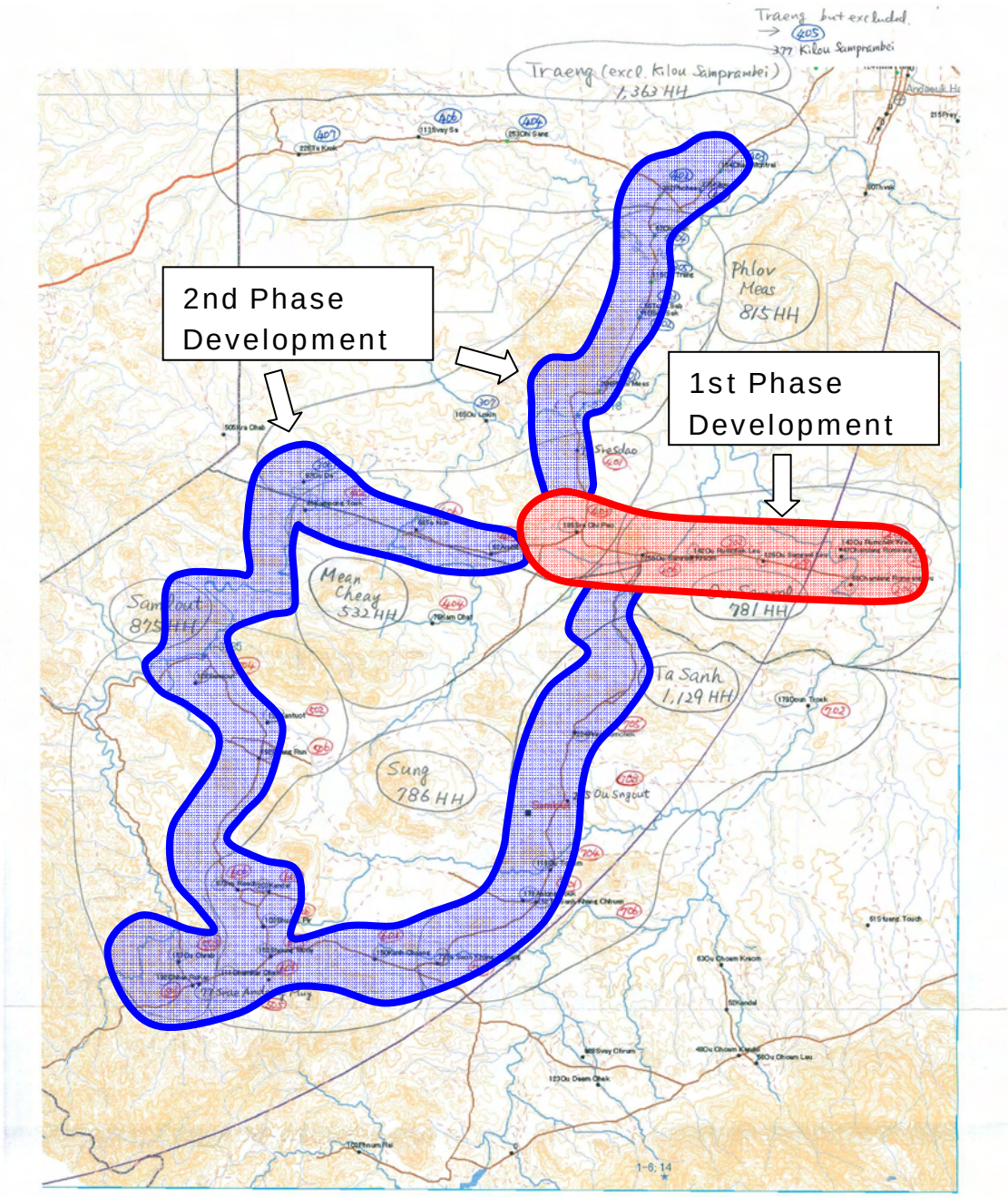
1.1 TARGET ELECTRIFICATION AREA



(Prepared by JICA Study Team)

Figure 2.3 Phase 1 and 2 Development Area

Target area covers the following 7 communes in Rotanak Mondol and Samlout Districts.

