency and it is one of cause of high electric tariff.

Table 3.3.9 Plant Factor of Generating Facilities

No.	Capacity Range	Nos. of Providers	Providers in %
1	More than 40%	2	2.3
2	20 to 40 %	11	12.6
3	15 to 20 %	5	5.7
4	10 to 15 %	31	35.6
5	5 to 10 %	29	33.3
6	Less than 5 %	9	10.3

Source: EAC's report for the year 2004 (analyzed by the Team)

3.3.4 Issues of Power Supply by Licensees

Main issues of power supply by licensees are as follows:

(1) Licensed Areas

Numbers of licensees as of 2004 are still limited and some provinces have no authorized power providers and their service areas also are concentrated to towns and/or areas along the national roads. Only 2.9 % (2004) of the families of the country enjoyed grid-quality electricity provided by licensees through mini-grids.

(2) Generating Facilities

As explained in Clause 3.3.2, most of the generating facilities owned and operated by licensees seem to be over-aged and its efficiency is very low. As a result of using these facilities, power supply is unstable and electricity tariff is very high.

(3) Power Distribution Facilities

According to the site visits in the country, distribution lines meeting the technical standards are limited and some part of the low voltage lines are hung on wooden or bamboo trees without insulators.

(4) High Energy Losses

As explained in the above item (5) of Clause 3.3.3, energy loss rates including station use of the consolidated licensees are in very high level. High loss rates of licensees with similar quality level of distribution system with the Phnom Penh system of EdC are included in the report of EAC. Of course, distribution systems of the consolidated licensees are rather poor in comparison with EdC's ones and higher loss rate may be acceptable, but the level of loss rates seem to be too high. It may include some non-technical losses.

(5) Energy Meter of Customers

Almost of all energy meters of customers of REE are procured in the market with very cheap price, but not procured from the manufacturers through necessary procedures like preparation of certain specifications, competitive tender, factory inspection before shipment, etc. Available energy meters in the market are used/scraped ones in the neighboring countries and/or rejected by the purchasers (normally electric company) as a result of factory inspection before shipment, because those meters do not meet the technical requirements. Then, reliability of those meters are very low.

3.4 POWER SUPPLY BY NON-LICENSED REE

Besides power suppliers licensed by EAC, there are number of REEs all over the country, which can be categorized as non-licensed REE. As discussed in previous section, power distribution systems outside provincial capitals and major towns are still limited. Non-licensed REEs are those relatively smaller in size than EAC-licensed-REEs and have few incentives to get a license as traveling to Phnom Penh for licenses costs substantially. In due course, however, all power suppliers have to obtain licenses by EAC. Generally, non-licensed REEs have similar features as follows.

- Non-licensed REEs are those who bought small diesel generators, mostly second-hand by self-financed capital or family loan due to limited access to public or commercial funds, and supply limited neighboring customers and commercial entities from 20 to hundreds.

- In many cases, they themselves have substantial demand of power for their own business, such as ice makers, repair shops, etc.
- Having used second-hand diesel generators, the cost of power supply is very high from US$ 0.3 per kWh to US$ 0.9 per kWh depending the remoteness and scale of generators.
- Due to lack of professional training, they have limited capacity to maintain, which results in large losses and poor quality.
- Service hours are limited as average four hours mostly only at night time as demand of daytime is limited in rural areas.

Since they are not licensed, the numbers of such enterprises, customers are not formally available. The number of REEs were estimated approximately 600 before EAC started the license system. Thus, the non-licensed REEs can be roughly estimated as 500. Due to the recent increase of oil price, many REEs face difficulties as their customers' purchasing power are limited. There are some REEs that stopped the operation due to accumulated uncollected electricity charges. The number of non-licenced REEs will be further clarified with the survey conducted by provincial DIMEs.

3.5 ELECTRICITY SUPPLY BY BATTERIES

In Cambodia, Battery Charging System (BCS) by diesel generator is in common practice. Costs of charging depend on battery size and location of BCS business. The type of batteries is shallow cycle lead acid, which is normally designed and used for vehicles. The sizes of batteries are 50 Ah, 70 Ah, 100 Ah (DC 12 V) and 5 Ah (6 V). Batteries are used to supply electricity for home lighting, TV, video, etc. In general, 50 Ah battery is used for home lighting, 70 Ah for lighting and TV, and 100 Ah for VCD/DVD or Karaoke set. Some people own more than one battery for their various uses. People use battery until it exhausts. Actually over-discharging damages batteries. This fact should be disseminated widely to the public. Small size batteries are used often for a head lamp to catch frogs, birds, insects and so on. The charging interval is 7 to 10 days on an average depending upon hours of utilization and capacity of battery. The batteries are imported from Thailand and Vietnam by distributors and sold in the country. Figure 3.5.1 (a) and (b) show views of typical diesel BCS observed nearby a provincial town and at a small village in remote area.

(a) Diesel BCS nearby provincial capital | (b) Diesel BCS at a remote village

Figure 3.5.1 Typical Diesel BCS

In most of the cases batteries are arranged in a series to match the output voltage of diesel generator to charge. Again, this way of serial charging will damage even new or good batteries if deteriorated

batteries are connected in the series. There is no such instrument to check whether batteries have been fully charged or not. The charging voltage is also not adjusted to an appropriate level. At most of BCS secondhand 3 phase AC diesel generator is used to charge batteries. In some cases especially in remote villages 12 or 24V DC brush motors are used to charge batteries. Normally, charging time is 7 to 8 hours.

Table 3.5.1 summarizes average charging costs in the country. The charging cost varies from place to place depending upon fuel price at market nearby and distance for fuel transportation to BCS.

Table 3.5.1 Average Tariffs for Battery Charging

No.	Battery Capacity (Ah)	Cost for Charging (Real)
1	5 Ah (6 Volt)	500
2	50 Ah (12 Volt)	1,000
3	70 Ah (12 Volt)	1,500
4	100 Ah (12 Volt)	2,000

Source: JICA Study Team

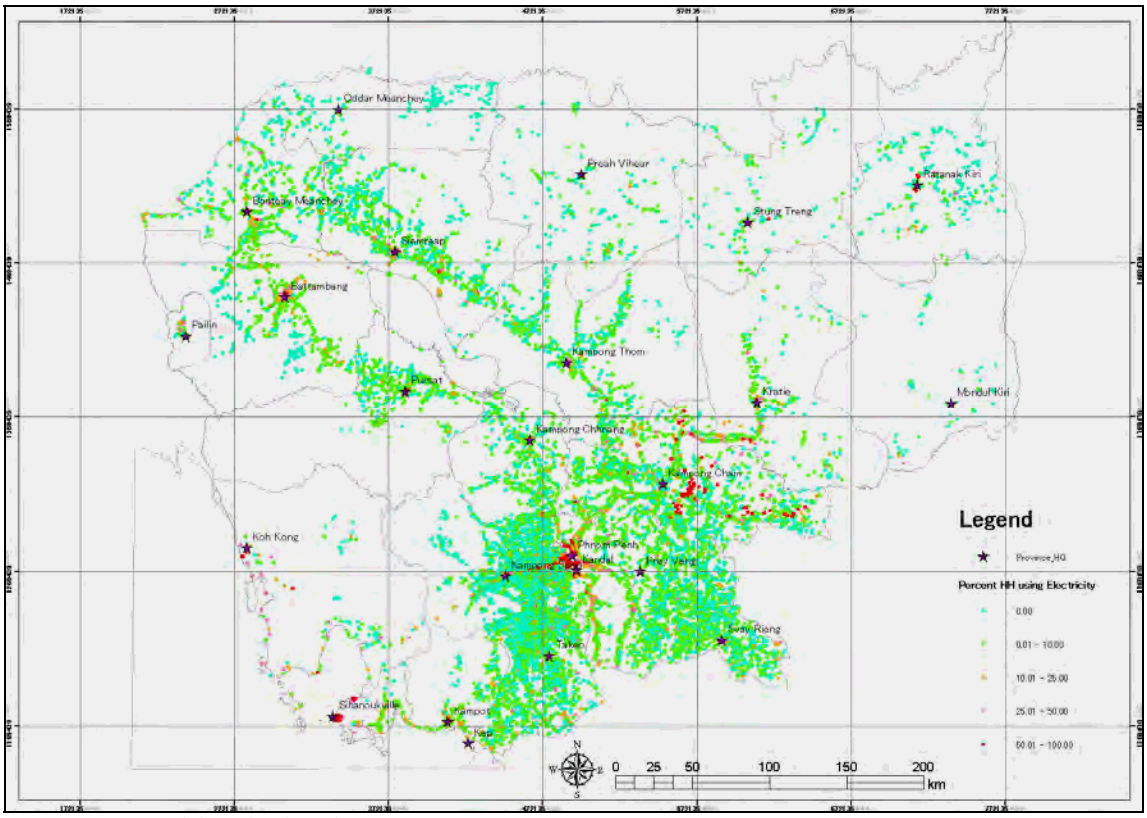
3.6 SPATIAL DISTRIBUTION OF NON-ELECTRIFIED VILLAGES

At present, there is lack of reliable statistical data that precisely and directly indicate the level of electrification in Cambodia. The national level statistics have collected the information of the household amenities including the source of lighting.

3.6.1 Electrified Situation Identified by NIS General Population Census 1998

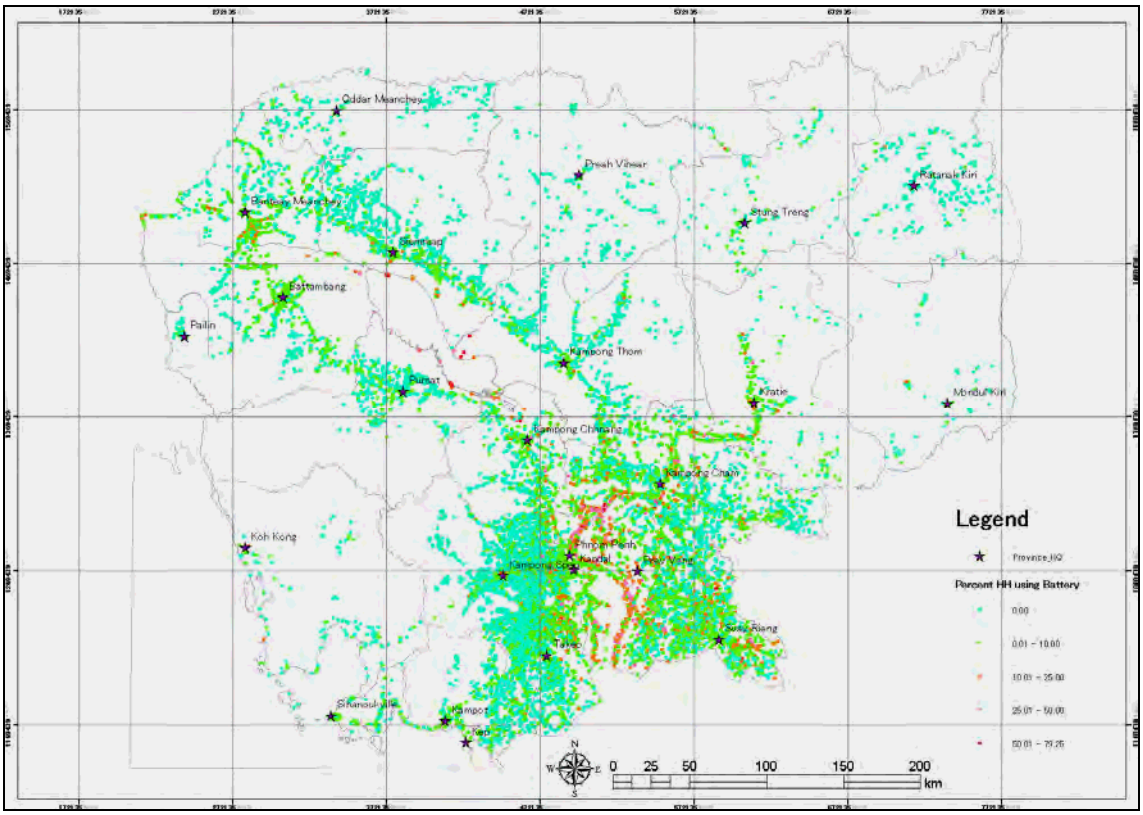
Although the data is relatively old, the estimation can be obtained from General Population Census 1998. There is attribute called "Main Light Source" with seven items, namely 1 CITY POWER, 2 GENERATOR, 3 CITY + GENERATOR, 4 DIESEL OIL, 5 CANDLE, 6 BATTERY and 7 OTHER The sum of items one, two and three gives the idea about the percentage household supplied with electricity from various source. Figure 3.6.1 shows village distribution with percentage of household supplied with one or another source of electricity (item 1, 2 and 3). Table 3.6.1 is same data compiled by provinces. The electricity here is defined as electricity originated from city power and generator, excluding battery, item 1,2 and 3. The electrified level of the total households is defined as 15%, while urban area as 53.6% and rural area as 8.5%. In 1998, the share of diesel oil as the main source of lighting is nearly 80% of Cambodia households.

As we know, many household in rural Cambodia use battery for lighting and TV, which might be considered as the one type of electrification. Item six shows (Figure 3.6.2) the percent of household those using battery as source of light. By analyzing these two maps, we can mark different region where level of electrification can be classified, but with some precaution as the data source is old. Besides, there are two fold of another problem with this data namely (i) all the villages were not surveyed due to some unavoidable circumstances at that time (year 1998) and (ii) the new villages emerged after that (currently exist and listed by Seila) still not included in the dataset.



Source: Team elaboration based on NIS Census 1998

Figure 3.6.1 Percent Level of Household Electrification by Grids



Source: Team elaboration based on NIS Census 1998

Figure 3.6.2 Percent of Households Using Battery

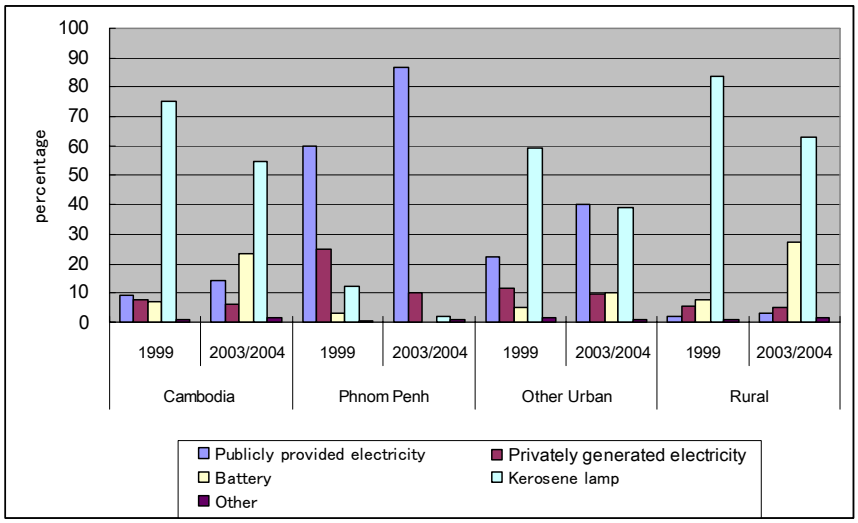
Table 3.6.1 Share of Household Using Electricity as Main Source of Lighting

Provinces	Households using electricity (%)		
	Total	Urban	Rural
Banteay Meanchey	12	28.8	8.8
Battambang	13.9	45.9	7.3
Kampong Cham	11.7	73.8	10.1
Kampong Chhnang	6	37.8	2.9
Kampong Speu	4	24.6	2.5
Kampong Thom	6.8	22.3	4.9
Kampot	6.8	59.9	3.6
Kandal	12.8	60	10.4
Kep	9.2	9.2	
Koh Kong	38.9	64.1	31.8
Kratie	13.5	19.4	11
Mondul Kiri	8.6	19	5.5
Oddar Meanchey	2.6	5.7	1.2
Pailin	23.1	23.1	
Phnom Penh	80.2	93.4	62.9
Preah Vihear	3.7	10.4	2
Prey Veng	3.9	19.6	3
Pursat	9.6	28.3	6.3
Ratanak Kiri	14.9	61.5	4
Siemreap	9.5	36.6	4.1
Sihanoukville	41.5	41.5	
Stung Treng	14.1	40.8	2.3
Svay Rieng	4.7	63.2	2.2
Takeo	4.6	28.8	3.4
Cambodia Total	15.1	53.6	8.5

Source: General Population Census of Cambodia 1998

3.6.2 Electrified Situation Identified by Cambodia Socio-economic Surveys (CSES)

The more recent electrified situation can be observed by outputs of Cambodia Socio-economic Surveys (CSES) done in 1999 and 2003/04. Although the methodologies of respective household surveys considerably differ (CSES 1999: Two rounds survey with 6,000 households, CSES 2003/04:14 months Diary method with 14,000 households), one can compare the level of electrification for analytical purposes. Figure 3.3 compared the "Energy source for lighting" by Cambodia total, Phnom Penh, Other Urban, and Rural. Within the five years, obvious changes can be identified.



Source: CSES (1999), Prelimiary Analysis of 9 months data of CSES 2003/04, Ministry of Planning

Figure 3.6.3 Change in Energy Source of Lighting in Cambodia from 1999 to 2003/04

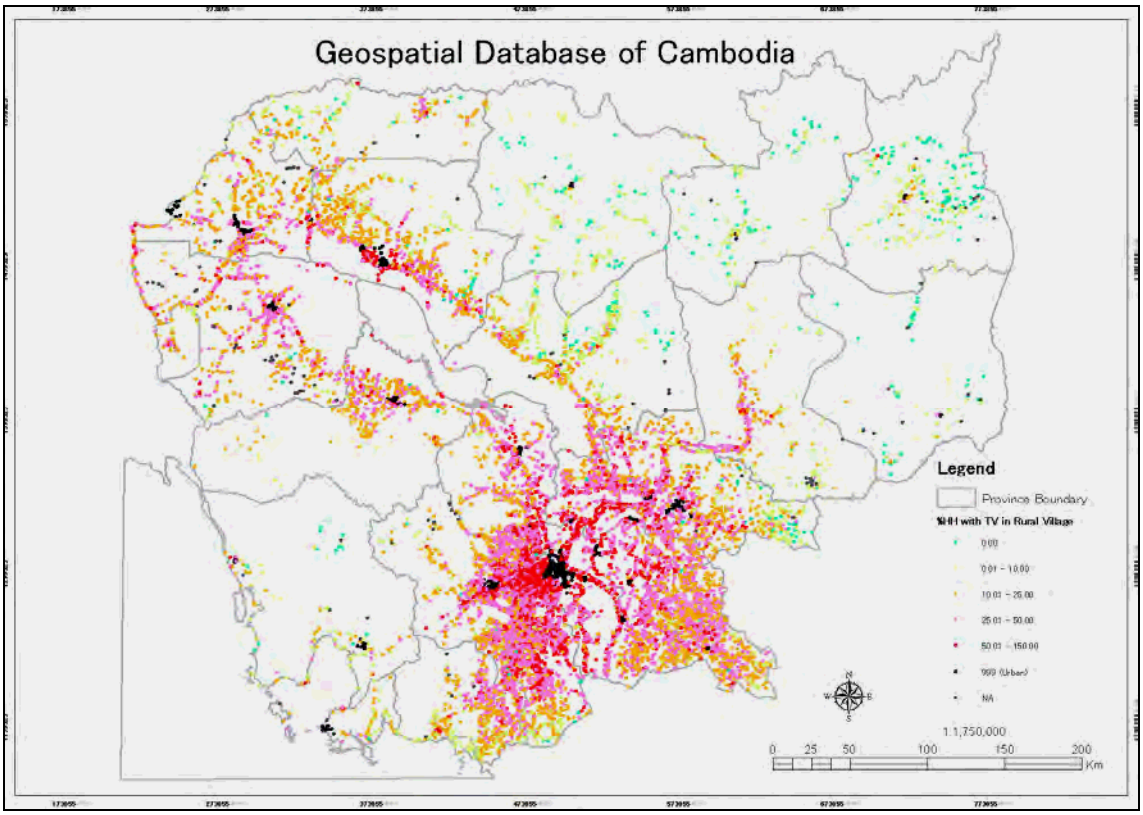
In rural area, the share of diesel oil has dropped substantially more than 20%, while the share of battery has increased from 7.7% in 1999 to 27.5% in 2003/04. The battery users increased more than three times as a country as a whole.