Ou Samrel, Mean Cheay, Ta Sanh, Phlov Meas, Sung, Samlout, Traeng

Electrification plans are formulated in two phases. First phase targets relatively densely populated Ou Samrel commune. Electrification is done by construction of biomass gasification power (BGP) station and medium voltage lines (MV lines). In the first phase, detailed survey and design will be mad for micro hydro power station (Sangke Micro Hydro Power Station), and construction is done in the second phase.

In the second phase, micro hydro power (MHP) plant construction, extension of MV lines, and additional installation of BGP are to be made.

Reflecting the result of field surveys and community workshops, target communes were classified as the first and the second phase electrification areas as follows.

Table 2.1 Target Electrification Commune, Households, Demand

Phase		Village Name	Commune Name	Total HHs	HHs to be electrified (80% of Total HHs)	Demand
1st Phase		Ou Samrel Kraom	Ou Samrel	255	204	27
		Sre Chi Pao	Mean Cheay	186	149	19
		Ou Rumchek Leu	Ou Samrel	142	114	15
		Ou Samrel Leu	Ou Samrel	126	101	13
		Chamlang Romeang Leu	Ou Samrel	68	54	7
		Chamlang Romeang Kraom	Ou Samrel	47	38	5
		Ou Rumchek Kraom	Ou Samrel	143	114	15
			Total of 1st Phase	967	774	101
2nd Phase		Sre Sdao	Mean Cheay	79	63	8
		Phlov Meas	Phlov Meas	204	163	21
		Prey Rumchek	Ta Sanh	224	179	23
		Ou Sngout	Ta Sanh	205	164	21
		Ou Tontim	Ta Sanh	118	94	12
		Ta Sanh Khang Chhuen	Ta Sanh	152	122	16
		Anlong Pouk	Ta Sanh	178	142	18
		Kampong Touk	Mean Cheay	61	49	6
		Ou Da	Phlov Meas	97	78	10
		Ta Non	Mean Cheay	68	54	7
		Ambib	Mean Cheay	62	50	7
		Samlout	Samlout	128	102	13
		Kantout	Samlout	129	103	13
		Bueng Run	Samlout	192	154	20
		Sre Reach	Sung	67	54	7
		Kandal	Sung	203	162	21
		Shuong Pir	Sung	103	82	11
		Shoung Muoy	Sung	152	122	16
		Chamkar Chek	Sung	111	89	12
		Srae Andoung Muy	Samlout	77	62	8
		Chhar Rokar	Samlout	192	154	20
		Ou Chrab	Samlout	157	126	16
		Kanh Chaang	Sung	150	120	16
		Ta Sanh Khang Tboang	Ta Sanh	73	58	8
		Sek Sak	Phlov Meas	110	88	11
		Tuek Sab	Phlov Meas	56	45	6
		Ou Treng	Phlov Meas	116	93	12
		Chi Pan	Phlov Meas	67	54	7
		Phcheav	Traeng	382	306	40
		Kilou	Traeng	235	188	24
		Chea Montrei	Traeng	154	123	16
			Total of 2nd Phase	4,302	3,443	446
			1st & 2nd Phase Total	5,269	4,217	547

(Source: JICA Study Team)

For formulation of electrification plan, it was assumed that 80% of households are to be electrified. Demand was assumed to be typical mini-grid use of 100 watt per household plus 30% distribution loss etc.

For actual figures, it is necessary to confirm through discussion by holding community workshop.

To cope with demand estimated in Table 2.1, electrification facilities shown in Table 2.2 were planned. Detailed descriptions of facilities are to be hereinafter described.

1.2 ENERGY SOURCES AND DISTRIBUTION LINES DEVELOPMENT PLAN

Principal features of electrification plan are as follows.

Table 2.2 Principal Features of Electrification Facilities

	1st Phase	2nd Phase	Total
Biomass Gasification Power Station	120 kW (60 kW x 2 nos.)	282 kW (94 kW x 3 nos.)	402 kW
Micro Hydro Power Station	-	180 kW	180 kW
Total	120 kW	462 kW	582 kW
Medium Voltage (MV) Line	6.3 km	53.9 km	60.2 km
MV+LV Line Dual Use	3.7 km	22.6 km	26.3 km
Low Voltage (LV) Line	2.5 km	7.0 km	9.5 km
Transformer			
25 kVA (Single Phase)	1 set	10 sets	11 sets
50 kVA (Three Phase)	3 sets	8 sets	11 sets

Note: Biomass Gasification Power Station will be installed at Ou Samrel Commune. Micro Hydro PowerStation will be installed in the upstream of Sangke River near Kampong Tuk Village in Mean Cheay Commune. Locations of these power stations will be examined in the next stage. (Prepared by JICA Study Team)

2 SOCIO-ECONOMIC SITUATION IN THE STUDY AREA

2.1 BASIC INFORMATION ON SAMLOUT TARGET AREA

All target areas		Household Number	Population	Number of TV - owned households	Literacy rate
District	Commune				
Total		7,284 (5,269*)	36,556	1,845	87.2%
Rotonak Mondol	Phlov Meas	882	5,065	148	77.2%
	Traeng	1,822	9,656	375	88.4%
Samlout	Ou Samrel	815	3,497	142	77.5%
	Mean Cheay	700	3,341	201	82.9%
	Samlout	948	4,648	264	93.3%
	Sung	831	4,102	372	90.2%
	Ta Sanh	1,286	6,247	266	94.4%

*: Year 2003 data in parenthesis. At the electrification plan formulation stage, only Seila 2003 data was available. For formulation of electrification plan and pre-feasibility study, Seila 2003 data was applied.
Source: Seila Commune Database 2004

The Samlout project covers part of two districts (Samlout and Rotanak Mondol) comprising 7 communes; Ou Samrel, Ta Sanh, Mean Cheay, Samlout, and Sung (Samlout), Phlov Meas, and Traeng (Rotanak Mondol). The population consists of more than 42% recent migrants and 6% of returnee from border camp as the area recently cleared mine after the war.

2.2 CURRENT HOUSEHOLD SITUATION IN SAMLOUT FOUNDED BY THE SOCIOECONOMIC SURVEY

The economic situation with details of the energy usage of the households and willingness to pay for electricity service was shown by the socio-economic survey conducted under this study, where each 26 sample, all together 52 households in the two villages Phlov Mea(Phlov Mea Commune, Rotonak Mondol

District), and Srae Andong Muy(Samlout commune, Samlout District) are interviewed.

(1) Household Economy

The first main sources of income are agriculture consisting more than 80% in Srae Andong Muy while only 50% in Phlov Mea. The income source is well diversified in Phlov Meas located n the junction of the main road, while Srae Andong Muy is depend on agriculture and livestock.

1) Major income sources (%)

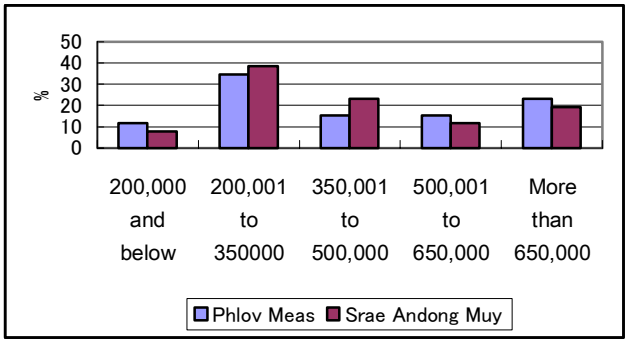
	Phlov Meas			Srae Andong Muy		
	1st	2nd	3rd	1st	2nd	3rd
Agricultural produce (crops)	50.0	21.7	18.8	80.8	12.0	
Livestock & poultry	3.9	17.4	25.0	3.9	68.0	15.8
Forestry (timber non-timber forest products)	3.9	13.0	6.3	-		10.5
Home-based crafts	7.7	4.4		3.9	4.0	
Rice/corn milling	-	4.4		3.9		
Repair shop	3.9			3.9		
Bakery/ grocery	23.1	13.0		-	12.0	
Food/ Restaurant business	-	4.4		-		
Salary from private business/ NGO	-		25.0	-		5.3
Salary from public service	-	8.7	18.8	3.9	4.0	36.8
Wage from seasonal labor	7.7	8.7		-		15.8
Construction		4.4				
Drug store			6.3			
Make vine						5.3
Other						5.3
Total	100.0	100.0	100.1	100.0	100.0	94.7