3.6.3 Seila Commune Database, Year 2003

There are two categories of village, namely (i) Rural and (ii) Urban. The Seila Commune survey only recorded the number of households supplied with electricity in Urban Villages. There is one item "TV_MUM" in Seila data, which is the total number of household having TV sets in Rural Villages. To run TV sets one needs to have electricity, this might come from City Power, Generator, Battery, etc. During the field survey by several member of the study team, it has been learned that most of the rural households use either electricity supplied by REE (generator) or battery. Figure 3.4 shows the percentage of households having TV sets in Rural Villages. There is direct correlation between level of electrification and the number of household with TV sets.

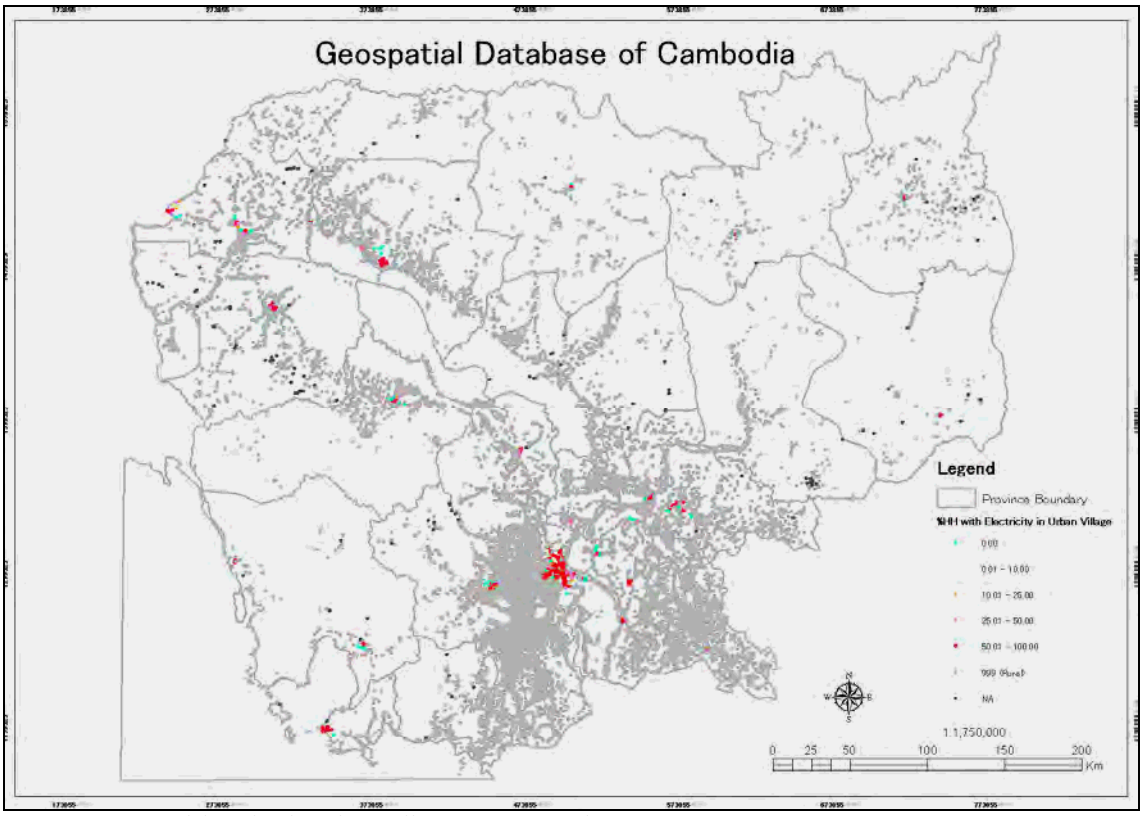
The Seila Commune Database is the most updated village data available in Cambodia where most of the villages have been listed. Total number of the village is 13,910 where 1,021 has been classified as Urban and 123 villages with no data. The question for item "TV_MUM" has not been administrated in Urban Villages. The value 999 (item not administrated) assigned to Urban Villages while value 9999 represents the village where data is not available.

Figure 3.5 of level of Urban Village electrification shows location and intensity of electrification, but only in urban villages. Here again 12766 Rural Village (where no information is available) has been assigned with 999 value and 123 village with 9999 vale where data is not available.



Source: Team elaboration based on Seila Commune Database 2003

Figure 3.6.4 Percentage of Households Having TVs in Rural Areas



Source: Team elaboration based on Seila Commune Database 2003

Figure 3.6.5 Percentage of Electrified Households in Urban Areas

3.7 ELECTRIFICATION BY SELF GENERATION

3.7.1 Micro Hydro Installations

(1) Self Generation by Micro Hydro

There are several cases of self generation by micro hydro in Cambodia. Through field survey made in January and February 2005, the Study Team visited some existing self generation schemes with micro hydro. Those micro hydros introduced below for reference:

(i) Micro Hydro in Mondul Kiri Province

There is one example of micro hydro in Oromis restaurant located about 2 km from center of Senmonorom Town (provincial capital). With an intake on the Oromis River upstream of a river bend, the scheme diverts river water to rotate a small turbine imported from Viet Nam. The scheme generates about 2 kW of power which is used by the Oromis restaurant itself. The Study Team visited the scheme in the end of January 2005. Though it was a beginning of dry season, there was a significant water flow available for generation.

	
Intake of Oromis Micro Hydro Scheme Main stream is closed to raise the water level by about a half meter to divert the water to a channel inlet.	Channel and Turbine Diverted water is guided to 0.5 m width rectangular shape wooden waterway to rotate a turbine and generator package.

(ii) Micro Hydro in Koh Kong Province

Another example exists in Koh Kong Province near a ferry boat station crossing Tatai River. As seen in the photograph below, the scheme uses a used car wheel with 18 vanes welded onto it. According to an interview from the owner, this wheel with vanes is rotated by diverting water from mountain about of 50 m high or more. However, the mountain water dries up during the dry season. Therefore this system is operated only in the rainy season from June to October. Capacity of this scheme is 5 kW, of which generated electricity is used by the hotel only during the rainy season.

	
Micro Hydro owned by a private hotel utilizing mountain water only for the rainy season	A small turbine made from car wheel, to be rotated using diverted water from mountain side

(2) Mini Grids of CBO by Micro Hydro

There is one mini grid operated by CBO in Stung Treng. The scheme is called as Ou Pon Mong. The Ou Pon Mong Scheme consists of upstream and downstream schemes. The Study Team visited the site in January 2005. The scheme has an installed capacity of 5 kW. This scheme distributes electricity to about 70 households. During nighttime, people play Video CD with two sets of television for their nighttime recreation. There were about 100 people enjoyed watching Video CD program when the Study Team visited the site at 19:30 p.m.

	
5 kW capacity micro hydro turbine and generator at Ou Pong Mon Upstream scheme	About 40 people enjoyed watching Video CD Program with two sets of television.

3.7.2 Solar Power Applications

According to MIME, as of December 2003, there were more than 204 kWp of photovoltaic (PV) modules installed in Cambodia. Such power by PV is mainly used for lighting, small equipment of public facilities and telecommunication company's repeater stations.

Of these, there are research demonstration projects in Sihanouk Ville Province and Kampong Cham Province operated jointly by NEDO (New Energy Development Organization, Japan) and MIME. These projects provide electricity to local mini-grid of near-by households. The system operation and management is carried out by Community Based Organization (CBO) with help of local government. Figure 3.7.1 shows photographs of NEDO and MIME research demonstration project.

For self generation system, there are some private companies that provide services commercially in Cambodia. These companies import PV module or solar home system (SHS) and related components as per demand of individual users. For an image of such self generation system, Figure 3.7.2 shows some examples of PV panels applied to telecommunication companies system. However, such PV panels are far beyond the level that private people can afford to buy.

(a) Large scale PV (50kWp) & Biogas Hybrid system (b) Large Scale PV (30kWp) & MH Hybrid system

Figure 3.7.1 Research Demonstration Projects by NEDO & MIME

3.7.3 Biomass Power Applications

There is one biomass mini grid electricity supply system operated by CBO in Cambodia. Anlong Ta Mei village (Bannan District, Battambang Province) has recently (February 2005) started its operation of community energy cooperative project. Currently electricity is supplied 7 hours (16:30-23:30) a day to 70 households. The project is organized by a NGO, Small and Medium Enterprise Cambodia (SMEC). SMEC received a grant ($24,000) from CIDA (Canadian International Development Agency) for the project. The initial cost for setting up a biomass gaification, electricity generation and distribution system are covered by the grant. The community energy cooperative will own, operate, maintain and manage the system on a non-subsidized, sustainable basis after the initial operational testing period. SMEC provide technical and supervisory input during the implementation period of the project (18-24 months).

The project introduced a 9 kWe biomass gasification electricity generation system (imported from India). Wooden posts are used for distribution line system. A meter is set for each house and customers are charged at kWh rate. Street lights were also installed (Figure 3.7.2).

(a) Gasifier electricity generation system.

(b) Electricity generation station.

(c) Distribution lines.

(d) A meter box.

(e) Street lights.

Figure 3.7.2 Woody biomass gasification electricity generation and distribution facilities at Anlong Ta Mei community energy cooperative project, Battambang Province

The total cost for initial establishment is about $23,436 which consists of Building ($1,500), Gasifier ($10,130), engine ($4,342) and distribution line $7,464 (Table 3.7.1). Community provided labor for the establishment. Customers are charged R50,000 ($12.50) for initial connection and the tariff is at R1,200/kWh ($0.30). Monthly electricity usage per household is estimated 13kWh. The monthly household expenditure for electricity is estimated $3.90. The tariff covers the future replacement cost of facilities such as gasifier (20 years), engine (8 years) and distribution line (30 years) (Table 3.7.2). The depreciation cost occupies 38% of monthly operational cost (Table 3.7.2).

Table 3.7.1 Initial Cost and the Depreciation of Biomass Gasification Electricity Generation and Distribution Facilities of Anlong Ta Mei Community Energy Cooperative Project, Battambang Province, Cambodia

	Depreciation period	Initial cost	Monthly depreciation cost
Building	30 yr	$1,500	$4.17
Gasifier	20 yr	$10,130	$42.20
Generator	8 yr	$4,342	$45.23
Distribution line	30 yr	$7,464	$20.73
Total		$23,436	$112.33

Source: JICA Study Team

Table 3.7.2 The Estimated Average Monthly Operational Cost of Anlong Ta Mei Community Energy Cooperative Project, Battambang Province, Cambodia

Items	Cost
Direct Cost	
Fuel wood	$47.00
Labour	$80.00
Lubricant	$15.00
Indirect Cost	
Maintenance	$15.00
Salary for accountant	$20.00
Depreciation	$112.33
Others	$8.00
Total	$297.33

Source: JICA Study Team

The project encourages village people to plant *Leucaena leucocephala* trees in their gardens (Figure 3.7.3). The project only uses *Leucaena* wood to avoid any conflict with any woody fuel currently used as domestic energy source. The energy cooperative purchases the *Leucaena* branches from village growers at $20/dry ton. *Leucaena* is a legume tree species. It fixes nitrogen and grows well at relatively nutrient poor soils and has generally positive impact on soils.

Figure 3.7.3 *Leucaena leucocephala* 0.5 year old stand planted at the corner of a farm garden (Anlong Ta Mei community energy cooperative project)

People can start to harvest branch wood one year after planting and is expected be able to harvest twice a year for many years (> 10 years). Annual wood production of the project site is about 20 t/ha according to SMEC. The green leaves are also sold to poulterers at R300/kg ($75/t) for feeding. Currently, *Leucaena* is planted a total of 8 ha by 60 cooperate members. The wood fuel efficiency for electricity generation is 1.5 kg/kWh. The current 7-hour operation requires 27 t of wood per year. Less than 1.5 hectare of *Leucaena* planting is sufficient to supply the wood fuel for the operation.

3.8 REVIEW OF EXISTING RURAL ELECTRIFICATION PLANS AND STUDIES RELEVANT TO MASTER PLAN

We review herewith two key plans of rural electrification relevant to the M/P study. These are: (i) Cambodia Energy Strategy Paper; and (ii) Renewable Energy Action Plan (REAP).

3.8.1 Cambodia Energy Strategy Paper

As of February 2005, MIME is preparing a new Cambodia Energy Strategy Paper to replace the existing Cambodia Power Sector Strategy Paper (1999 – 2016). The current power sector development plan has been guided by the Government's national power development master plan formulated in 1998 and the WB's Cambodia Power Sector Strategy completed in 1999. The master plan becomes quickly outdated due to rapid growth of demand, the changing pattern of loads, and emerging context of GMS power trade strategy. The serious need of updating is recognized by both the Government and donors. The 1999 Strategy aimed to meet the development objectives of the sector by focusing on short- to medium-term measures while keeping in mind the longer-term vision. Most of its recommendations remain relevant and some of the key measures such as the Electricity Law and the creation of EAC have actually been implemented in the last few years. With the rapid growth of demand, there is need for a new round of sector strategy review. This is the background of the review of the current plan and preparation of the new strategy paper.

The basic policy on rural electrification of the new strategy paper advocates the following:

Principles:

- to integrate RE with rural development and poverty alleviation agenda
- to decentralize service provision to local entities (REEs and local communities)

Objectives:

- to provide reliable, clean, affordable electricity services for rural population
- to act as a market enabler and to encourage Private Sector Participation (PSP) for service provision
- to provide effective legal and regulatory framework
- to promote renewable electricity system of least-costly option for each community
- to ensure adequate resources and appropriate institutional mechanism to empower rural poor

Goals:

- 70% of rural households to be electrified with grid-quality levels by year 2030
- 100% of villages to be electrified with any means by year 2020[14]

RE Strategies:

[14] The draft paper states a goal that 90% of villages to be electrified by the year 2030 would be appropriate. This goal was improved to 100% by the year 2020 by the JICA Study Team based on the discussion with MIME.

The RE component consists of two systems: (i) grid-based supply to provincial and district towns for which **EdC** is principally responsible; and (ii) off-grid (mini-grid) for rural areas (with no access to public grids), of which implementation first **MIME** and then **REF** will be basically responsible.

The WB is also initiating the energy sector strategy review of Cambodia inviting other major donors to assist and coordinate with the Government updating the energy sector strategy.

The Study Team will prepare the M/P to reflect and be consistent with the above strategy paper in general and that on RE in particular.

3.8.2 Renewable Energy Action Plan

The Renewable Energy Action Plan (REAP) was prepared by MIME in 2002. The REAP is a strategic plan funded by the WB's Energy Sector Management Assistance Program (ESMAP) in order to encourage the generation of electricity from renewable energy sources. The first edition was produced in May 2003 by an international consultant with an assistance from MIME officials and the input of 150 stakeholders, both local and foreign, through a series of national workshops over a period of three years (2001 – 2003).

The REAP was supposed to be implemented under 3-phase 10-year program: (i) market preparation phase (2002-2004); (ii) early growth phase (2005-2007); and (iii) rapid growth phase (2008-2011). The 10-year plan proposed priority renewable energy projects comprising four types of electrification with a total estimated cost of 37 M$ as shown in Table 3.8.1. The proposed project will serve 145,000 households with a capacity of 17 MW. The capital costs will be financed by three main sources of grants, loans and equity of which shares will vary depending on the type of electrification and local socio-economic conditions. In average, grants account for 45%; loans, 32% and equity, 23%.

Table 3.8.1 Indicative Priority RET Projects Proposed by REAP

Priority Projects	Targets		Estimated Cost (M$)	Fund Sources		
	Households	MW		Grants (%)	Loans (%)	Equity (%)
1. Grid-connected mini-hydro	100,000	10	31.0	45	32	23
2. Mini-grid community-scale hydro	30,000	5	4.0	38	38	24
3. Pico-scale hydro	5,000	1	0.5	60	40	-
4. Solar PV system	10,000	1	1.5	67	20	13
Total/Average	145,000	17	37.0	45	32	23

Source: REAP (May 2003)

Out of the 10-year program, the first 5-year action plan (2002 – 2007) includes: (i) 6 MW mini-hydro and 850 kW village hydro; (ii) 50,000 new households by REE off-grid systems; and (iii) 12,000 households by solar PV systems. The scope of the 5-year action plan was adopted by the WB Rural Electrification and Transmission Project as discussed in the next section.

3.9 CURRENT ACTIVITIES OF DONORS

The WB, ADB and the Japanese Government (JICA/JBIC) are the major donors in the electric power sector and broadly share the same strategic thinking. The WB and ADB have been working together to

help the Government develop policy, strategy, and institutional set up especially capacity building for EAC and finance distribution, rural electrification and transmission.

The Rural Electrification and Transmission (RE&T) Project includes the ADB/WB co-financing for a transmission line between Vietnam and Phnom Penh, which is a key investment to secure supply and reduce costs for Cambodia. This is the crucial first step for the implementation of GMS power interconnection plan. The two agencies are working closely in supporting the GMS power trade program. There has been increasing dialogue between the WB and JICA/JBIC on the sector issues and donor programs.

3.9.1 Rural Electrification and Transmission Project

The RE&T Project which has an indicative project cost of 143 M$ was approved by the WB in December 2004 and has the following four components:

Part A: The **Transmission Line** (T/L) component (91M$) to be implemented by EdC comprises: (i) construction of a 109 km long double circuit 220 kV line from the border with Vietnam to Phnom Penh and two associated substations; (ii) reinforcement of the 115 kV grid around Phnom Penh involving about 20 km of 115 kV lines and modification of the 115 kV substations and 22 kV extension; (iii) a national control center to optimize load dispatch operations in the EdC system and increase system security; and (iv) building EdC's capacity in project management, land acquisition, resettlement and environmental monitoring and mitigation. Component (i) within Cambodia would be financed by ADB.

Part B: The **Rural Electrification** (RE) component (15M$), to be implemented by EdC, comprises the EdC grid extension program covering 516 km of MV and 536 km of LV lines and electrification of about 50,000 households. The Project will support the symbiotic relationship of EdC and REEs, and will make use of REEs in the operation and maintenance of the rural distribution systems. EdC would identify existing and prospective REEs and various options for public/private partnership including distribution licensing, billing and collection arrangements, management contracts, and leasing arrangements.

Part C: The **pilot REF** component (28 M$) to implement off-grid (mini-grid and stand-alone systems) rural electrification program. The creation of the REF as a transparent institutional mechanism for promoting RE, has been widely accepted in the country through three national stakeholders consultation workshops. As a result, the REF has come to be established by the Government as an independent public institution with administrative, managerial, technical and financial autonomy to channel sub-grants and TA to the private sector and rural communities to implement RE sub-projects. The REF will provide assistance to private sector developers (REEs and CBOs) for: (i) provision by REEs of about 45,000 new connections; (ii) provision of electricity to about 12,000 households using solar home systems; and (iii) addition of at least 6 MW of mini-hydro and 850 kW of micro hydro.

Part D: The Institutional Development and Sector Reform TA component (9M$) comprises consulting and advisory services to: (i) **MIME** in renewable energy policy development, power market analysis, and development of a power master plan; (ii) **REF** for implementation support, promotion of rural income generation options, renewable energy business development, REE improvement and association building, and capacity building of financial institutions; (iii) **EAC** for institutinal strengthening; and (iv) **EdC** for

services of a project implementation consultant and in-house advisor, creation of an independent monitoring agency and a project grievance committee, improvement of commercial practices, management training, capacity building for land acquisition, resettlement and environment, and power investment planning.