2) Land ownership and Assets

Asset			Land			
Type of assets	N	Ownership	Type of lands	N	Ownership	Mean(ha)
Tractor koyons/cars	14	26.9%	Home-lot	52	100.0%	0.133
Horse/ox carts	7	13.5%	Garden	1	1.9%	0.015
Bicycle	21	40.4%	Own paddy land irrigated	11	21.2%	0.766
Motorbike	27	51.9%	Rented paddy land irrigated	1	1.9%	1.500
Generator	4	7.7%	Own cultivated dry land (non-irrigated	9	17.3%	0.646
Fishing net	9	17.3%	Agricultural land renting to others	2	3.8%	3.000
Diesel water pump	4	7.7%	Own chamkar	45	86.5%	1.637
Rice mill	2	3.8%	Rented chamkar	2	3.8%	0.850
Sewing machine	8	15.4%				
House for rent	2	3.8%	All land	52	100.0	2.001

Irrigated paddy land owner is limited to 21 %. Majority of the households depend on the field without irrigation(86%). 100 % households own their home lot. Owner of generator and rice mill will be potential large users of electricity.

3) Monthly expenditure (Riel)



Both villages of Phlov Meas and Srae Andong Muy have similar distribution in terms of monthly expenditure. Those who can spend more than US$100 consists more than 30%. The poorest spends merely US$15, while richest spends more than US$350. Besides basic necessity of food, the expenses of medical treatment and education are great.

4) Household monthly median expenses (Riel)

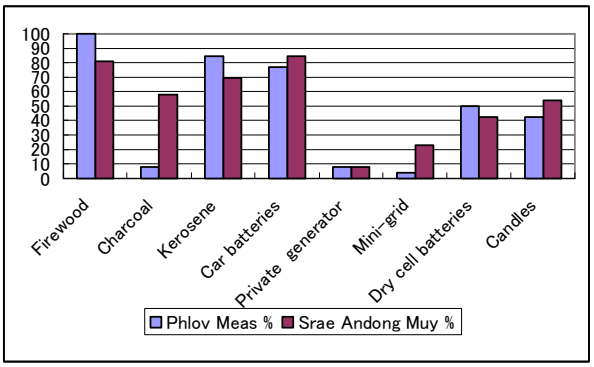
Expense item	n	%	Minimum	Median	Maximum
Food	52	100.0	15,000	30,000	600,000
House (rent/repairs)	2	3.8	400,000	400,000	400,000
Clothing	22	42.3	1,000	39,000	150,000
Child care	7	13.5	1,000	12,000	45,000
Education	41	78.8	1,000	20,000	480,000
Medical treatment/medicines	45	86.5	500	20,000	200,000
Transportation	29	55.8	5,000	50,000	300,000
Amusement/recreation	18	34.6	3,000	12,000	60,000
Fuel for lighting/cooking	44	84.6	1,000	6,000	120,000
Personal care	47	90.4	1,400	10,000	80,000
Water	6	11.5	10,000	16,000	50,000
Payment of debt/loan	26	50.0	4,000	42,500	700,000
Saving	21	40.4	1000	30,000	200,000
Lending	3	5.8	50,000	100,000	1,000,000
Others	9	17.3	8,000	23,000	200,000
Total expenses	52	100.0	63,000	405,550	1,483,000

5) Credit and Savings

Approximately 70 % of respondents experienced to obtain loans. Majority of them borrowed from NGO (56%), followed by the relative(32%), money lender (15%). Almost half of the respondents save regularly and 70% put money at home, yet about 10% at bank, and about 15% at NGO and saving community.

(2) Current Situation of Energy Use and Needs

1) Energy usage



The kerosene and car batteries are both widely used about 80% of respondents. On average, kerosene was consumed 5,760 Riel per month and used 4.3 hours a day. 2 kerosene lamp was owned per household. Car batteries are recharged 5 times and spent 11,300 Riel per month.