The TA for MIME of Part D would be our great concern due to the proximity to our study purposes and scope. The Study Team would coordinate and discuss these common issues with the WB during the course of the Study. Meeting with a WB coordinator in Bangkok in Feb. 2005 gave us an assurance that the WB would take due consideration of JICA Study's findings and recommendations to their implementation of this TA sub-component.

The Study Team believes there are things to be improved in the scope and selection criteria of sub-projects for Part C (pilot REF component). Particular areas to be reviewed are:

- Lack of definition of rural areas to which REF support is applied
- As energy sources, diesel, solar and hydro are taken, but biomass is excluded.
- As for solar system, solar home systems (SHS) are taken up, but there is no mention of more tangiblel solar battery charging stations (BCS).
- The number of households is capped at 300 or more. This hurdle is very high considering the median number of households per village is 140. Relaxing this condition is desirable.
- There is no mention of concrete and specific description of capacity building of financial institutions, including provision of smart credit mechanism using ODA two-step loans and guarantee scheme. It is difficult to leverage private finance without these credit enhancement measures.

These areas of improvement were informed to MIME and it is expected due considerations would be taken in their policy and strategies, including developing special funds for biomass mini-grids and solar BCS to complement the REF.

3.9.2 Other Projects Concerned

Besides the RE&T Project, there are a number of foreign assistance projects which contribute to provincial and rural electrification development, including private sector projects as shown below.

Table 3.9.1 List of Power Sector Projects in RGC

Fund Resource	Name of Project	Amount of the fund
Government of Japan (grant)	The rehabilitation and expansion of the distribution system in four suburban areas of Phnom Penh	USD 30 million
Investment from CETIC	The rehabilitation and operation of Kirirom hydropower plant of 12 MW and transmission line of 115 kV from Kirirom to Phnom Penh and substations to distribute the electricity at Kampong Speu provincial town Also conduncting the feasibility study of Kirirom 3 hydropower plant (13 MW)	USD 26 million
	The construction of a 22 kV distribution system from Thailand to distribute in Koh Kong, Pailin, Poi Pet and Malay of Banteay Meanchey Province, Kam Rieng, Phnom Prek and Sampov Lun of Battambang Province, Osmach of Odomean Chey province	N/A

Fund Resource	Name of Project	Amount of the fund
Investment from Thai and Vietnamese private sectors (Partially granted by the government of Vietnam)	The construction of a 22 kV distribution system from Vietnam to distribute at Barat of Svey Rieng Province, Memot and Pongnea Krek of Kampong Cham province, Kampong Trach of Kampot Povince and Snoul of Krate Province	N/A
	The construction of power plants No. 1 (Jupiter Power) and No. 2 (CUPL) with a total combined capacity of 63 MW	N/A
Government of Japan (grant)	10 MW power plant in Siem Reap provincial town	USD 17 million
ADB (loan)	The power supply system rehabilitation and expansion of 8 provincial towns	USD 19 million
NEDO	- The installation of solar and wind systems on bridges, schools, training centers, resorts, hospitals, pagodas, households and public facilities with a total capacity of 6,356 W - Pilot experimental project by NEDO, Japan with a total capacity of 218.7 kW at Tuk Chhar resort (hybrid system of solar and micro-hydro) and Mong Riththyy cow farm at Sihanoukville (hybrid system of solar and biogas);	N/A
Investment of Chilbo Company from South Korea	Generation and distribution project in Kampong Thom (2 MW)	N/A
Investment of the GTS Company, Malaysia	Generation and distribution project in Kampong Cham (4 MW)	N/A

Source: JICA Study Team

3.10 ISSUES OF ELECTRIFICATION IN OFF-GRID AREAS

The issues to be addressed for promotion of electrification in the off-grid areas discussed in the previous sections are summarized as follows:

- Low level of rural electrification by grids at about 11% as of 2004 and most of the households (about 50%) depend on battery lighting;
- High tariff of electricity of 30¢-91¢/kWh because of small scale, low load factor (around 10%), high fuel cost, low efficiency of unsuitably large generator capacity (low capacity factor and low fuel efficiency) and aged diesel generators (low efficiency);
- Social injustice for rural people to bear higher electricity costs than urban people who have higher cash income. Unit cost of electricity at the consumer end of battery users amounts to as high as $1.05/kWh, which is 12 times the subsidized tariff at Riel 350/kWh for users of limited electricity (< 50 kWh per month) in Phnom Penh, that is, the poorest pay at the highest rate;
- Frequent interruption of power supply and significant voltage drops of mini grids;
- Social disparity between urban and rural areas in the nationwide development;
- Most of DIME have not monitored the latest situation and issues of rural electrification;
- Most of the stakeholders of the rural electrification sector do not have means to access the latest technology for rural electrification by biomass gasification power in particular;

- REEs can hardly get commercial loans because of high interest rates and too much collateral requirements.
- The high interest rate and short maturity periods make renewable energy-based electrification which calls for long-term financing, practically impossible. Thus provision of government long-term credit programs in addition to the existing REF grant program is definitely required.
- REF pilot projects are limited only to those large RE schemes serving greater than 300 households as well as only to those by solar power, micro hydro and diesel power.
- Although EdC is gradually extending its supply to large towns, private providers remain the major source of supply for small towns and the rural areas. Thus privately owned and operated REEs continue to be the only realistic source of electricity supply for rural areas.
- Participation of REEs is greatly encouraged to promote RE but no countermeasures are shown to reduce the current high power tariff, probably the world highest.

4. SOCIO-ECONOMY AND ELECTRIFICATION DEMAND

4.1 PRESENT SITUATION AND PERSPECTIVE OF SOCIO-ECONOMY OF CAMBODIA

4.1.1 Political Regime of Cambodia

The Royal Government of Cambodia (RGC), which has been created on the principles of free democracy and multi-party, has made more efforts with high responsibility in the socio-economic development and the increase of wealth and well-being of the population. The RGC has implemented the policies to accelerate pro-poor economic growth in conjunction with social programs that are keys to alleviate suffering of millions of Cambodians still living below the poverty line.

In 2003, the RGC has adopted a comprehensive reform agenda, called "Rectangular Strategy" with good governance as its backbone. The strategy includes four pillars: (i) creating high economic growth and enhancing Cambodia's competitiveness; (ii) creating employment; (iii) improving social equity; and (iv) increasing the effectiveness of the public sector.

The enabling environment for successful implementation of this strategy includes: (i) peace, political stability and social order; (ii) partnership with development partners; (iii) macroeconomic and financial stability; and (iv) Cambodia's integration into the regional economy. Cambodia has acceded to the World Trade Organization (WTO) in September 2003. The rectangular strategy includes the following areas as the priority sectors: (i) strengthening agriculture as a viable sector; (ii) promoting private sector development and employment; (iii) building physical infrastructure; and (iv) stimulating human resource development.

4.1.2 Present Situation of Economy

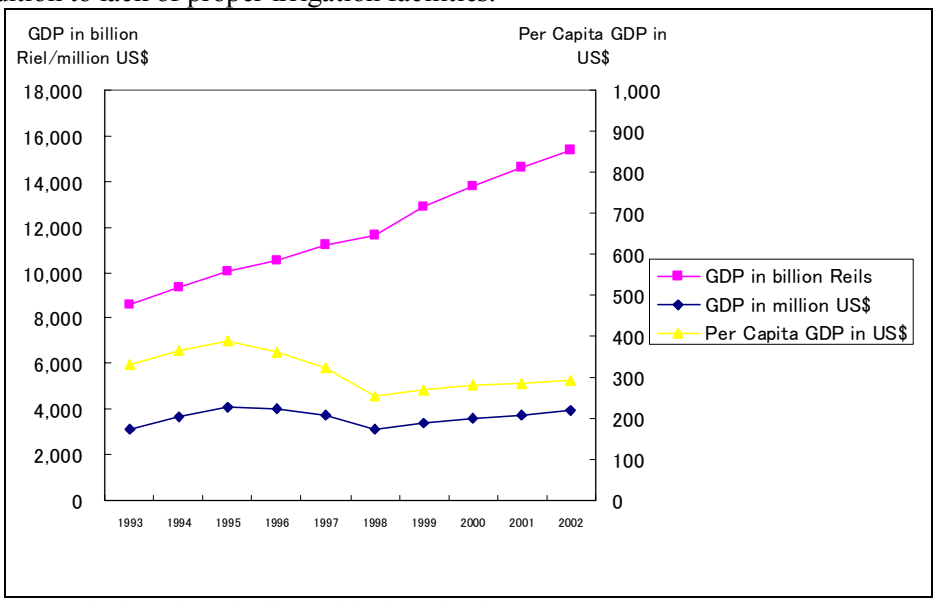
(1) GDP

Cambodia is an agricultural country originally with fertile land and rich water resources blessed by the Mekong River, and an exporter of rice and rubber in the 1960's. However, devastated by the long continued turbulent history, livestock and other agricultural production declined, its human resources became scarce, and all the other industries suffered a major damage. Particularly under the Pol Pot rule, cities were destroyed, many were forced to live in the rural areas, number of working population dropped drastically as they were either killed or fell sick, and the industries were left in devastating conditions.

Since 1986, with the aim to shift towards market economy, Cambodia started its efforts of nation building to rebuild and reform its economy and legal framework, with foreign economic assistance and direct investment. After the 1991 Paris Peace Agreement, foreign countries and organizations restarted their development aid, which supports Cambodia's economy to date. As a result, as shown in Figure 4.1.1,

Cambodia's overall economy has achieved a rapid growth.

In 1998, growth rate dropped to 2.1% due to the armed conflict of July 1997 and suspension of aid from foreign governments and organizations, in addition to the aftereffect of the currency crisis in Asia in 1997. In 2000, the growth rate reached a high 7.7% as garment production for export expanded. In 2001, growth rate dropped to 6.3% due to the decline in the tourism influenced by the terrorist activities in the U.S. and slowdown of garment export. In 2002, growth rate decreased to 5.5% as little progressed in the agricultural sector, which comprises about 40% of the total GDP. Drought and floods were the major causes, in addition to lack of proper irrigation facilities.



Source: Kingdom of Cambodia Statistical Yearbook 2003

Figure 4.1.1 Change of Real GDP

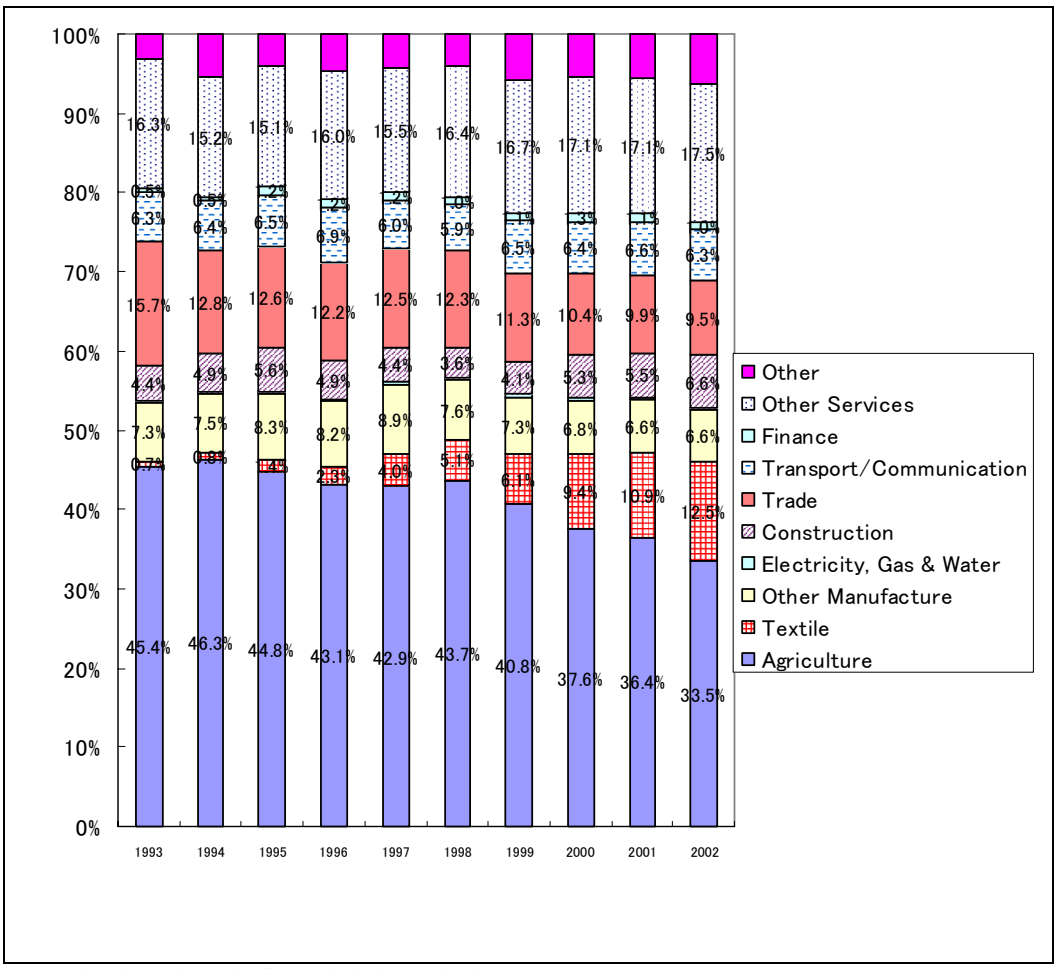
(2) Agriculture / Industry / Services

Figure 4.1.2 shows the composition of the real GDP. A comparison between 1993 and the recent years shows the major changes in the agricultural sector, which declined by 12%, and the garment sector, which increased by 12%. Agriculture, forestry and fisheries comprise about 34% of the total GDP. Agricultural sector is susceptible to climate change such as drought and floods, which is an unstable factor to Cambodia's economy. Improving productivity in the agricultural sector is a major challenge for Cambodia in order to achieve steady economic growth and improve its competitiveness in the international market.

Industry comprises 24% of the total GDP (2001). Major manufacturing was once rice polishing and other food processing, but due to Generalized System of Preferences (GSP) from Europe and the U.S., garment related industries grew rapidly. In 2000, growth rate of garment industry was 79.2%, and in 2001, 26.8%, which boosted the growth of the manufacturing sector. However, as GSP is a time-bound scheme, Cambodia is required to put an end to an extreme dependency on the garment industry. For this reason, in addition to strengthening the food manufacturing industry utilizing abundant agricultural produce, improving home appliances and transport equipment industry should be pursued in view of increasing demand in the future Cambodian market. With regards to effective improvement of Cambodia's home appliances and transport equipment industry, taking into account the level of technology in Cambodia, it

will be appropriate to initially promote foreign enterprises to invest into assembling factories. Cambodia should pursue its industrial development within ASEAN countries, with which Cambodia has already developed strong ties, following the catch-up type economic growth model.

Services sector comprises about 30% of the total GDP. With tourism on the rise, hotel and restaurant sector as well as transportation and communications sectors are also doing well (2000). On the other hand, as many banks were closed in 2001, growth in the services sector slowed down to 2.9% in the same year.



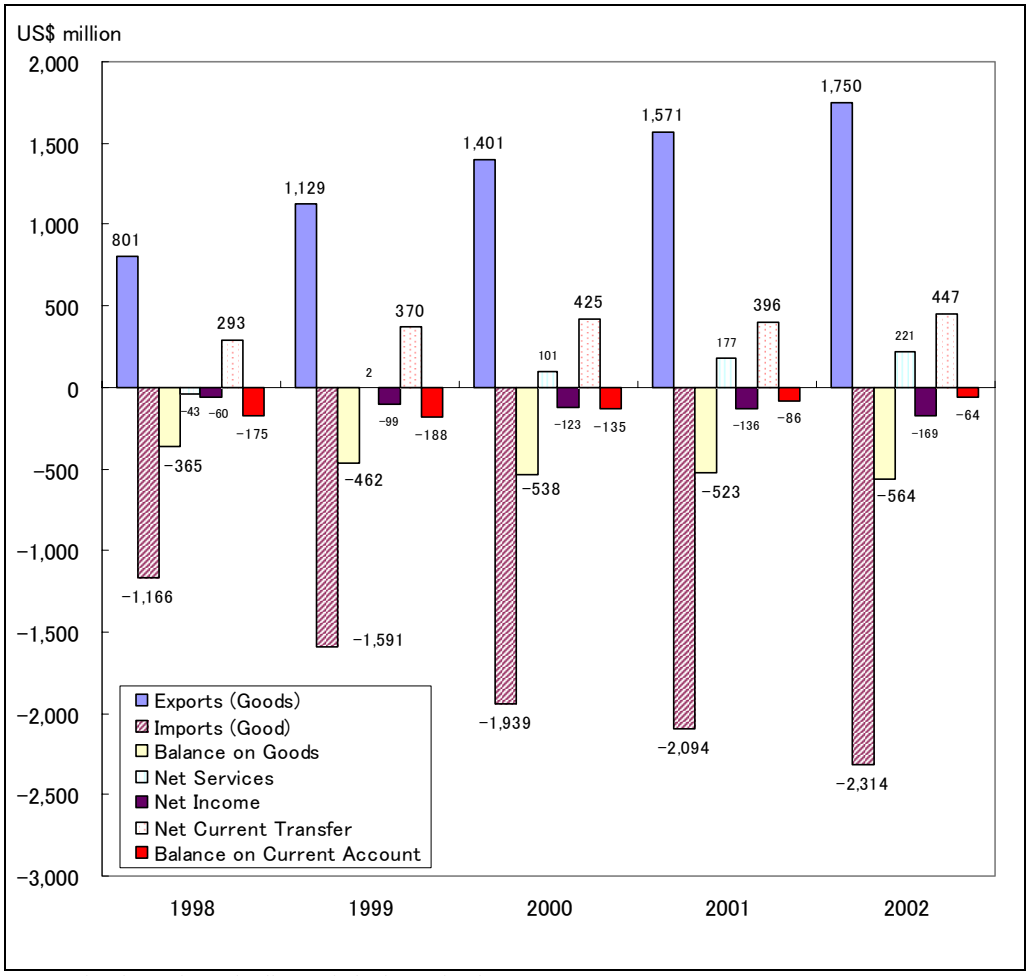
Source: Kingdom of Cambodia Statistical Yearbook 2003

Figure 4.1.2 Composition of GDP

(3) Current Account

Figure 4.1.3 shows the balance of payments in the last five years. Deficit in the trade balance is on the upward trend. Due to the expansion of export of garment and related products, total export is on the upward trend. However, due to the expansion of import of machinery and vehicle, the rate of increase on the import was higher. As a result, the situation of trade balance deteriorated. Deficit on the current account is being suppressed, but this is due to the dependence on current transfers of the public sector such as international aid. This might not be sustainable in terms of financial management. As international aid includes loans which shall be repaid, the debt amount in the public sector is increasing. This is likely to add a financial burden in the future.

In order to improve balance of payments, apart from efforts to reduce trade deficit, it is important to lessen its dependency on the international assistance by increasing foreign direct investment.