2) Current usage of major lighting sources, kerosene and car battery

Kerosene (N. of users: 40 share 76%)		Car battery (N. of users:42, share 81%)	
Cost of kerosene per liter		Number of baterries owned /household	
Mean	2,523	Mean	1.33
Standard Error of Mean	24.67	Standard Error of Mean	0.07
Minimum	2,200	Minimum	1
Maximum	3,000	Maximum	2
Liters consumed per month		Number of times recharging batteries per month	
Mean	2.25	Mean	4.57
Standard Error of Mean	0.21	Standard Error of Mean	0.49
Minimum	1	Minimum	1
Maximum	8	Maximum	15
Monthly expenses for month		Expenses for recharging batteries per month	
Mean	5,760	Mean	11,257
Standard Error of Mean	565	Standard Error of Mean	2,139
Minimum	2,200	Minimum	1,000
Maximum	21,600	Maximum	84,000

Type of battery	Number	Share	Cost of battery
12 Volt - 100 Ah	3	5.9%	148,333
12 Volt - 70 Ah	18	35.3%	90,317
12 Volt - 50 Ah	15	29.4%	77,067
6 Volt - 5 Ah	15	29.4%	14,600

3) Present ownership and future demand of electric appliances

APPLIANCE	Currently owned		Want to buy	
	n	%	n	%
Electric lighting	34	66.7	46	90.2
Electric rice cooker	-	-	41	80.4
Television (color)	11	21.6	35	68.6
Television (black and white)	13	25.5	1	2.0
Video (VHS/VCD)	13	25.5	14	27.5
Radio/radio cassette	20	39.2	19	38.0
Electric fan	4	7.8	39	76.5
Electric water pump for drinking/household	1	2.0	39	76.5
Electric water pump for irrigation	2	3.9	22	43.1
Iron	2	3.9	20	39.2
Refrigerator	-	-	16	31.4
Washing machine	-	-	15	29.4
Video game	1	2.0	4	8.0
Karaoke	2	3.9	13	25.5
Grain/cereal/meat grinder	-	-	10	20.0
Others	-	-	-	-
Water pump for washing moto	-	-	1	2.0
Motor for wood plane	-	-	2	4.0
Sewing machine	-	-	1	2.0
Electrical pot	-	-	-	-

Electric lights, radio and TVs are most popular items 20%. VCD, Karaoke are popular appliances for gen-set owner, yet many still needs the lighting source. After electrification, therefore, 90% respondents will buy lighting followed by rice cooker(80%), fan(76%) and electric water pump(76%). Special attention needs to be paid for those who would like to purchase energy consuming appliances as it will directly affect the demand.

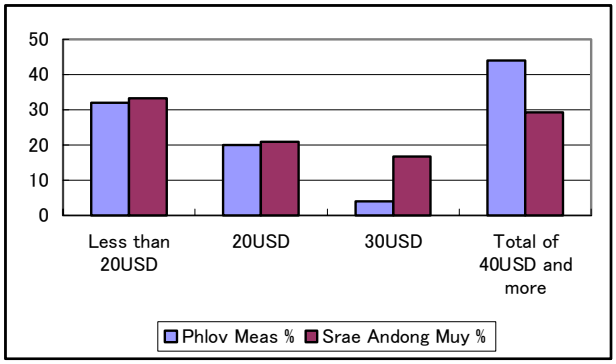
(3) Economic activities

In target area, mainly produces rice and some beans, vegetables and livestock for their own consumption. In addition, there are some service sectors and cash crop for selling to the border market.

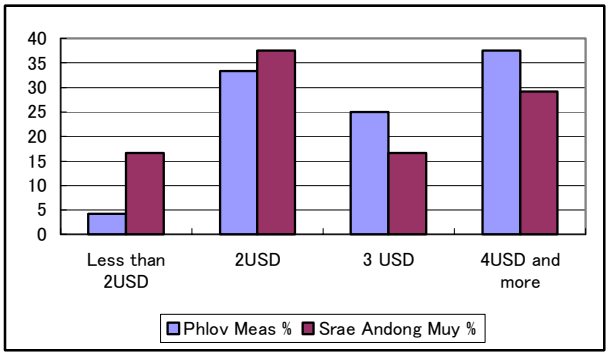
(4) Willingness and ability to pay for the electricity services

1) Willingness to pay for initial connecting fees

Since nearly 80% of respondents are able to purchase car batteries cost more than US$20, those who are willing to pay more than US$20 are about 70%.