Source: Kingdom of Cambodia Statistical Yearbook 2003

Figure 4.1.3 Current Account

(4) Export

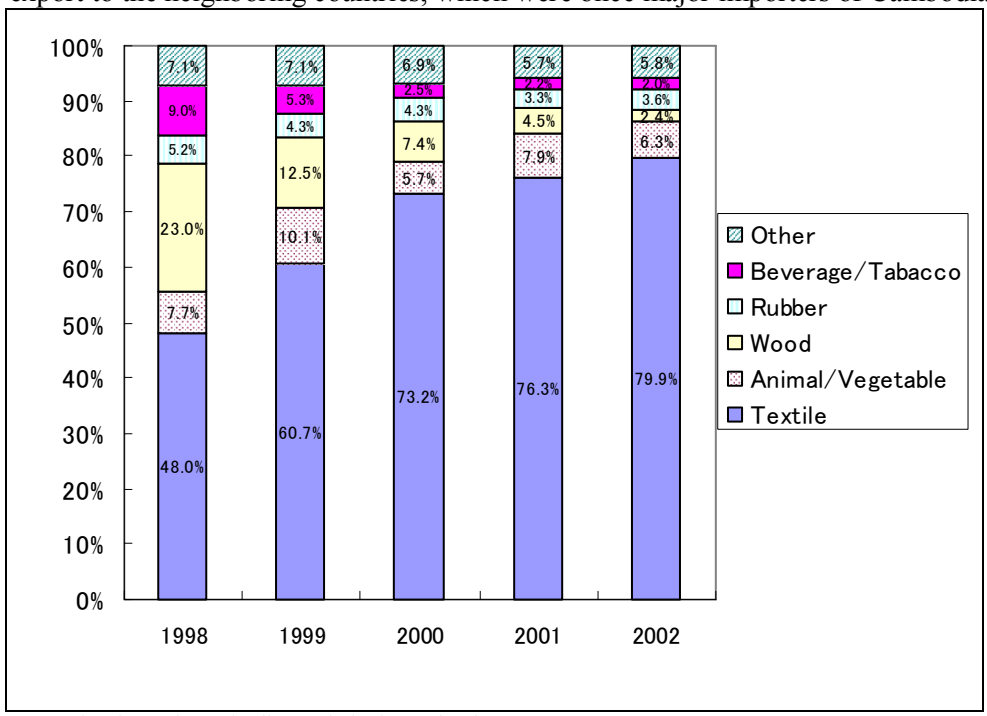
Figure 4.1.4 shows the composition of export in the past five years. Originally, timber and rubber were the major export products of Cambodia, but the recent export composition has significantly changed after the garment products for Europe and the U.S. improved dramatically.

Breakdown of export of 2001 includes garment and other related products under GSP, which increased by 13.2% compared to the previous year, comprising about 80% of the total export. Major importer of such products is the U.S. This is due to GSP being granted by the U.S. in May 1997. In 1999, the U.S. started to set conditions concerning import of 13 garment related products from Cambodia, which are revised according to the changes in the labor conditions of garment industry within Cambodia.

GSP and the import conditions set by the U.S. and EU are time–bound, therefore efforts to improve the international competitiveness of garment industry is important. At the same time, it is also important that Cambodia improves export industry other than garment in order to diversify its industry and to achieve balanced composition of export industries.

Major importers of Cambodia's export goods are the U.S. (61.4%), Germany (8.9%) and the U.K. (7.2%).

About 50% of the total export was for Asian countries in 1999, but export to Europe and the U.S. jumped after the dramatic increase of garment export in 2000. Cambodia is encouraged to diversify its export market. Taking advantage of its member status to ASEAN Free Trade Area (AFTA), it shall be pursued to increase its export to the neighboring countries, which were once major importers of Cambodian goods.



Source: Kingdom of Cambodia Statistical Yearbook 2003

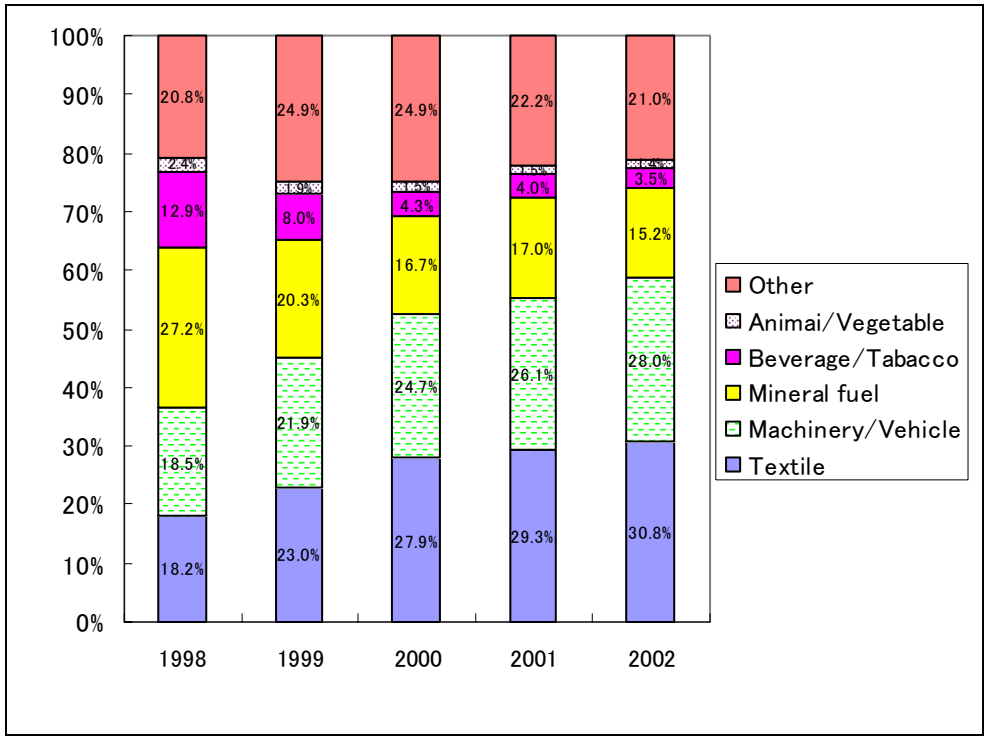
Figure 4.1.4 Composition of Export

(5) Import

Figure 4.1.5 shows the composition of import during the past five years. In 1998, the ratio of tobacco and oil related products were dominant, but in 2002, the ratio of garment and automobile products jumped. Increase of import of raw material for manufacturing of garment products is acceptable. However, increase of import of agricultural and dairy products, once major export products of Cambodia, is now on the rise, which is a factor deteriorating Cambodia's trade balance. In order to improve Cambodia's trade balance in the future, it is encouraged to increase the import of raw materials which can help develop industries and increase export, while preventing excessive import of final products.

The biggest exporter to Cambodia is Thailand (30.2%), Singapore (21.5%) and Hong Kong, (10.2%), which are all Asian countries. There is a possibility that import rate might become excessive after joining AFTA, as import from competitive ASEAN countries is expected to increase. It is encouraged that Cambodia maintains a reasonable trade balance with the ASEAN partner countries while making efforts to expand its exports to those partner countries.

Cambodia is criticized that compared to the statistical figures of the neighboring countries of export towards Cambodia, the statistical figures of Cambodia's import is rather small. As the major source of revenue of Cambodia is tax against imported goods, it is encouraged to improve the administrative ability to collect such import taxes in order to better Cambodia's financial situation.



Source: Kingdom of Cambodia Statistical Yearbook 2003

Figure 4.1.5 Composition of Import

(6) FDI

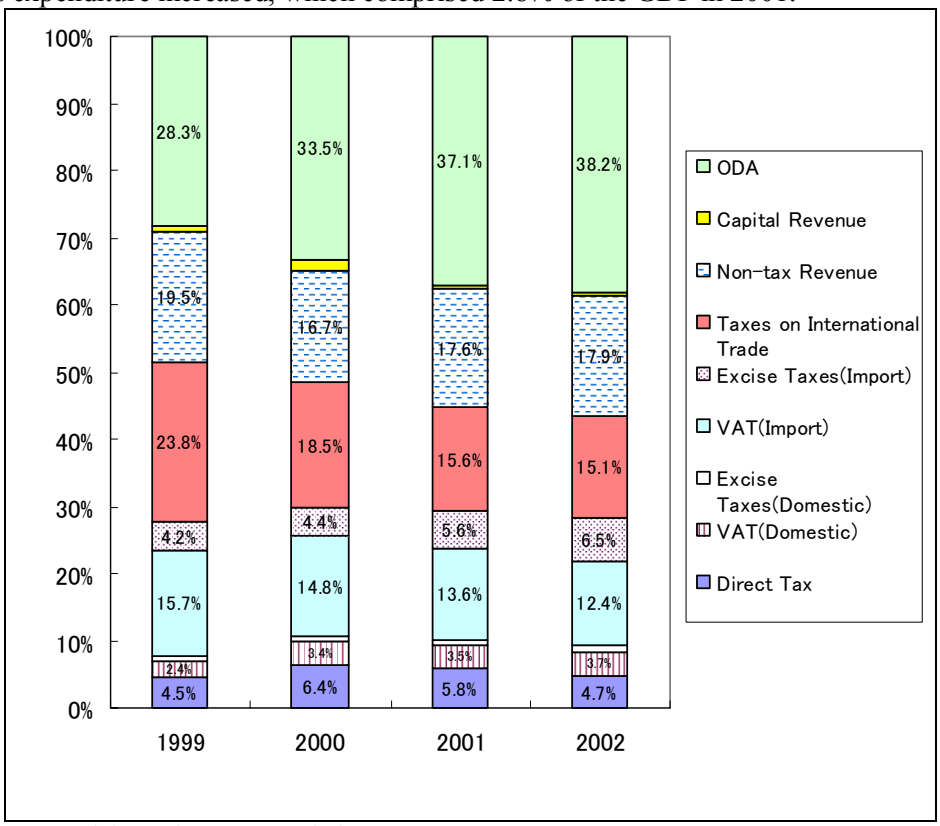
Following the Foreign Investment Law enacted in 1989, foreign direct investment (FDI) increased in the field of oil, natural gas, timber, tourism and banking. The Law was revised in August 1994 and February 2003. As a result of this revision, encouragement measures were reduced, such as raise of corporation tax (from 9% to 20%), and shortened tax waiver period (from eight years to three years).

Cumulative approved investment between 1994 and the end of 2001 is 5.97 billion US dollars. Major investors to Cambodia are Asian countries. Major industries invested are garment, timber processing and tourism. However, since 1998 which marked 850 million US dollars, the approved amount is on a downward trend. Decrease of direct investment is due to the unfavorable investing environment, namely, poor infrastructure, such as road and port, as well as inadequate legal framework, which still requires reforms.

(7) Government Finance

Cambodia's government financial sector is in a state of chronic deficit. Foreign aid continues to be used to fill the deficit. Improvement of financial situation is one of the most important challenges in Cambodia's policy making. Figure 4.1.6 shows the composition of revenue of the RGC in the past four years. Cambodia began efforts to increase its taxation scheme through the adoption of value added tax (VAT) in January 1999. The breakdown of tax revenue in 2001 shows 42.5% was collected from VAT and commodity tax against imported goods, and 34.6%, from customs duties. Over 70% of the revenue comprises tax against imported goods, while domestic collection of income tax and corporation tax is very weak. Improvement of tax collection environment is a big challenge as Cambodia, now a member state of AFTA, will be required to reduce its customs duties in the near future.

Expenditures are on the rise due to an increase of current expenditure and an increase of capital expenditure caused as a result of implementation of aid programmes. Financial deficit has expanded since 2000 as expenditure increased, which comprised 2.8% of the GDP in 2001.



Source: Ministry of Economy and Finance

Figure 4.1.6 Revenue Structure

(8) Inflation, Money Supply and Exchange Rate

Inflation rate is moving steadily since 1999. The exchange rate of Riel against U.S. dollars is also stable. However, this stability is a result of the influence of dollarization of Cambodian economy, where a large amount of U.S. dollar was brought into the country during the UNTAC occupation between 1992 and 1993. The fact that the U.S. dollar comprises a large portion of circulated currency means that there is little room for the financial policy set out by the Central Bank to take effect, posing a challenge for Cambodia to pursue its own initiative in economic administration.

4.1.3 Priority Areas of Economic Policy for Future Development

The Study Team considers that to achieve stable and sound economic development of Cambodia the Government should focus on four types of policies, including: (a) Strengthening economic cooperation with neighboring countries; (b) Promoting export-oriented economic development through WTO; (c) Supply of cheap electricity and rural development; and (d) Securing sustainable source of funds for rural development including rural electrification.

(1) Strengthening Economic Cooperation with Neighboring Countries

As a member state of ASEAN, Cambodia is under the process of a “catch-up” economic growth. For this

reason, it is encouraged to consider transfer of industry from ASEAN countries, in particular, Thailand and Vietnam, which are more industrialized. However, there is no essential supporting industry to manufacture parts for major industries in Cambodia, such as home electric appliances and automobile industries. Therefore, promotion of foreign direct investment and transfer of technology is highly recommended through initially inviting assembly plants for the products which Cambodia now depends heavily on import. By doing so, as nation-wide electric power development progresses further, trade deficits caused by the import of home appliances will be minimized. Moreover, as Cambodia's industries are currently centered around its strong garment industry where there are job opportunities mainly for women, development of home appliances and automobile industries means more job opportunities for men.

(2) WTO

Cambodia's admission to WTO was approved in September 2003. The goal of Cambodia's admission to WTO is to end its dependency on aid, and to pursue export-oriented economic development through promoting the inflow of direct investment.

However, as a result of the admission to WTO, Cambodia is required to make a large reduction of customs duties and to abolish its non-customs duties measures, such as license system, quota, and restriction of quantity of import through imposing embargo. This means that Cambodia will lose the opportunity to pursue the development strategy through import substitution aimed to strengthen its domestic industry.

(3) Supply of Cheap Electricity and Rural Development

By promoting industrialization through foreign direct investment, Cambodia will be able to develop import replacement industries and export-oriented. As a result, Cambodia will be able to enjoy expansion of government finance source and higher income of the general public. In order to achieve economic development through industrialization, supply of cheap electricity is crucial. Promotion of rural development including electrification is also a very important policy issue in terms of developing regional economy, which is far behind that of the capital, and alleviating poverty in general.

(4) Securing Sustainable Source of Funds for Rural Development including Rural Electrification

In order to complete a nation-wide electrification to foster economic and rural development in Cambodia, sufficient and sustainable sources of funds are required. To achieve higher sustainability of the rural development and electrification plan, the following issues and challenges need to be addressed in the long run:

(i) Deterioration of financial situation in Cambodia

70% of tax revenue comprises import related taxes and the large financial deficit is covered by international assistance.

(ii) Trade deficit on an upward trend

Although garment export is expanding, increase of import of home electric appliances, automobile, food, daily commodities and others exceeds the former by far. Most part of the trade deficit is covered by international assistance.

(iii) Foreign direct investment on a downward trend

There is a concern that review of GSP and others may have an adverse effect to the export of garment products. High cost of labor and electricity is an obstacle to the efforts to expand foreign direct investment. Large quantity of import of home electric appliances from neighboring and other countries, which is boosting the demand of electricity, is the cause of increasing trade deficit. Reinforcing the system of taxation against the import of final product of home electric appliances, and utilizing the revenue as part of a secure source of funds, will help maintain the balance between supply and demand while decreasing additional burden on the state finance. There will be some plans to decrease customs duties in the future as Cambodia became members of WTO and AFTA. However, since it is a tax for a specific purpose, there should be room for consideration.

4.2 PRESENT SITUATION OF SOCIO-ECONOMY AND RURAL INFRASTRUCTURES

4.2.1 Overview of Population and Demography

In 1998, the first formal census in 36 years was conducted and provided the population characteristics and the base for population projections. Various household surveys in 1993/94, 1996, 1997, and 1999 called Cambodia Socio-economic Surveys (CSES) were also conducted. The Cambodia Inter-Census Population Survey 2004 (CIPS) updated information on population size and growth, fertility, mortality, migration and other population features as well as household faculties and amenities. The basic features of national level population based on CIPS 2004[15] are summarized in Table 4.2.1.

Table 4.2.1 Estimated Population in Regular Households (2004)

	Total Pop. (x 1,000)	Male (x 1,000)	Female (x 1,000)	Sex Ratio*	Average HH size	Age Dependency Ratio**
Total	12,824	6,187	6,627	93.5	5.1	74
Urban	1,921	932	989	94.3	5.4	60
Rural	10,903	5,255	5,638	93.4	5.0	77

Notes: *) Number of males per 100 females
**) % of population in the younger (0-14) and older (65+) age groups to population in the age group 15-64
Source: CIPS 2004

4.2.2 Spatial Distribution of Population

In Cambodia, regions are divided into four ecological zones of Plain, Tonle Sap Lake, Coastal, and Plateau and Mountain Regions. Land area, population, density and administrative bodies of respective zones are summarized as Table 4.2.2. Nearly 85% of the population live in rural areas. Cambodia's urban population is principally located in two centers, Phnom Penh and Kampong Cham. Six provinces categorized as Plain region located in the central plains and around the capital contain close to 50% of the total population.

[15] The CIPS 2004 was conducted in a nationwide representative sample of 21,000 households within selected 700 villages out of 13,886 villages.

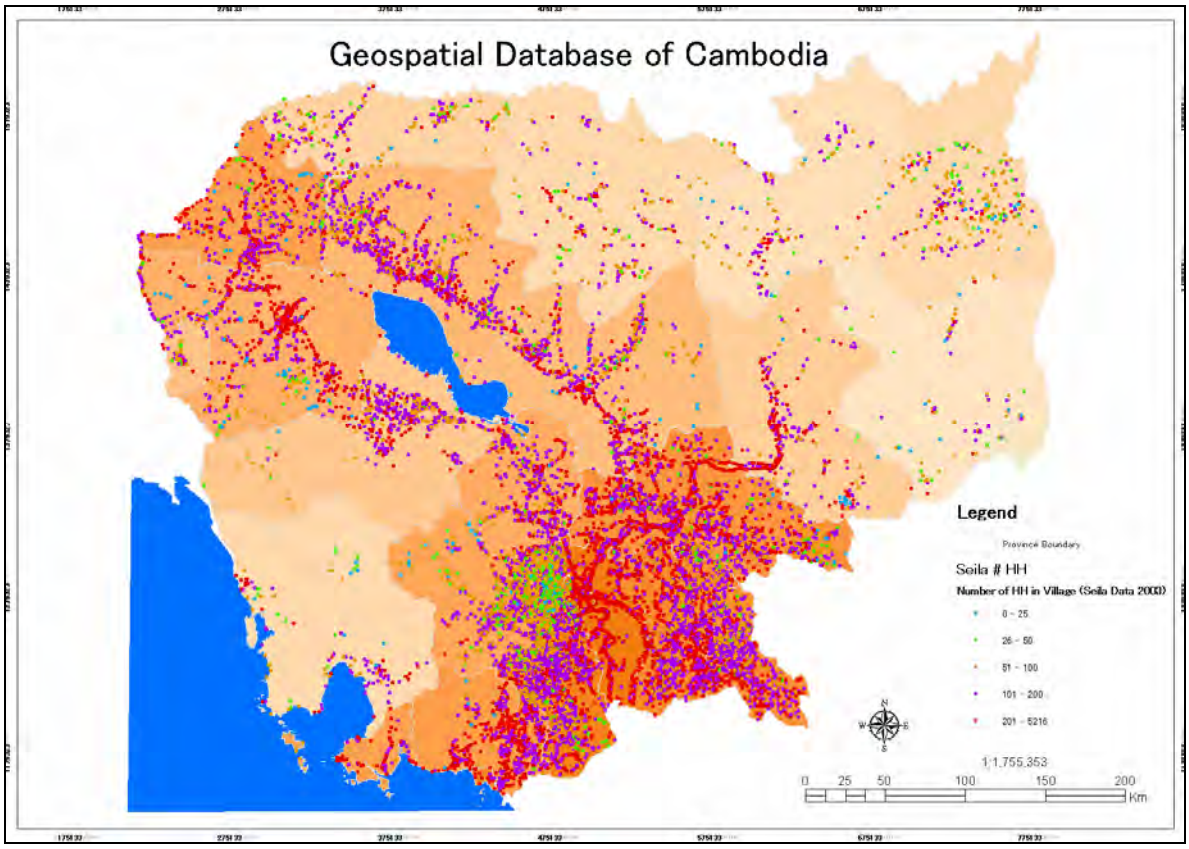
Table 4.2.2 Land Area, Population, Density and Number of Administrative Bodies by Province/City