2) Willingness to pay for monthly tariff for the electricity



Considerable number of households consume kerosene and charging car batteries within the range of US$ 3~5 per month. Ability to pay is estimated to be higher than responded willingness to pay once they understand more about convenience of mini-grid system..

3) Expected demand

Population trend in the target area

Village	2003	2004	Annual growth rate
Total	6281	7284	13.8%
Phlov Meas	815	882	7.6%
Traeng	1363	1822	25.2%
Ou Samrel	781	815	4.2%
Mean Cheay	532	700	24.0%
Samlout	875	948	7.7%
Sung	786	831	5.4%
Ta Sanh	1129	1286	12.2%

The interview regarding the possible businesses that can be started if households are electrified, showed interest in starting the store / restaurant (35%), followed by not engaged any (20%), rice cake making /milling (19%). The daytime demand can be expected for these purposes. Besides the household demand which is targeted to 80 % of the total 7,000 households, there are also demand from the public utility offices such as schools and health centres. Special attention needs to be paid for this area as growth rate of household is over 13% on average due to intense migration, while national average is merely 2%. The demand survey, therefore, has to reflect inflow of the settlers. Unfortunately, the trend is not well captured as two communes, Ta Sanh, Mean Cheay established in 1999 and not included in general population census in 1998. The household number of Treang and Mean Cheay communes increase well over 20% between 2003 and 2004.

4) Appropriate tariff for the village for sustainable operation

Tariff can be set for equally per kWh basis. Although the poverty level differs by village by village, the tariff structure has to be integrated in order to streamline the management system.

2.3 DEVELOPMENT PLAN AND THE PRESENT DEVELOPMENT EFFORTS (COMMUNITY ACTIVITIES)

There is wide range of support from the NGO and Seila Commune Development Program for the project area. According to the Key informant survey in 5 communes in Samlout District, there are five major NGOs acting in the target area, which are CARITAS, World Vision, HI- Handicap International, CVD-Cambodian Vision for Development, MJP- Madox Jolie Projects for environment project.

Commune	**Development activities**
Ou Samrel	**CARITAS** Credit and Saving community: **,**- Water users group - School committee/Parents association - Pagoda community
MeanCheay	- Water users group, - School committee/Parents Association **World Vision**: Credit and saving community: - Self-help group - Women and Children Protection committee - Pagoda committee
Samlout	**CARITAS** community Forestry - Woman Association
Sung	**CARITAS and World Vision-**Credit and saving community: - Self-help group, - Forestry Protection group
Ta Sanh	**CARITAS** 1) Community Forestry, 2) Farming Tractor community, 3)Self-help group and disable people group **World Vision and Department of Social affair**-Saving children project: - Pagoda committee - Water users group

Thanks to various development projects, most of the villagers already participated in community activities like road construction, well building and other infrastructure works except electricity. Households are accustomed to contribute labor or money.

3 FORMULATION OF ELECTRIFICATION PLAN

3.1 POSSIBILITY OF GRID ELECTRIFICATION

Target electrification area is geographically within 40 km from provincial capital of Pailin. Pailin town buys electricity from neighbouring Thailand via medium voltage line. As even in the town of Pailin, voltage drop is significant, further extension of medium voltage line is technically difficult. In addition, the target area is in a distance of more than 40 km from Battambang town which means it is outside of PAGE area.

Considering the above conditions, the target area has less possibility of electrification by grid extension in the future.

3.2 PLANNING CONCEPT OF MINI-GRID

3.2.1 Characteristics of the Region

Most of houses are distributed along the road, especially along trunk road going southward from national road No. 57 has dense household distribution (Refer to Figure 2.2 Household Distributions in Samlout Electrification Area (by Handy GPS Survey).

In the target electrification area, unite of each commune is relatively strong compared with other regions of the country, and has strong sense of cooperation. In reality the area has experiences of cooperative works in commune level on road improvement etc.

For such area, from economic efficiency point of view, adoption of wide-area mini-grid is preferable for supply of electricity to wide area, rather than construction of mini-grids in every village or every commune. That is to say, by concentrating power stations in several limited locations and supply electricity by medium voltage line network. To cope with increase of demand and expansion of demand area, expansion of generation capacity or extension of medium voltage line would be made. Merits of adoption of wide-area mini-grid are as follows.