Code	Province	Land Area (km^2)	No. of Family (Households)	Total Population	Average Household size	Density (Pop/km^2)	Administrative Bodies*		
							District	Commune	Village
I. Plain Region		**24,541**	**1,258,000**	**6,282,435**	**5.0**	**256**	**63**	**692**	**6,454**
12	Phnom Penh	374	179,236	974,572	5.4	2,608	7	76	669
8	Kandal	3,564	226,460	1,161,443	5.1	326	11	147	1,087
3	Kampong Cham	9,483	353,300	1,706,431	4.8	180	16	173	1,754
20	Svay Rieng	2,868	109,264	526,904	4.8	184	7	80	690
14	Prey Veng	4,762	221,990	1,050,743	4.7	221	12	116	1,138
21	Takeo	3,490	167,750	862,342	5.1	247	10	100	1,116
II. Tonle Sap Lake Region		**57,879**	**728,149**	**3,759,387**	**5.2**	**65**	**55**	**459**	**4,054**
6	Kampong Thom	12,448	120,693	616,370	5.1	50	8	81	736
17	Siemreap	10,544	138,456	759,836	5.5	72	12	100	906
1	Banteay Meanchey	6,148	130,262	669,714	5.1	109	8	64	635
2	Battambang	11,858	175,915	899,543	5.1	76	13	96	724
15	Pursat	11,586	73,280	378,572	5.2	33	6	49	501
4	Kampong Chhnang	5,295	89,543	435,352	4.9	82	8	69	552
III. Coastal Region		**18,478**	**173,900**	**886,524**	**5.1**	**48**	**21**	**152**	**719**
18	Sihanouk Ville	1,492	31,028	163,279	5.3	109	3	22	93
7	Kampot	4,718	111,759	565,381	5.1	120	8	92	482
9	Koh Kong	12,116	24,345	124,239	5.1	10	8	33	128
23	Kep	152	6,768	33,625	5.0	222	2	5	16
IV. Plateau and Mountain Region		**78,161**	**297,025**	**1,509,775**	**5.1**	**19**	**46**	**318**	**2,561**
5	Kampong Speu	6,965	127,708	668,931	5.2	96	8	87	1,345
13	Preah Vihear	14,031	27,548	137,002	5.0	10	7	49	208
19	Stung Treng	12,017	17,524	91,833	5.2	8	5	34	127
16	Ratanak Kiri	11,785	23,453	114,594	4.9	10	9	49	240
11	Mondul Kiri	13,669	9,366	42,698	4.6	3	5	21	89
10	Kratie	11,973	55,770	280,521	5.0	23	5	46	250
22	Oddar Meanchey	6,632	25,392	129,123	5.1	19	5	24	224
24	Pailin	1,091	10,264	45,073	4.4	41	2	8	78
	N/A		N/A	N/A					123
Cambodia-Total		**179,059**	**2,457,074**	**12,438,121**	**5.1**	**69**	**185**	**1,621**	**13,911**

No. of Village Location in Seila Data = 13910
No. of Village Where Attribute Data Not Available (NA) = 123
*No. of Administrative bodies substantially changed from 1998 census, especially for villages.
Source: Computed by JICA Study Team based on the Seila Commune Database 2003

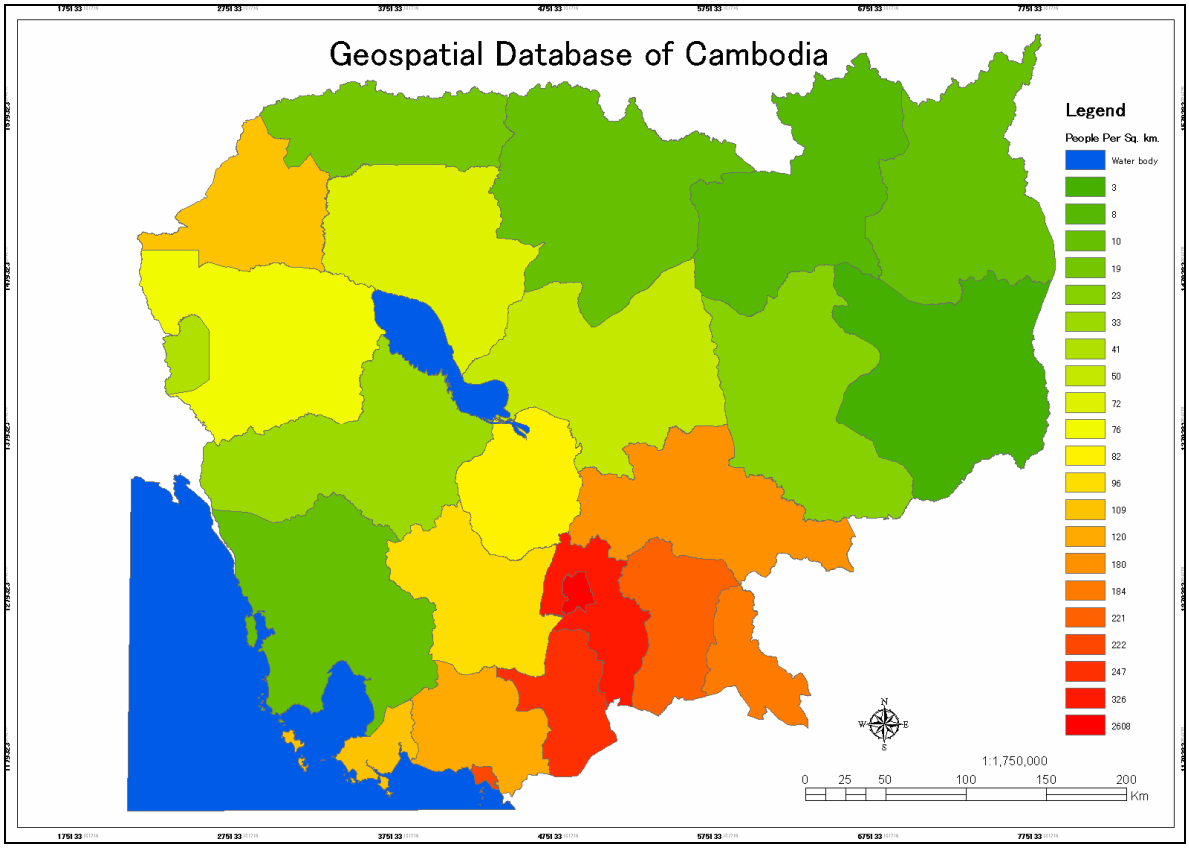
4.2.3 Village Distribution and Scale

The spatial distribution of village are shown in Figure 4.2.1 which illustrates three items namely (i) Spatial distribution of village, (ii) Scale (size) by using the number of family residing in village and (iii) Population density of the provinces as background (deeper the color, higher the density). Figure 4.2.2 presents the average population of the provinces living in one square kilometer. This is the standard measure of the population density of any geographical area in question. From these maps, it can be clearly observed that the concentration of the population lies in the area (i) Southeast flood plain and (ii) two corridors (up and down side) along the Lake Tonle Sap. The rest of the country is thinly populated.



Source: Team elaboration based on Seila Commune Database 2003

Figure 4.2.1 Village Distribution

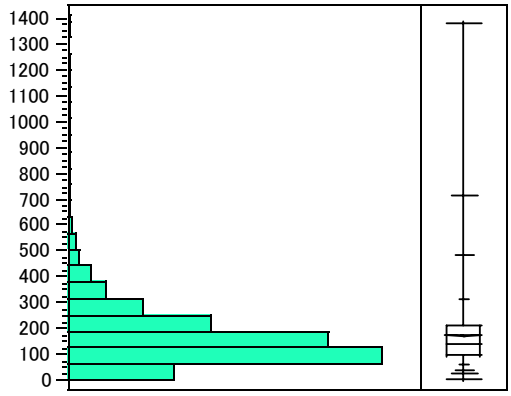


Source: Team elaboration based on Seila Commune Database 2003

Figure 4.2.2 Population Density by Provinces

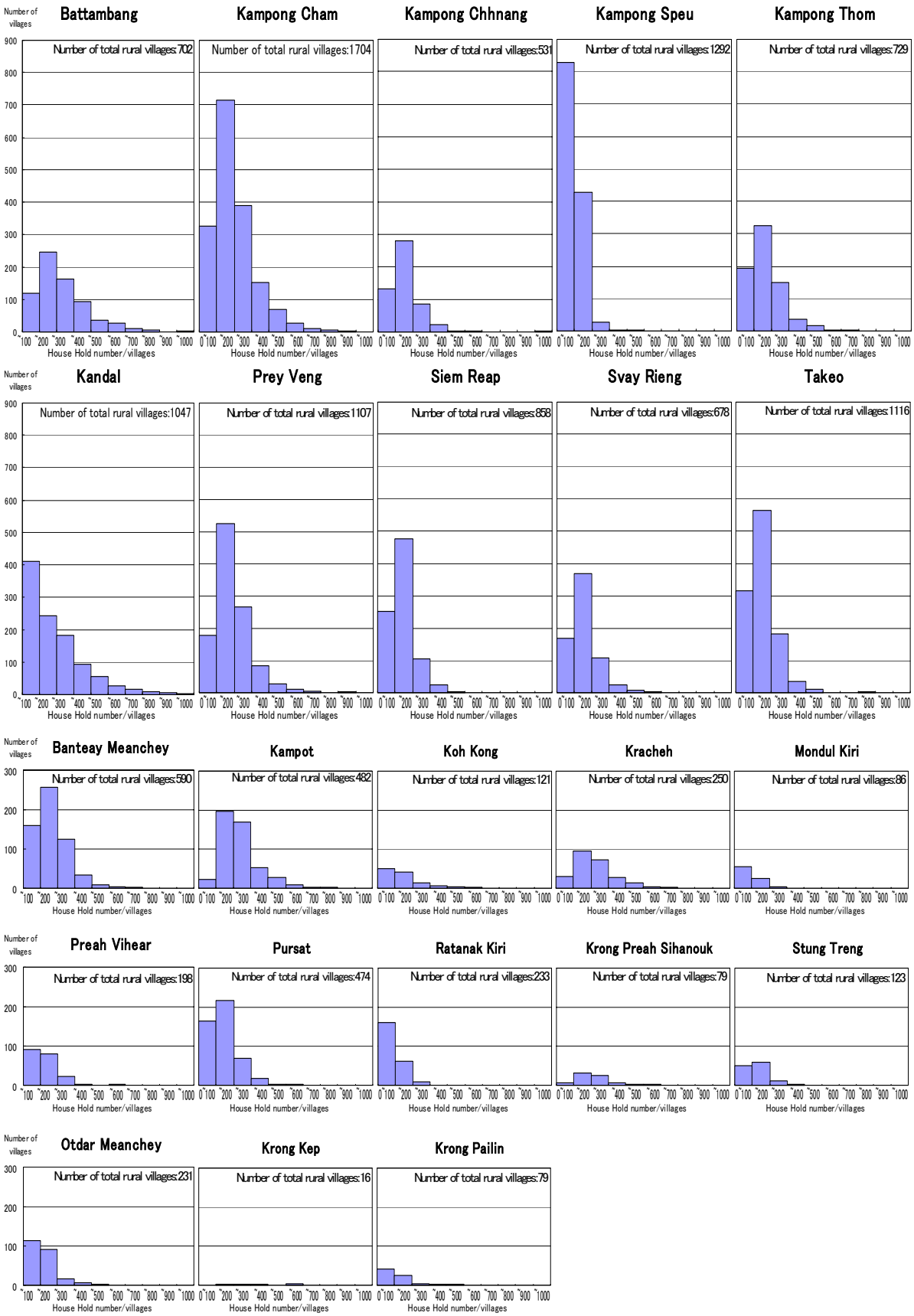
The distribution of household number per rural village (12,859 villages) is described as Figure 4.2.3. The medium household number per village is 140, while minimum 2 and maximum 1,377.

There are large differences among provinces as Figure 4.2.4 shows.



Source : JICA Study Team based on the Seila Commune Database 2004

Figure 4.2.3 The number of households per rural village (12,859 villages).



Source : JICA Study Team based on the Seila Commune Database 200

Figure 4.2.4 The number of households per rural village in Cambodia

4.2.4 Overview of Administrative Structure and Rural Investment Schemes

(1) Administrative Structure in the Regions

The administrative structure of Cambodia has three tires. Provinces (khet) and municipalities (krung) is the first-tier territorial sub-division of the country. Provinces are further divided into districts (srok) as the second-tire, and communes (khum) as the third-tire. Similarly, municipalities are divided into sectors (khan) and urban communes (sangkat). There are 1,621 communes and sangkats, of which 1,510 are communes (rural) and 111 are sangkats (urban). Villages (phum) are found in both rural areas and urban areas, but they are not formally regarded as administrative bodies. There is a wide range in the number, population and area of the second- and third-tier administrative sub-divisions across provinces / municipalities. The number of districts ranges from 16 in Kampong Cham to 5 in Mondol Kiri which is listed second from the bottom. Correspondingly, the number of communes ranges from 173 in Kampong Cham to 21 in Mondol Kiri.

(2) Local Governance System: Seila Program[16]

The Seila program (hereinafter referred to as Seila) initiated officially in 1996, institute decentralized systems and strategies for poverty alleviation and good governance at the provincial and commune levels. From its inception, Seila developed a unique flexible mechanism to coordinate partnership with other donors. This partnership framework has proved very effective for mobilizing substantial external resources and delivering services and infrastructure to the commune level. Attracted by that framework, many donors, such as the World Bank, UNDP, IFAD, WFP, DFID, Sida, GTZ, AusAID, DANIDA agreed to channel their resources through Seila. The amount of external resources mobilized through the Seila framework has nearly doubled from US$12 million in 1996 to US$ 23 million in 2003.

In order to develop a comprehensive decentralized framework for the delivery of services and infrastructure, Seila have developed following four systems.

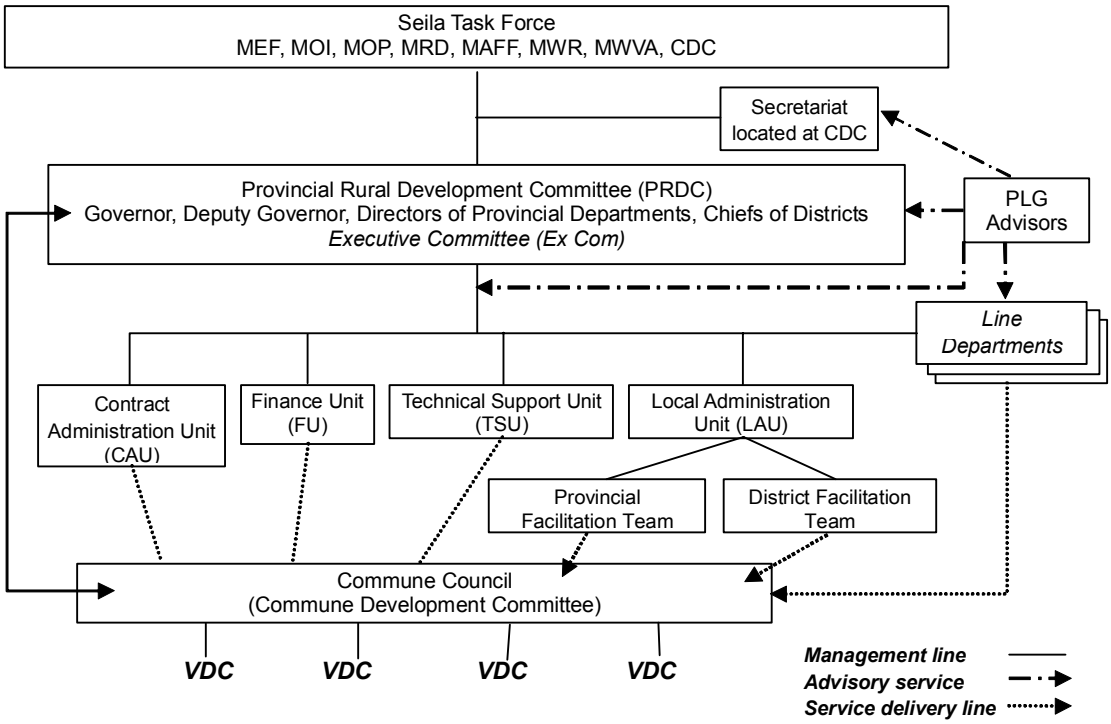
(i) Financing system (1) The Commune/ Sangkat Fund, (2) the Provincial Investment Fund (PIF) financed by external grants and loans, and annual national budget appropriations were established in order to deliver services and infrastructure. Seila has developed criteria for allocation of these funds, standard procedures for procurement, disbursement, accounting and auditing of the projects financed by these funds.
(ii) Planning system A set of technically sound and participatory planning procedures for the preparation of five year development plans, three year investment programs and annual working plans and budgets of commune councils and provinces were introduced.

[16] Seila means "foundation stone" in Khmer. The Seila Program, which was officially launched in 1996, aims to ameliorate poverty at the province and commune levels, as well as to establish a decentralization system and strategy to realize good governance.

(iii) Management and capacity building system A comprehensive management structure of which the roles and responsibilities of villages, communes, districts and provinces are clearly defined in managing local investment programs. Seila assists the provincial administration in providing support and supervision services for commune council including planning facilitation, training and technical services.
(iv) Monitoring and evaluation system Seila has developed: (1) the provincial level management information system that tracks the physical and financial progresses of all the projects executed under Seila program and provides consolidated quarterly reports; (2) the commune database (including poverty index database) to support the poverty-based geographic targeting of the program's resources; and 3) a program to evaluate Seila's efficiency and development impact.

Source: Chapter 8. Local Governance: Seila Program in "Practices and Lessons Learned in the Management of Development Cooperation: Case Studies in Cambodia" (2004)

The Seila Program is guided by the Seila Task Force(STF), consisting of the various ministries described in Figure 4.2.5



Source: Practices and Lessons Learned in the Management of Development Cooperation: Case Studies in Cambodia 2004

Figure 4.2.5 Seila Program Management Structure

(3) Implication for Rural Electrification

Through the discussion with several Seila Program Advisors based on respective provinces, some communes that expressed the needs of electricity by developing distribution systems and purchase of generators were identified. Compared to other infrastructure projects, the electricity projects require larger budgets, which easily excess the ceiling of the allocation funds. In addition, technical backstop for electricity service is substantially required, which is not often available within the communes, especially in remote area.

MIME is not a member of Seila Task Force in national level, and DIME rarely participates in Seila Program as a member of Provincial Rural Development Committee (PRDC) as there are not many prospects of fund allocation from the Commune and Provincial Investment Funds.

While there are many infrastructure projects such as road / bridge construction, water supply implemented utilizing the Seila fund, not a single project on electricity has ever been materialized under the Seila program. Those communes requested for power supply are located where national grid extension is least expected in the short run. They are normally not attractive enough for private sectors to invest due to remoteness, small size, low affordability, etc. In short of capacity to prepare investment fund by them, remote communes have no breakthrough to materialize electricity supply on their own.

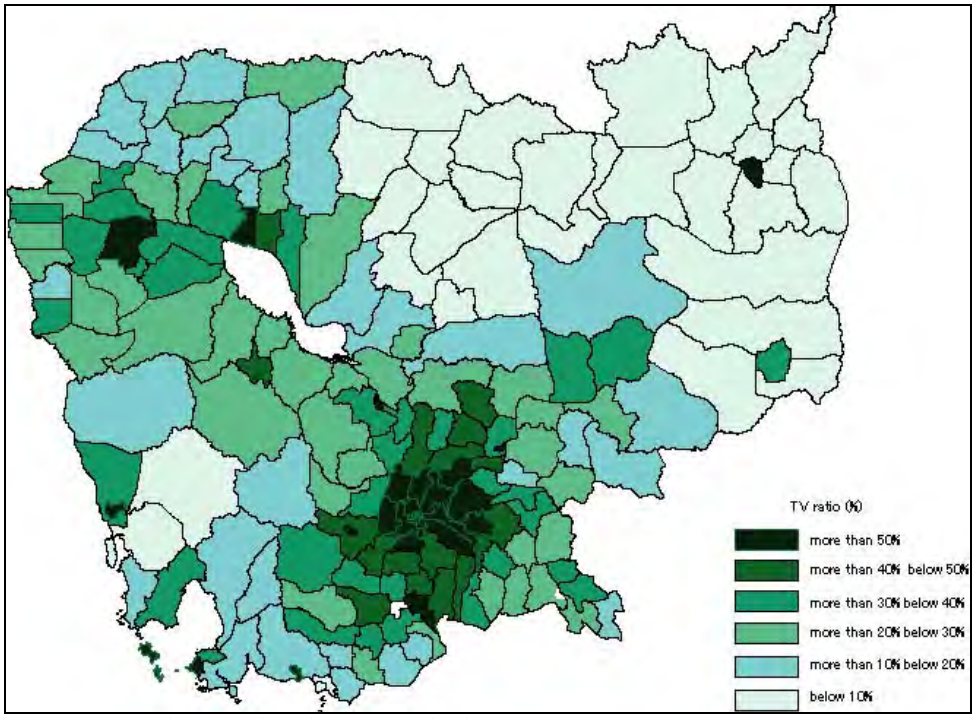
Busra communes in Mondol Kiri, for example, prioritized the needs of electricity utilizing hydropower in their commune development plan and requested the Seila Commune Fund. Obviously, PRDC has no technical expertise. Neither, DIME in Mondol Kiri has not been able to provide technical support to the communes and there are no incentives for central MIME to outreach for small scale hydropower. Although commune development council in Busra has been motivated and prioritized the needs, funds are not expected to deliver in short-run.

With collaboration with Seila program, respective communes provides significant information as to communes which have prioritized electricity projects. However, further collaboration mechanism among stakeholders, namely, local administrative bodies, DIME, MIME, Rural Electricity Enterprises, local investors, etc. needs to be consolidated for materializing the rural electrification projects.

4.2.5 Poverty Situation

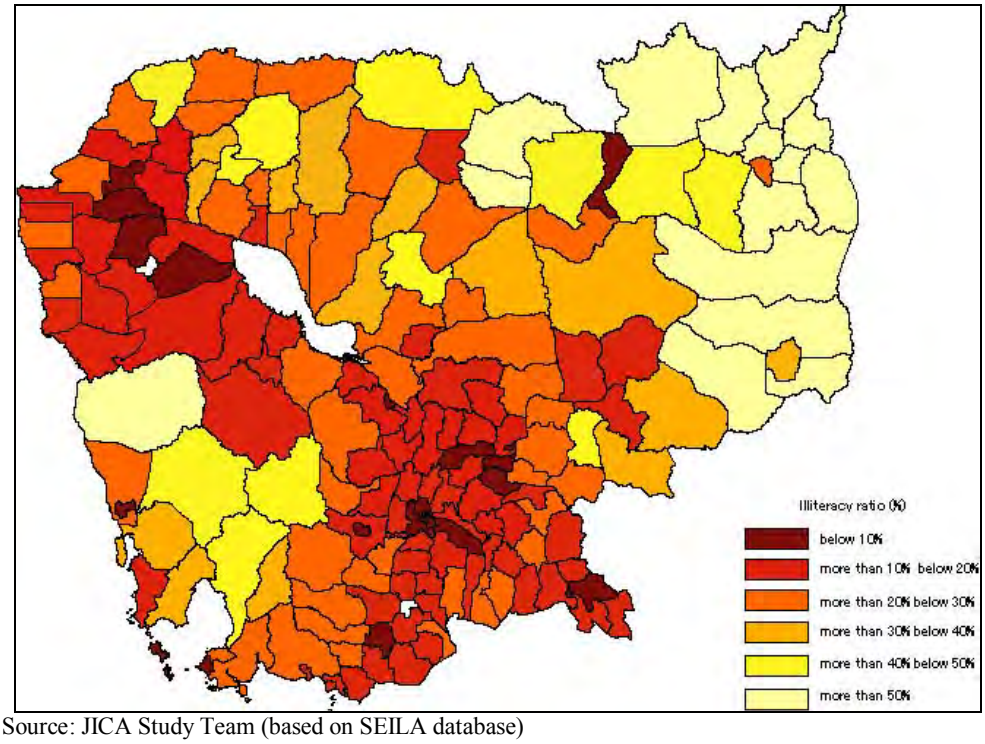
The poverty reduction and improvement of the quality of life for the rapidly growing population is the most important issues of the RGC. The National Poverty Reduction Strategy (NPRS) in 2002 reported 36 percent of the Cambodia population lives below the poverty line of US$0.46-0.63 at the current exchange rate. Poor household is defined as those with consumption expenditure below the 54,050 Riel per capita per month based on poverty line expenditure to afford 2,100 calorie food basket per day and minimal other basic expenditures such as shelter and clothing.

Figure 4.2.6 illustrates the ratio of TV holder by districts and Figure 4.2.7 shows the illiterate ratio by district. The poverty situation has correlation with the ratio of TV holder that is indicator of electricity dissemination and ratio of illiterate that is indicator of education level.



Source: JICA Study Team (based on SEILA database)

Figure 4.2.6 Ratio of TV Holder by Districts



Source: JICA Study Team (based on SEILA database)

Figure 4.2.7 Illiterate Ratio by District

4.3 REVIEW OF GIS DATABASE

4.3.1 Review Along with Some Suggestion for Updating/Creating Village Database

There are three types of data, namely (1) MPWT Database, (2) NIS Database, and (3) Seila Commune Database. Respective databases have the following features:

(1) Ministry of Public Works and Transportation (MPWT) Database

This database was created/compiled through JICA funded project "Cambodia Reconnaissance Survey Digital Data". The project was undertaken by PASCO Corporation, Japan in collaboration with the Ministry of Public Works and Transportation (MPWT), Kingdom of Cambodia. Although, the main purpose of the project was to create geographic map data, it has also taken account for the village level demographic data. Accordingly based on the year 1998 NIS (National Institute of Statistics, Ministry of Planning) General Population Censuses, the village point coverage data set was created. Besides village point location, this data set has also some basic demographic data, like number of households (HH), total head count, etc. The data was compiled during year 2001 and 2002 and submitted to JICA and MPWT March 2003. Besides location, the available attributes in this dataset are sown in Table 4.3.1.

Table 4.3.1 Sample of the JICA/MPWT March 2003 Village Point Attribute Table

PHUM_CODE	PHUM_ENNAM	URBRUR	TOTHH	REGHH	MALES	FEMALES	PERSONS	KHET_CODE	SROK_CODE	KHUM_CODE
1020101	Ou Thum	2	129	129	367	376	743	1	102	10201
1020102	Phnum	2	199	196	559	582	1141	1	102	10201
1020103	Banteay Neang	2	342	341	898	987	1885	1	102	10201
1020104	Kouk Pnov	2	128	128	348	402	750	1	102	10201
1020105	Trang	2	107	106	311	307	618	1	102	10201
1020106	Pongro	2	183	183	504	499	1003	1	102	10201
1020107	Kouk Tonloab	2	208	208	617	627	1244	1	102	10201
1020108	Trabaek	2	86	86	245	259	504	1	102	10201
1020109	Khile	2	162	161	473	477	950	1	102	10201
1020110	Samraong Pen	2	127	127	298	331	629	1	102	10201
1020111	Dang Run Lech	2	176	176	475	521	996	1	102	10201
1020112	Dang Run Kaeut	2	152	151	398	396	794	1	102	10201
1020113	Ou Snguot	2	201	201	503	548	1051	1	102	10201
1020114	Prey Changha Lech	2	174	173	428	490	918	1	102	10201
1020115	Prey Changha Kaeut	2	79	79	237	224	461	1	102	10201
1020116	Ou Andoung Lech	2	86	86	207	241	448	1	102	10201
1020117	Ou Andoung Kandal	2	134	133	337	377	714	1	102	10201
1020118	Ou Andoung Kaeut	2	317	317	808	803	1611	1	102	10201

Attributes Definition:
PHUM_ENNAM, PHUM_KHNAME: Name of Village both in English and Khmer
_Code: Khet (Province), Srok (District), Khum (Commune) and Phum (Village)
URBRUR: Urban and Rural Type
TOTHH, MALE, FEMALE, PERSONS: Total #HH, Male, Female and Total # person in village respectively.
There are 12923 villages in this dataset.

Source: JICA/MPWT March 2003

(2) National Institute of Statistics (NIS), Ministry of Planning Dataset

The source of this data is the 1962 and 1998 General Population Censuses and different household surveys, like 1996 demographic survey, 1993/94, 1996, 1997 and 1999 Socioeconomic Surveys and 2000 Demography and Health Survey (Source: NIS Statistical Yearbook 2003). The data was extracted from "1998 Census WinR+ Population Database" CDR, May 2000. The CDR was prepared by NIS and

funded by United Nations Population Fund (UNFPA). There is another Data CDR, namely "CAMInfo ver 1.1" year 2004, which is based on the same source and also prepared by NIS, but funded by GTZ, UNICEF and UNFPA.

These are various type datasets, slightly different to each other depending upon the time and sponsor of dataset production. So, careful selection of dataset is a crucial factor here to have right and most updated dataset. Furthermore, it need to conduct more data roaming so that it will be possible to know what attributes are available along with proper coding and geographic location information.

The data is not straightforward to be used, but need to be extracted from their customized CDR. There are wide variety of attributes and the selection/extraction of desirable one depends upon user. Although there is need of more research, with preliminary analysis, the following dataset (attribute) has been extracted and checked as an example. Note: the village location point data was obtained from the MPWT for this data and there are some villages, which has either no ID (code) or geographic coordinate information.

Table 4.3.2 The Type of Fuel and Light Source used by HH in Village (NIS 1998 Census)

(A) Main source of Light	(B) Main source of Cooking Fuel
(1) CITY POWER	(1) FIREWOOD
(2) GENERATOR	(2) CHARCOAL
(3) CITY + GENERATOR	(3) DIESEL OIL
(4) DIESEL OIL	(4) LPG
(5) CANDLE	(5) ELECTRICITY
(6) BATTERY	(6) NONE
(7) OTHER	(7) OTHER

VILLAGE_1	V_NAME	HHOLD0	FUEL1	FUEL2	FUEL3	FUEL4	FUEL5	FUEL6	FUEL7	LIGHT1	LIGHT2	LIGHT3	LIGHT4	LIGHT5	LIGHT6	LIGHT7
01020101	Ou Thum	129	128	0	0	1	0	0	0	0	4	0	120	0	5	0
01020102	Phnum	199	192	4	0	0	0	0	0	10	0	13	157	0	16	0
01020103	Banteay Neang	342	333	6	0	1	1	0	0	6	6	52	258	0	19	0
01020104	Kouk Pnov	128	124	2	1	1	0	0	0	0	0	7	106	0	15	0
01020105	Trang	107	105	0	0	1	0	0	0	7	0	13	65	0	21	0
01020106	Pongro	183	182	0	1	0	0	0	0	69	2	3	83	0	26	0
01020107	Kouk Tonloab	208	191	6	6	1	0	1	3	12	1	0	146	0	49	0
01020108	Trabaek	86	85	0	0	1	0	0	0	0	0	0	85	0	1	0
01020109	Khile	162	159	0	0	0	0	0	2	0	1	2	155	0	3	0
01020110	Samraong Pen	127	126	1	0	0	0	0	0	2	2	1	108	0	14	0
01020111	Dang Run Lech	176	171	4	0	1	0	0	0	0	2	1	163	1	9	0
01020112	Dang Run Kaeut	152	150	1	0	0	0	0	0	1	0	5	138	0	7	0
01020113	Ou Snguot	201	183	13	0	1	0	0	4	14	12	31	140	0	4	0
01020114	Prey Changha Lech	174	172	0	1	0	0	0	0	22	4	3	140	1	3	0
01020115	Prey Changha Kaeut	79	79	0	0	0	0	0	0	1	0	8	70	0	0	0
01020116	Ou Andoung Lech	86	86	0	0	0	0	0	0	0	0	0	73	0	13	0
01020117	Ou Andoung Kandal	134	132	0	0	1	0	0	0	3	0	0	107	0	23	0
01020118	Ou Andoung Kaeut	317	306	2	7	1	0	0	1	1	0	3	310	0	3	0
01020119	Kouk Kduoch	126	125	0	0	0	1	0	0	2	1	0	114	0	9	0
01020201	Khtum Reay Lech	46	45	0	1	0	0	0	0	0	0	0	42	0	4	0
01020202	Khtum Reay Kaeut	108	108	0	0	0	0	0	0	0	1	0	92	0	15	0
01020203	Anlong Thngan Kaeut	166	165	0	0	1	0	0	0	0	8	12	135	0	11	0
01020204	Anlong Thngan Lech	122	118	2	0	1	0	0	0	2	1	1	116	0	1	0
01020205	Bang Bat Lech	96	96	0	0	0	0	0	0	0	0	10	76	0	10	0

Source: NIS 1998 Census

There are 13,046 Villages in this dataset with missing data for some village. During the meeting with Director of NIS on 7 Dec 2004, it was learned that now officially recognized village in Cambodia is 13,886 (Complied from information provided by Geographic Dept. and Ministry of Interior), but there is no location coordinate available for the additional villages. Following further information about the NIS, data has been extracted. According to the data CDR "1998 Census WinR+ Population Database" the following political boundary structure was followed during the 1998 census.

(i) No. of Province: 24 including Municipality of Phnom Penh and Krong (or Towns), Preah Sihanuk, Kaeb and Pailin.
(ii) No. of District: 183
(iii) No. of Commune: 1,609
(iv) No. of Village: 13,406

However, due to military operation some are not covered, which has total population of about 45,000. These are (i) Whole districts of Anlong Veaeng in Otdar Mean Chey province, Samlot in Bat Dambang province and Veal Veaeng in Pursat province (ii) Ou Bei Choan village of Ou Chrov district in Banteay Mean Chey province. Also refugees were not counted. Thus the CDR contain database of 180 districts, 1,594 commune and 13,339 villages. Besides, 377 special settlements were also enumerated with the uniform code of 91. But these settlements had not separate identity and affiliated with nearby village. Finally the database contains 13,716 villages (13,339 + 377). Again it has been observed some discrepancies in the number of village, which needs to be checked further.

Urban and Rural area: Districts having provincial headquarter towns were considered as urban area. Also, entire area of Krong Preah Sihanouk, Krong Kaeb and Krong Pailin were put in urban classification. For Phnom Penh municipality four districts (Doun Penh, Chamkar Mon, Prampir Meakkakra and Toul Kouk) were under urban classification. All the other areas of Cambodia were put under rural code. Code for urban village is 1, while for rural village is 2.

For geographic codes, Geographic Department coding system was adopted for 1998 census, which was originated during UNTAC period. Afterward there was some change in administrative division (for example new province, districts and communes were formed while other some were merged with existing one). This resulted into un-sequential coding scheme. For example, in Province 01 Banteay Mean Chey, the first district of Mongkol Borei bears code 02, in province 17 Siem Reab, the districts 05 and 08 were transferred to form part of a new province. The geographical codes therefore may have breaks and should not be confused with serial numbers.

(3) Seila Commune Database (CDB)

The Seila Program is explained in Section 4.2.3, as an aid mobilization and coordination framework for support to Cambodia's decentralization and deconcentration reforms. Under the governments overall reform program, a three-tiered system of planning and budgeting is emerging in the country focused on the commune, the province and the national levels. The Seila Commune Database (CDB) is a national information system of the General Directorate of Planning in the Ministry of Planning. The CDB is managed by the Provincial Departments of Planning under the technical supervision of the Ministry of Planning. Seila Program has started to conduct village survey since 2002. The data for year 2002 and 2003 is freely available and can be downloaded from their homepage (www.seila.gov.kh). For year 2004, they were conducting survey in December 2004 and the compiled data will be officially available by April 2005.

Method of Data Collection

The basis for the data collection is Village Level Questionnaire Survey. The detailed questionnaire is prepared and one questionnaire was used for each village. The village chief fills the questionnaire. The commune chief is sole elected representative to control and coordinate the village chiefs in commune in

question. The questionnaire is prepared in the following way:

1) The standard national questionnaire prepared by Ministry of Planning is followed as standard.
2) Besides national level questions, questions for some additional information may be included. Such inclusion is being done by discussion with (a) Provincial Government and (b) District Government.
3) The questionnaire adopted for the particular province is explained to the commune and village chiefs.
4) Finally village chiefs fill the questionnaire for respective villages.
5) The questionnaires are collected from each village by the commune chief and submitted to the district government.
6) The data input and compilation is conducted at provincial government office using SPSS (Statistical Package for Social Sciences) software.
7) Finally Seila put data in their database and publish through homepage.

The ownership of the data lies to Planning Department, Ministry of Planning. The data can be used freely, but with acknowledgement to Commune Database, Seila Program, Phnom Penh, Cambodia[17]. In this dataset there are 13,910 villages (with Location Coordinates) recorded in year 2004. The data set of year 2003 is the most updated available socioeconomic data for 13,877 villages.

Location Data

The location of villages is well documented as shown in Table 4.3.3. First two columns (Corrected_ and Corrected_) represent Village Code (Second Column should be used) followed by PHUMCODE. Column FISPHUM seems to be similar to PHUMCODE. The name of villages is available both in English and Khmer (Vill_Name_ and PHUM columns are written with the Khmer character). The geographic coordinate is given in column XPHUM and YPHUM.

Table 4.3.3 Seila Commune Database Geographic Coordinate of Villages

CORRECTED	CORRECTED_	PHUMCODE	GISPHUM	VILLAGE	VILL_NAME_	PHUM	XPHUM	YPHUM	NOTES
2130602	2130602	02130101	2130101	Krang Svaak	ក្រាំងស្វាយ	ក្រាំងស្វាយ	305420	1404884	CIDA
2130601	2130601	02130102	2130102	Chhnal Moan	ឆ្នាល់ទាល់	ឆ្នាល់ទាល់	306737	1406070	CIDA
2130607	2130607	02130103	2130103	Samraong	សំរោង	សំរោង	303371	1395387	CIDA
2130604	2130604	02130104	2130104	Ruasei Preah	ឫស្សីព្រះ	ឫស្សីព្រះ	307979	1405857	CIDA
2130606	2130606	02130105	2130105	Prey Toteung	ព្រៃធទឹង	ព្រៃធទឹង	303390	1403865	CIDA
2130605	2130605	02130106	2130106	Prey Sen	ព្រៃសែន	ព្រៃសែន	306227	1400233	CIDA
2130603	2130603	02130107	2130107	Banteay Chaa	បន្ទាយចារ	បន្ទាយចារ	307435	1406606	CIDA
2130303	2130303	02130201	2130201	Sambour	សំបួរ	សំបួរ	315615	1413977	CIDA
2130304	2130304	02130202	2130202	Samaki	សាមគ្គី	សាមគ្គី	313590	1413466	CIDA
2130307	2130307	02130203	2130203	Slaeng Chhuor	ស្លែងឈូរ	ស្លែងឈូរ	317181	1410943	CIDA
2130305	2130305	02130204	2130204	Trapeang Dang Tuek	ត្រពាំងដងទឹក	ត្រពាំងដងទឹក	313741	1414157	CIDA
2130306	2130306	02130205	2130205	Kouk Trom	គោកត្រុំ	គោកត្រុំ	319442	1418115	CIDA
2130302	2130302	02130206	2130206	Chambak	ចំបក់	ចំបក់	315987	1414304	CIDA
2130301	2130301	02130207	2130207	Hob	ហប	ហប	315986	1415508	CIDA
2130409	2130509	02130301	2130301	Boeng Preah Kralanh	បឹងព្រះក្រឡាញ	បឹងព្រះក្រឡាញ	311827	1410672	CIDA
2130406	2130506	02130302	2130302	Kuy Veang	កុយវាំង	កុយវាំង	311379	1403429	CIDA
2130407	2130502	02130303	2130303	Boeng Preah	បឹងព្រះ	បឹងព្រះ	313152	1408942	CIDA
2130404	2130504	02130304	2130304	Kab Prich	កាប់ព្រីច	កាប់ព្រីច	311342	1408754	CIDA
2130403	2130503	02130305	2130305	Prey Phdau	ព្រៃផ្តៅ	ព្រៃផ្តៅ	311483	1408928	CIDA

Source: SEILA

[17] Information based on meeting with Mr. Tuy Pheap, UNOPS, Seila Project on 10 Dec 2004

Socioeconomic Data

So far the Seila Program has conducted national surveys for three consecutive years starting from 2002. The compiled/coded data is available for year 2002 and 2003. The latest data of year 2004 has been collected and coding process is currently going on. In this dataset, there are about 105 attributes with various aspects covering socioeconomic status of village. Example of data is shown is Table 4.3.4.