1) By concentrating power station in limited location,
   a) Centralized operation and maintenance becomes possible
   b) Save number of operators
   c) As control of demand-supply balance for whole system becomes easy, stable operation of the system is possible.
2) For off-grid area's electrification, some extent of subsidy will be required. By formulating wide-area mini-grid, there will be a scale merit due to wide-area and effective use of subsidy becomes possible.

3.2.2 Formulation of Electrification Plan by Wide-area Mini-grid

This electrification plan is formulated as an example having the following characteristics.

1) Electrification with Micro Hydro Potential
2) Electrification with Micro Hydro and Biomass Hybrid Energy Source
3) Electrification applying Wide-area Mini-grid

In formulating electrification plan, present status and situation after electrification can be described as follows.

(1) Composition of energy source

Available energy sources for formulating electrification plans are as follows.

a) Through map study, 100 to 150 kW micro hydro potential was identified in the Sangke River. Detailed descriptions are to be given later.
b) According to land use map of the area and through field survey, the target area was judged to have enough land for fuel wood farming. This means that the area has enough physical potential for biomass gasification power generation.

(2) Characteristics of Energy Source

Comparison for characteristics of energy sources of Micro Hydro and Biomass Gasification are summarized as follows.

Table 2.3 Characteristics of Each Energy Source (Merit/Demerit)

Energy Source	Micro Hydro Power (MHP)	Biomass Gasification Power (BGP)
Merit	a) 24 hour operation is possible b) Fuel cost is free c) Operators work load is not so heavy as biomass gasification	a) Construction cost is cheaper compared with micro hydro b) Fuel wood is locally available, and will contribute to income increase of local people c) Expansion is possible against demand increase
Demerit	a) Construction cost is expensive compared with biomass b) Need longer time for study, design, and construction c) Expansion is difficult against demand increase	a) Much more work load is necessary for operators (for fuel wood processing, input into gasifier, treatment of waste water etc.)

(3) Operation Rule

Taking into account of the above characteristics, operation rules are proposed for rainy season and dry season as follows.

1) Rainy Season (from June to December)

River discharge is abundant in the rainy season, and 24 hour operation of micro hydro power (MHP) is possible. MHP covers base load and biomass gasification power (BGP) covers night time peak load.

2) Dry Season (from January to May)

In the dry season there would be cases when river discharge is less than required discharge for MHP. For such cases, with maximum operation of MHP, back up operation of BGP is required to cover the demand. In case of driest period of the year, environmental flow release should be taken care of.

(4) Development Configuration

Micro hydro power development needs longer time for study, design and construction. Implementation of electrification is done in two phases.

1) 1st Phase: Construction of Biomass Gasification Power (BGP) Station and Medium Voltage (MV) Lines, Detailed Survey and Design of Micro Hydro Power (MHP) Station
2) 2nd Phase: Construction of MHP Station, Expansion of BGP Station, and Extension of MV Lines

The 1st phase development will complete after one to two years. Two to three years time is necessary for the 2nd phase.

(5) Operation System

1) Operation and Maintenance of Power Stations and MV Lines

Power stations and MV Lines are to be operated by Regional Power Company (RPC) to be established through public invitation.

2) Operation and Maintenance of Low Voltage Line

For sub-area where people need electrification, local small scale Rural Electrification Enterprise (REE) or Community Electricity Company (CEC) will obtain distribution license from EAC and distribute electricity to the target community by purchasing electricity from RPC. In this case, low voltage lines construction and household connection will be done by REE or CEC.

Considering above features, electrification plan is to be examined.

3.3 RESULT OF WORKSHOP (SAMLOUT)

3.3.1 Outline of Workshop

Workshops were conducted in five (5) communes in Samlout District. The outline is shown in the table below.