Table 4.3.4 Example of Socioeconomic Seila Data

V.GIS	Province	District	Commune	Village	Type	FAMILY	FEM_TOT	MAL_TOT
1020101	Banteay Meanchey	Mongkol Borei	Banteay Neang	Ou Thum	Rural	137	411	388
1020102	Banteay Meanchey	Mongkol Borei	Banteay Neang	Phnum	Rural	191	510	424
1020103	Banteay Meanchey	Mongkol Borei	Banteay Neang	Banteay Neang	Rural	345	939	880
1020104	Banteay Meanchey	Mongkol Borei	Banteay Neang	Kouk Pnov	Rural	168	430	422
1020105	Banteay Meanchey	Mongkol Borei	Banteay Neang	Trang	Rural	121	349	351
1020106	Banteay Meanchey	Mongkol Borei	Banteay Neang	Pongro	Rural	246	517	509
1020107	Banteay Meanchey	Mongkol Borei	Banteay Neang	Kouk Tonloab	Rural	224	672	778
1020108	Banteay Meanchey	Mongkol Borei	Banteay Neang	Trabaek	Rural	105	278	252
1020109	Banteay Meanchey	Mongkol Borei	Banteay Neang	Khile	Rural	164	495	477
1020110	Banteay Meanchey	Mongkol Borei	Banteay Neang	Samraong Pen	Rural	137	406	397
1020111	Banteay Meanchey	Mongkol Borei	Banteay Neang	Dang Run Lech	Rural	191	500	445
1020112	Banteay Meanchey	Mongkol Borei	Banteay Neang	Dang Run Kaeut	Rural	146	312	368
1020113	Banteay Meanchey	Mongkol Borei	Banteay Neang	Ou Snguot	Rural	175	447	452
1020114	Banteay Meanchey	Mongkol Borei	Banteay Neang	Prey Changha Lech	Rural	186	488	493
1020115	Banteay Meanchey	Mongkol Borei	Banteay Neang	Prey Changha Kaeut	Rural	92	199	236
1020116	Banteay Meanchey	Mongkol Borei	Banteay Neang	Ou Andoung Lech	Rural	93	257	227
1020117	Banteay Meanchey	Mongkol Borei	Banteay Neang	Ou Andoung Kandal	Rural	140	398	367
1020118	Banteay Meanchey	Mongkol Borei	Banteay Neang	Ou Andoung Kaeut	Rural	399	976	1056
1020119	Banteay Meanchey	Mongkol Borei	Banteay Neang	Kouk Kduoch	Rural	146	417	419
1020201	Banteay Meanchey	Mongkol Borei	Bat Trang	Khtum Reay Lech	Rural	33	83	57
1020202	Banteay Meanchey	Mongkol Borei	Bat Trang	Khtum Reay Kaeut	Rural	160	347	337

Source: SEILA

4.3.2 Recommendation Regarding Current GIS database

The following recommendation/suggestion has been made regarding the use of socioeconomic data:

1) One source of data is not sufficient and complete.
2) Data should be analyzed carefully and most appropriate attribute should be selected from different data set.
3) Selected attributes should be compiled to create socioeconomic database that comprise all desirable attributes (variables) in complete form.
4) The detailed socioeconomic attributes can be extracted both from NIS and the Seila Commune Database.
5) The Seila Commune Database has some advantage, for example it is more comprehensive/complete and recent.
6) Other attribute data might be taken from line agencies/organization, for example EdC may provide the information about electrified houses in village.

Necessary Action

For reliable GIS Database, each data should be studied thoroughly. Furthermore, the data from authorized organization should be used. Also, the opinion of MIME (Ministry of Industry, Mines and Energy) should be taken into account.

As mentioned above, the data unification can be done by selecting appropriate attributes (variables) from different sources and linked together. For linking datasets, we need the following information:

1) Unique ID number
2) Geographic coordinate or location (X, Y) information

3) Map projection system

4.3.3 Seila Data Integration between "Village Location Data" and "Socioeconomic Data"

(1) Creation of Village Map

In order to create the village location map, a GIS data file, by extracting ID and X and Y coordinates from Village Location Data file, was created. Village Location Map was generated by importing the location information along with the unique ID from this data file. Thus the generated map has location information of each village and its unique ID. The unique ID is an important attribute in the map that can be used to link other data file. As mentioned earlier the village location map resulted with the total number of 13,910 villages. This data was acquired by Seila Commune Database in year 2004 and it is the most updated village location data available in Cambodia.

(2) Socioeconomic Data

Linking the socioeconomic data with geospatial data is an important step to make GIS analysis. This gives opportunity to make logical analysis among the available attributes in the datasets. Besides, the analyzed output result can be plotted into respective maps for visualization. To materialize this capability, the "Socioeconomic Data" was linked with the "Location Map" using unique ID. This integration resulted into GIS dataset of the village.

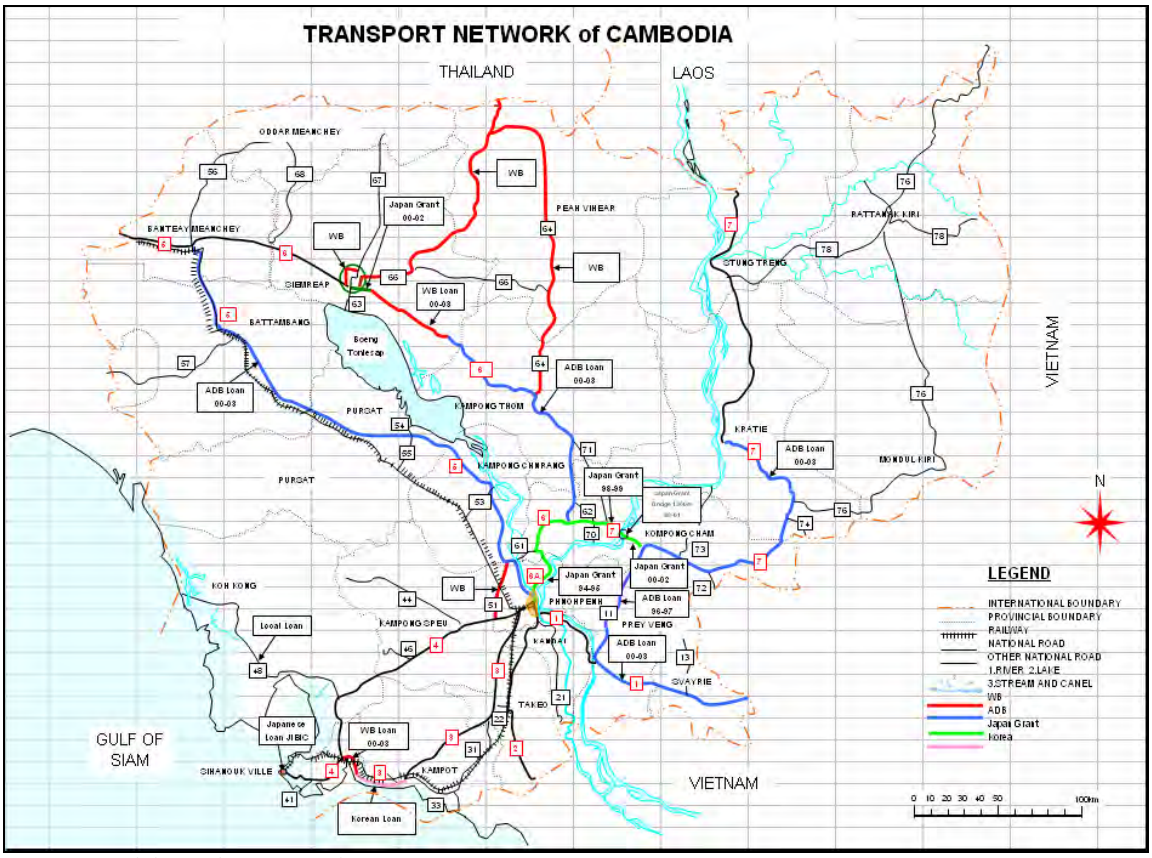
The "Socioeconomic Data" of year 2003 was used here. This dataset has village information of 13,876 villages. While comparing the number of available villages in "Location Data" this has shortfall of 34 villages. Besides, there is some amount of mismatch between the given unique ID in these dataset. The result from this ambiguity is unavailability of socioeconomic data for some villages in the created "GIS dataset of the Village". The numbers of such villages stand to 123 at present.

Currently The Seila Program is compiling the village survey data that has been conducted in year 2004 and will be available by the April of year 2005. It has been planned to update the "GIS dataset of the Villages" once this dataset will be available. And it is assumed that most of the ambiguity, mentioned above, will disappear with this update.

4.4 RURAL INFRASTRUCTURE

4.4.1 Transportation Network

The current transport system which was severely damaged by war has been recovered with concerted effort by the government and donor communities. The following map shows the current transport network. The rural transport development is essential to improve quality of life and to increase accessibility of electricity. The road network development study for formulating a master plan currently undergoing by other JICA study team, will be referred in order to assess the future accessibility to the electricity by batteries and small scale generators.



Source: Ministry of Transportation

Figure 4.4.1 Transportation Network in Cambodia

4.4.2 Communications

Post and telecommunication services have been available only in Phnom Penh and large township areas. The number of public telephone booths rose from 15,475 in 1996 to 37,700 in 2002. The mobile phone usage showed remarkable growth from 23,000 in 1996 to 108,000 in 2000. The PV systems have been used by telecommunication companies as it has been both technically and economically viable. A major initiative in the pipeline in the communication sector is the establishment of the Cambodia Telecom (CD), the rehabilitation and extension of customer telephone networks of Phnom Penh, and construction of a transmission link among major provinces.

4.5 ELECTRIFICATION DEMAND OF OFF-GRID AREAS

4.5.1 DIME Rural Electrification Study

There is no official data existed regarding electrified situation in rural areas. Identification of non-electrified villages should be given with priority at the Master Plan stage. In 2004, during the first Seminar of the JICA Study, the JST requested for respective DIME directors to conduct the survey to collect basic electrified situation for respective Districts together with basic economic situation. Since DIME has limited capacity as to monitor and supervise the electricity supply business even in capital town and major towns within the province, many provinces face difficulties to deliver detail information

to the Study Team. Therefore, the qualities of data obtained from DIME vary and many provinces provided incomplete data. The table 3.1.1 is the summary of the results. Even under these limited output, the number of households using battery were substantial and indicates the number of potential electricity users. The Plain and the Tonle Sap Lake regions, where population density is high, have higher electrification levels. In addition, those relatively populated provinces have incentives to invite REEs to operate. Thus, the information is more consistent than the other areas, but it also depends on leadership of DIME directors.

4.5.2 Preceded Socioeconomic Surveys on Rural Electrification

There are two major village-based surveys on electrification that have been done previously as follows:

1) Rural Electrification Strategy and Implementation Programme component of the Cambodia Rural Electrification and Transmission Project funded by the World Bank, March 2001. Consultancy services were provided by Meritec Limited of New Zealand in association with KCEC of Cambodia. Hereinafter called "RE&T study in 2000".
2) Feasibility Study on the Establishment of a Centralized Photovoltaic Rural Electrification System, March 2004 Japan Bank for International Cooperation. Consultancy services were provided by UNICO of Japan in association with Cheang Engineering of Cambodia. Hereinafter called "The JBIC funded study in 2004".

(1) RE&T Study in 2000

In order to establish the baseline of energy consumption in rural areas, 15 households per 200 villages, a total 3,000 households were surveyed over a ten week period in 2000.

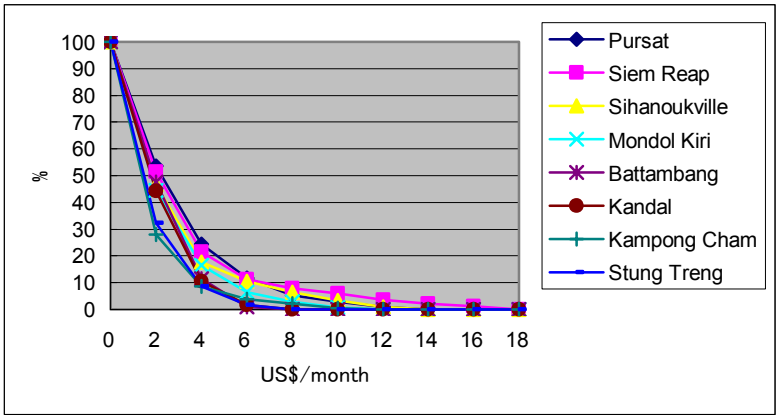
The following are the summarized findings:

- Batteries are widely used in rural areas, but practically many households use also diesel oil for lighting. Consumers are well aware of the high cost of battery power and reserve it for services for electrical lighting, black and white TVs, radios and so on that cannot be powered by diesel oil.
- Grid connected households clearly spend more (US$5-10 / month) for electricity supply could and consume significantly more kWh / month (10-30 times than battery users who spend US$2-3 / month and use 2-6 kWh/ month.
- Electricity is perceived as a means to enhance learning opportunities, to improve standard of living, to increase social activities in evening, while more than 40% of respondents recognize diesel oil lamps cause health problems.

(2) JBIC-funded Study in 2004

Approximately 580 households of 8 provinces (Kandal, Sihanoukville, Pursat, Battambang, Siemreap, Stung Treng, Mondol Kiri, and Kampong Cham) were surveyed for r the rural electrification by means of PV systems can be formed on a commercial basis in technical, financial and management aspects.

Since this study aimed to form commercially viable PV systems, the project sites were selected by criteria of 1) high willingness to pay, 2) relatively good condition in road infrastructure, 3) many REEs exist. Therefore, the figures of willingness to pay for electricity per month presented below were represented by relatively better-off households. Yet, the households that can pay more than US6$ / month are very small, majority are willing to pay around US$ 2-4.



Source: F/S on Establishment of a Centralized Photovoltaic Rural Electrification System, 2004 JBIC

Figure 4.5.1 Willingness to Pay by Targeted Areas of 8 Provinces

4.5.3. The result of Energy consumption survey for the six provinces

Due to the limited information on non-electrified villages, the 6 provinces (Koh Kong, Mondol Kiri, Stung Treng, Rattanakiri, Prey Vehir, Kampong Thom) were studied for the current electrification situation under the JICA study. The survey items were existing electricity service of REE and BCS. The number of non-electrified villages was also surveyed based on the hearing from local DIME and district offices. All 6 provinces have isolated hilly areas or islands. Thus the survey revealed that more than 70 to 90 % of the villages under surveyed provinces have no means of electricity with few exceptional households owning car batteries or private generators.

Table 4.5.1 Electrification Level by REE and BCS in 6 Provinces

Districts (number)	Village		REE				BCS	
	Non-elctrified village	Total village numbers	No. of REE	Tariff Rate (Riel/KWh)	Initial connection fee(Riel)	No. customers	Tariff of 12V-70Ah	Estimated customers
Kaoh Kong (7)	75	132						
Botum Sakor	8	20	2	1500 / 2000	n.a	52/24	1500 / 2000	115 /35
Kiri Sakor	8	9	1	1500	n.a	518	2000	518
Kaoh Kong	6	11	2	1900/2100	n.a	60/35	3000	40/50
Smach Mean Chey	0	11	Town grid	n.a	n.a	n.a	n.a	n.a
Mondol Seima	9	13	Town grid	n.a	n.a	n.a	2000	20
Srae Ambel	29	37	1	1500	n.a	1130	1500	35
Thma Bang	15	17	1	1500	n.a	7	3000	40
Kampong Seila	0	14	1	2000	n.a	10	1000	100-250
Kampong Thom (8)	504	727						
Baray	106	181	5	1500-2000	600000-100000	50-1101	700-1500	20-350
Kampong Svay	59	82	2	2500-3000	n.a	65/108	1000-1200	20-70
Stueng Saen	36	55	1	3000	n.a	50	1000	20-213
Prasat Balangk	41	64	2	6000 Riel/ 1Lamp	n.a	40/50	1000-2000	20-200
Prasat Sambour	36	66	1	2500	n.a	52	1200-1300	40-160
Sandan	72	71	1	2500	n.a	80	1000-1500	40-800
Santuk	50	71	2	2500	60000	380/430	1000-1500	30-200
Stoung	104	137	1	1800	n.a	706	100-1300	30-130
Mondol Kiri(5)	80							
Kaev Seima	25	25	0	-	-	-	3500	7/15/20
Kaoh Nheak	25	26	0	-	-	-	3500	25/30
Ou Reang	7	7	0	-	-	-	3000	6/5
Pechr Chenda	18	18	0	-	-	-	3500	10/15
Saen Monourom	5	14	2	2000	n.a	150/280	2000	10/20/40
Preah Vihear(7)	151							
Chey Saen	20	21	0	-	-	-	2500	163
Chhaeb	25	26	1	2000	n.a	25	2000	21-84
Choam Khsant	20	26	1	1500	n.a	60	3000	24-30
Kuleaen	16	22	0	-	-	-	3000	44-212
Rovieng	50	57	1	2500	25000	128	2000	31-438
Sangkom Thmei	20	24	1	1700		25	2000-4000	12-25
Tbaeng Mean	n.a	32	Town grid	n.a	n.a	n.a	n.a	n.a
Ratanak Kiri(9)	216							
Andong meas	19	21	0	-	-	-	2500	20
Bar Kaev	33	35	1	1500	n.a	10	1000	8/10
Kon Mom	22	23	0	-	-	-	2500	8/10
Lum Phat	23	26	1	1500	n.a	15	3500	11/12
Ou Chum	37	37	0	-	-	-	1500	30
Ou Ya Dav	28	29	1	1500	n.a	15	2500	10
Ta Veaeng	20	20	0	-	-	-	2500	20
Veun Sai	34	34		1500	n.a	20	2000	15
Ban Lung	n.a	16	Town grid	n.a	n.a	n.a	n.a	n.a
Stung Treng (5)	106							
Se San	20	22	3	2000	n.a	20-25	1500	9-10
Siem Bouk	15	16	1	1500	n.a	40	2000	6-10
Siem Paeng	27	28	1	2500	n.a	70	3000	20
Thala Barivat	44	44	0	-	-	-	2500	6/8
Stung Treng	n.a	17	Town grid	n.a	n.a	n.a	n.a	n.a

Source: JICA study team

The tariff level of the mini-grid is much higher than the capital and provincial town as from R1,500 to 2,000 (US$ 0.4 to 0.5) per kWh. The tariff for battery charging is much more expensive in remote area. Compared to the standard tariff by EdC and EAC described in Chapter 3, these figures clearly feature the electrification situation in Cambodia as “the rich pay less, the poor pay more”.

4.5.4. The result of socioeconomic survey of the 10 schemes

In order to establish a baseline of social, economic and energy-use parameters of rural communities and beneficiaries’ willingness to pay for future electricity service, 10 rural communities in 9 provinces were studied. The surveyed areas were as follows.

Table 4.5.2 Sample Household Distribution for Socioeconomic Survey

Energy Source	Scheme	Province	Commune	Village	Household number	
					Given HH	Actual Sample
Micro-hydro power	Samlout	Battambang	Phlov Meas	Phlov Meas	204	26
			Samlout	Srae Andong Muy	77	26
	Pramaoy	Pursat	Pramaoy	Stung Thmei	308	27
				Pramaoy	274	26
	Bay Srok	Ratanakiri	Ka Laeng	Bay Srok	360	25
				New Ka Laeng	70	25
	Bu Sra	Mondulkiri	Bu Sra	Phum Lekh Bei	84	25
				Phum Lekh Mouy	108	25
Biomass	Phnum Kravanh	Pursat	Leach	Leach	290	26
				Krouch Chhmar	238	26
	Svay Bakav	Kampong Chhnang	Ta Ches	Svay Bakav	342	54
	Takeo CelAGrid	Takeo	Samlung	Angk Ta Phouk	80	26
				Krang Tnaot	173	25
	Kraya	Kampong Thom	Kraya	Dang Kdar	451	25
				Kraya	203	25
Solar*	Srea Ta Pan	Stung Treng	-	Srea Ta Pan	89	25
	La Meuy	Ratanakiri	-	La Meuy	104	25

The survey items are 1) demographic information, household expenditure, type of dwelling, etc, 2) utilization and consumption patterns regarding of various energy sources;3) electricity consumption and expenditure, including electric appliance ownership and use; 4) interest in and willingness to participate in proposed project; 5) perceptions regarding electricity; 6) willingness and ability to pay. The highlight of the survey will be summarized as follows.

- Car batteries are widely used, yet diesel oil is simultaneously used for lighting purposes. This is due to the expensive cost for charging of car batteries. They prioritize to consume car batteries for TV or radio while lighting can still be depend on diesel oil.
- Where available, electricity is provided to a few houses by a handful of privately owned generators. Their productivity use of electricity is limited to rice milling, vegetable processing and some service sector such as repair shops, restaurant and grocery shops.
- Willingness to pay for the more reliable electricity service varies depends on their economic standing. In average, they spend US$1~5 for diesel oil and car battery charging fees.
- Considering that the lifetime of car batteries are within a few years, yet costing substantial amount (e.g. US$30 for 12V, 70Ah), villagers would be able to finance the substantial initial connect fees. Once they were certain for service, they would be able to finance themselves by selling livestock or pay by installments.

4.5.5. Demand Forecast

The socioeconomic studies identified several important features including the current energy expenditure with respective energy sources and their willingness to pay for electricity. The rural inhabitants substantially pay for expensive electricity from car batteries which indicates strong desire for electricity. Yet, there were few exceptional respondents those who eager to have electricity only when they could

afford it merely US$ 1 per month. Among ethnic minorities who live on subsistence farming, those who even cannot afford for batteries exist.

The power consumption patterns were studied for 3 existing mini-grid systems, which are 1) Leach commune in Pursat, 2)Trepeang Sab Commune in Takeo powered by diesel engine and 3) Anlong Ta Mai village in Battambang powered by biomass. Leach mini-grid have 24 services which is quite exceptional case for REEs. The result shows that average power consumption during the peak hour varies from 120 to 450 W per household. Those spent large amount are electric iron and rice cooker owners which rarely seen in normal rural community.

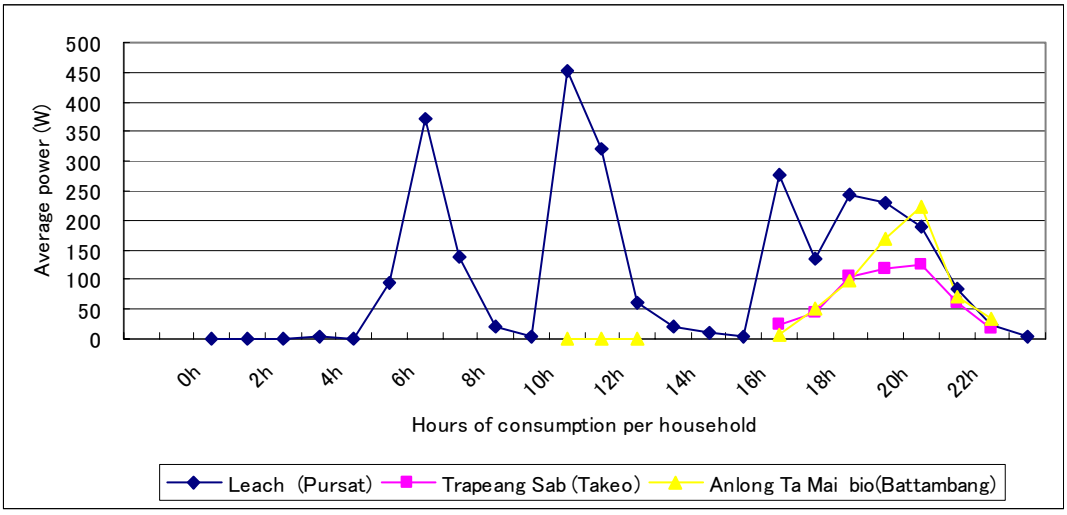


Figure 4.5.2 Average power consumption in 3 mini-grid systems in Pursat, Takeo and Battambang.

Unit household demand needs to be assessed in formulating electrification plan of a village at early stage through commune / village-based surveys.

4.6 COMMUNITY BASED ELECTRIFICATION

Although there is strong demand of electricity from inhabitants in rural areas especially in the Plain and Tonle Sap Lake regions, yet many communes remain non-electrified due to various obstacles to attract REEs such as little purchasing power, remoteness etc. Currently, REE (Rural Electrification Enterprise) provides power supply to rural (semi-urban) areas that are commercially viable. Marginal areas remain to be suffered from no supply, or if any, the electricity is too expensive for villagers to have minimal service. There are, however, a few cases where NGOs tried to promote electrification in community level by utilizing the external donor funds.

4.6.1. Case Studies of Rural Electrification Projects

(1) Trapeang Sab Commune Rural Electrification Project

The first case is a decentralized electrification project by mini-grid in Takeo Province which is currently supported by French NGO, GRET, and KOSAN Engineering, a Cambodian consulting firm.

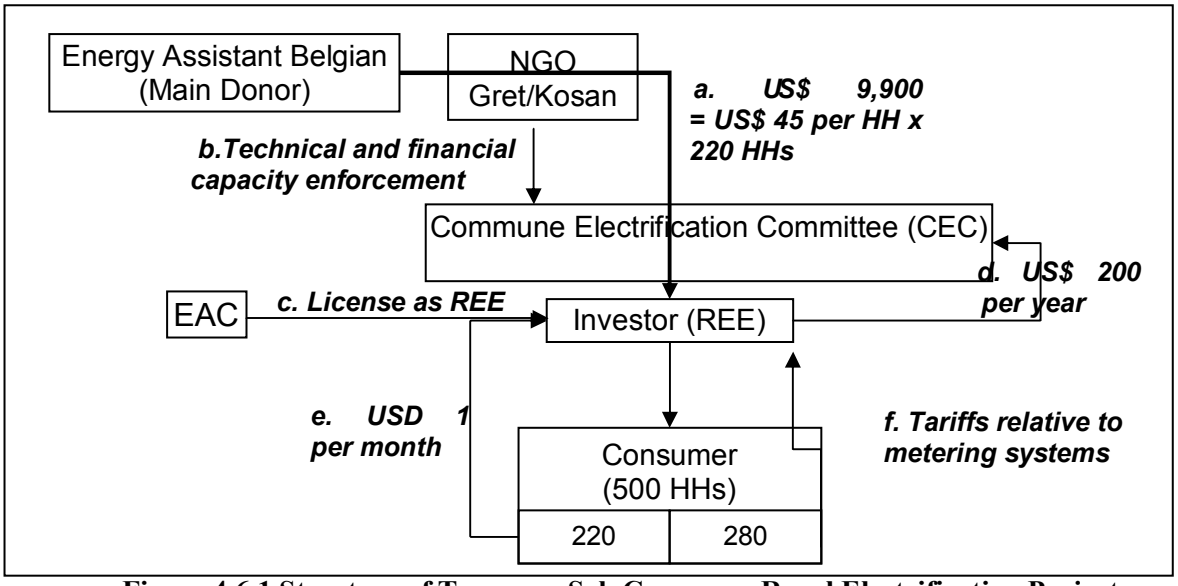


Figure 4.6.1 Structure of Trapeang Sab Commune Rural Electrification Project

a. The external donor, "Energy Assistant Belgian" provided grant to the REE, (hereinafter called as "the investor") through Gret / KOSAN. The grant was used for the subsidy, US$ 45 per poor households. The project has the 500 targeted households and the 220 households are listed as poor households with the criteria prepared by the CEC.

b. For enforcing such an operational and managing capacity, KOSAN has technical and financial capacity enforcement programs.

c. The investor is licensed as a Rural Electrification Enterprise (REE) by EAC.

d. The investor is a licensed REE in the commune and has the obligation to pay US$200 annually for 15 years. The money may be one of financial resources of the CEC to manage the project.

e. The 220 households who are selected as subsidized households will pay US$1 monthly to the investor. They are allowed to use only 10 W daily.

f. The other 280 households have the obligation to pay monthly tariffs, charged by the metering systems, to the investor. They do not have any limit for enjoying electricity services.

The CEC consisting of 9 members selected those to be subsidized for with own criteria. CEC opened the account for the Commune Electrification Fund at the local bank and receives revenue for US$ 2 per household for expanding the consumers. The revenues are utilized for management activities. The community is responsible for the operation of the facility and financial management of the project.

Even the REE have long experience of operating the two large generators, financing the additional fund for expanding services to the poorer household is not practical as their small capacity to pay. Yet, the REE received the assistance from NGO not only for technical assessment, but also for the local bank loan. The REE received the loan with annual interest rate 14% for 5 years repayment period with assistance by the NGO.

(2) Anlong Ta Mei Village Rural Electrirication Project by Biomass

The second village based electrification by a biomass gasification plant which is supported by an NGO called, SMEC (Small and Medium Enterprise Cambodia) in Battambang.

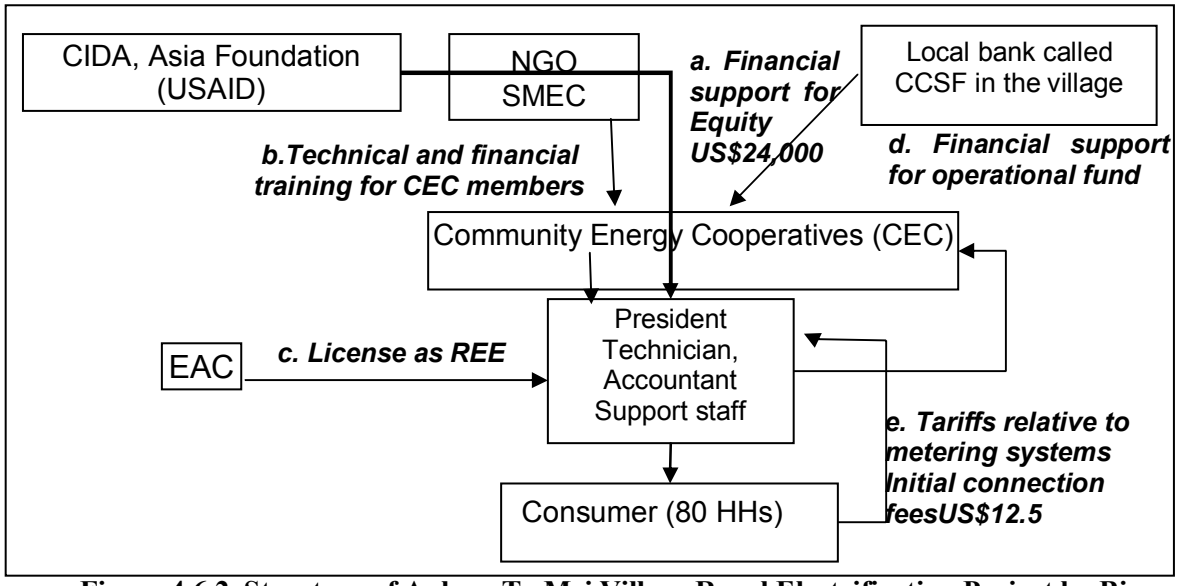


Figure 4.6.2 Structure of Anlong Ta Mei Village Rural Electrification Project by Biomass

a. The external donor, CIDA, Asia Foundation, USAID provided grant to the CEC through SMEC. The grant was used for purchasing the biomass gasification plant and some other necessary equipment. The project aimed to target over 100 households, yet due to the limited fund for purchasing the plant. The beneficiaries were decreased to 74 households.

b. For enforcing operational and managing capacity, SMEC has technical and financial training for the CEC members.

c. The CEC representative is licensed as a Rural Electrification Enterprise (REE) by EAC.

d. The Cambodian Community Savings Federation (CCSF) has a branch in the village since 1998. There are 100 members in the village and well trusted organization. CCSF lent operational fund to CEC for purchasing the electrical poles and cement for transmission system.. 20 households borrowed from CCSF for initial connection fees.

e. The 74 households who were connected contributed the initial connection fees and some labour and obliged to plan fuel trees.

While the village has long experienced for community work for credit and saving and cow bank, the infrastructure management is totally new. As biomass gasification plant requires substantial technical knowledge, the technical operators who once received training in the border camp had great advantage. They also visited Thailand for study purpose.

While NGO had to invest in technical training for CEC, the information dissemination such as explaining the subsequence of planting trees, the amount of consumption allowed for respective households needed to be done more progressively by CEC.

Having experienced war and political turmoil, efficacy of government organization as well as local social institution has been diminished. Whole communities were also affected by lack of public goods such as access to basic services and infrastructure. Collective involvement in decision-making process has been deteriorated. While the Seila program and other donors assisted program support for improving local-

level infrastructure, low level of the institutional capacity still remains in many sectors and regions. In order to materialize rural electricity programs, empowering local communities by training technical and management capacities has to be ensured. These principally require external supports such as experienced NGOs and consultants as well as provincial government support, namely DIME and other relevant line departments.

4.7 GRID EXTENSION PLAN OF EDC

The "Transmission Master Plan & Rural Electrification Strategy" study was completed in June 1997 and its final report was prepared by HECEC (Australia) in February 1998 under the financial assistance of WB.

In the report, energy trading with neighboring countries was proposed in the following three levels:

1) Low level energy purchase, most likely through distribution lines to provide cost effective sources of power supply to areas close to the border. The capacity of such links is usually a few MW depending on the length of the feeder from substation in the neighboring country.

2) Low capacity transmission links with the initial function to import energy to provincial load centers, and possible future energy export. Typically this can be a transmission link with capacity of maximum 100 MW and the reliability (single or double circuit) justified on a case by case basis.

3) Large capacity transmission lines dedicated to energy export and power wheeling between countries. This category can contain heavy 230 kV or 500 kV transmissions and generally will be of interest to organizations studying regional interconnections.

Planning of grid extension and energy trading with neighboring countries afterwards follow the recommendation made in the report. For trading energy with neighboring countries, the following agreements were concluded and signed by both the Governments:

1) Agreement on the Power Sector Cooperation with Vietnam in June 1999
2) Agreement on Power Sector Cooperation with Lao PDR in October 1999
3) Agreement on the Power Sector Cooperation Program with Thailand in February 2000

4.7.1 Medium Voltage Cross Border Links

As explained in Section 3.2.4 of Part 1, from Vietnam, in accordance with power purchase agreement signed by EdC and Company No.2 of Vietnam, EdC supply electric energy imported via 4 medium voltage cross border links to Memot and Ponhea Krek areas of Kampong Cham, Baveth area of Svay Rieng and Kampong Trach area of Kampot. In addition to these EdC's supply, Snul area of Kratie is supplied by REE (No.059L) by imported energy via a medium voltage cross border ink constructed under the grant assistance of Vietnam in accordance with the power purchase agreement signed by DIME and Company No.2 of Vietnam.

From Thailand, 8 areas near the border are served electricity imported by 4 REEs via 7 medium voltage

cross border links in Oddar Meanchey (1 area), Banteay Meanchey (1area), Battambang (3 areas), Pailin (2 areas) and Koh Kong (1 area). Among 8 areas, one area (Pailin) is supplied by purchased energy from other distribution licensee who import energy from Thailand.

4.7.2 Low Capacity Interconnection

Low capacity interconnections will typically include the supply of 20 to 50 MW of load separated from the source by the distance of 50 to 100 km. In this category, the following transmission schemes are under planning/consideration:

1) Banteay Meancey, Battambang and Siemreap 115 kV Transmission Project

   For this project, Power Purchase Agreement (PPA) was signed between EdC and EGAT in 2002. Contract for BOT for the project has been signed by EdC and Cambodian investor. The construction works has been commenced in December 2005 and is scheduled to be completed in 2007.

2) Laos-Stung Treng 115 kV Transmission Project

   This plan is scheduled to be constructed under the Phase-1 GMS project. The project consists of construction of 115 kV transmission line of total length 86 km (Laos: 26km & Cambodia: 60km) from Ban Hat substation in Champasak province of Lao to Stung Treng province town and associated substations with financial assistance of IDA. As of the end of 2005, more detail study (F/S) is on-going.

3) Vietnam – Kampong Cham 115 kV Transmission Project

   This plan has initially been studied by EdC. However, more detail study is under way together with above transmission project by consultant.

4) Phnom Penh – Kampong Cham 115 kV Transmission Project

   This plan has been roughly studied under the Feasibility Study for the First Transmission Link between Phnom Penh and the Southern Region of Cambodia.

4.7.3 Large Interconnection

Large interconnections include 230 or 500 kV transmission for providing power supply to a large load center, increasing reliability, facilitating import/export of bulk energy from or to the neighboring countries and participating in power wheeling among countries. This category includes the project explained hereunder.

Following the Power Transmission Master Plan and Rural Electrification Strategy prepared by HECEC in 1998, the WB commissioned a further study “Feasibility Study for the First Transmission Link between Phnom Penh and the Southern Region” in 2000, as a component of the Rural Electrification and Transmission Project under the Japanese PHRD TF-025765. This study, undertaken by APW/HEC, was completed in 2001.

The project has been commenced and it is separated into two components to be financed by WB and ADB

as follows:

ADB Funded Works

- Construction of a 220 kV double circuit transmission line of 100 km from the Vietnamese border to West Phnom Penh substation (WPP) via Takeo substation.
- Construction of 220/115/22 kV WPP substation including 220/115 kV (2 x 120/200 MVA) and 115/22 kV (2 x 30/50 MVA) transformers.
- Construction of 220/22 kV Takeo substation including 220/22 kV (2 x 4 MVA) transformers.
- Construction of the National Control Center adjacent to WPP substation.

World Bank Financed Works

- Construction of 400 MVA capacity 115 kV double circuit transmission line from WPP to the existing transmission ring (about 9 km).
- Installation of the second circuit on the existing transmission ring (about 23 km).
- Supply and installation of a second 115/22 kV, 30/50 MVA transformers at each existing GS2 and GS3.
- Bus work and protection / control change at the existing GS1.

The double circuit 220 kV transmission line route follows National Route 2 from Vietnam border to Takeo, and the railway track from Takeo to the new site close to the intersection of National Route 2 and 3.

In order to meet the above scope of works, the existing Kirirom line will be re-routed by CETIC from the existing GS1 substation to the WPP to be constructed under the above project.

4.7.4 Transmission Extension Plans in the Country

(1) Takeo – Kampot 220 kV Transmission Project

The Government requested KfW of Germany in August 2001 to construct a single circuit 220 kV transmission line between Takeo and Kampot by grant and KFW made a study. Construction works will be started after the commencement of the 220 kV cross border line and scheduled to be completed in 2008.

(2) Kampot – Sihanoukville 220 kV Transmission Project

This plan was studied by NEWJEC as a Project Finding Mission of ECFA of Japan and the study report was prepared in March 2002. A detail feasibility study has been done by APW (Australia) under ADB's fund in 2005.