Outline of Workshop

Commune Name	Date	Time	No. of Participants
1. Ou Samrel	Dec. 2, 2005	10:00 – 16:00	37
2. MeanCheay	Dec. 3, 2005	9:00 – 15:00	116
3. Samlout	Dec. 4, 2005	11:30 – 16:00	27
4. Sung	Dec. 5, 2005	10:00 – 14:30	17
5. Ta Sanh	Dec. 6, 2005	9:00 – 14:30	46

3.3.2 NGO Activities and Community Activities

Various types of NGOs are operating in various activities. Major NGOs and their activities are as follows:

- Karitas: Self-Help Group, Animal Raising, Saving Group, etc.
- HI: Road, Water, Infrastructure, School, Fish Raising, etc.
- MGP: Community Forestry, etc.
- Handicraft: Support for handicapped people, etc.
- ADA: Rice bank, Family Vegetable, Training for animal doctor, etc.
- Charity: Training for animal doctor, Training of agriculture technology, etc.

There is a traditional mutual help for poor people and starved people, and help for a family in funeral as a community activity. There is, however, no other community activity, which was initiated by community-self.

On the other hand, there are several community activities organized by NGO's support. The major community activities are as follows:

- Water Maintenance Committee: to maintain wells
- School Committee: to maintain school buildings
- Animal Raising Committee: raising animals by group as a livelihood activity
- Farming Committee: to cultivate by farm machine used by group
- Credit Committee: to operate micro credit by group

In this connection, it seems difficult for community to operate some activities by their own. It seems, however, that the community can operate some activities once NGO or some other supporter from outside supports community.

3.3.3 Existing REE

There are several REE in this district. Most of them are on a small scale, which supply electricity for several to ten households. A larger REE supplied electricity in Samlout commune and Sung commune. This REE run away under cover of darkness after collection of initial connection fee from the households. Therefore the people in this area have mistrust to REE.

Existing REE

Commune Name	No. of REE	Remarks	Possible person initiate REE
1. Ou Samrel	1		No
2. MeanCheay	1		No
3. Samlout	0	A REE run away.	unknown
4. Sung	2-3	A REE run away.	unknown
5. Ta Sanh	2	One has stopped already.	No

3.3.4 Literacy of Electricity

Most of the people possess 6V or 12V batteries. Most of the battery owners use kerosene or candle for lighting.

It was observed that some participants could not answer how much they spend for battery charging fee or kerosene per month or answered inappropriately in the workshop. This is because they are not used to think of income or expenditure per month. Their style of expenditure is daily or a few days basis. They thought difficult to pay 50$ for an initial connection fee as described later. They were, however, surprised at the amount, which was accumulated daily expenditure to be a monthly one.

The following table shows a situation of using battery and charging cost.

A duration of battery life is about 1.5 year and it costs about 30$ in case of 12V battery. Therefore it costs about 3$ per month as a lighting charge.

Battery Use（Mean Cheay）

Battery Use Situation	No.
Possess only 6V	32
Possess 12V	46
Total	115

Battery Charging Cost(Mean Cheay)

Monthly Charging Cost (Baht)	No.
20	6
30	4
40	2
50	6
60	30
70	8
80	1

Battery Use (Samlout)

Battery Use Situation	No.
Possess only 6V	6
Possess only 12V	13
Possess 6V and 12V	10
No possession	3
REE（including own generator）	5

Battery Charging Cost (Samlout)

Type of use	Cost	No.
Battery Owner	30B/month	2
	35B/ month	2
	50	1
	70	1
	100	7
	150	2
	200	2
	60B/ month	1
Using only candle	75B/ month	2
Using only Kerosene/Diesel	Diesel 1L/day =3hours/day	4

Battery Use (Sung)

Battery Use Situation	No.
Battery Owner	11
Using only kerosene without battery	1
Using own generator	4

Battery Charging Cost (Sung)

Type of Use	Cost	No.
Battery Owner	100B/month	10
	150B/month	1
Using only kerosene	60B = 2L/month	1
Using own generator/Diesel	Diesel 1L/day=3hours/day	4

Cost of Own Generator (Sung)

No.	Cost (Baht)	Remarks
1	21,000	
2	21,000	
3	35,000	Using tractor, which was bought by tractor association, as a personal generator at night
4	20,000	

Battery Use (Ta Sanh)

Battery Use Situation		No.
Battery Owner	Possess only 6V	10
	Possess 6V and 12V	10
	Possess only 12V	14
Using only kerosene without battery		11

Battery Charging Cost (Ta Sanh)

Type of Use	Cost	No.
Battery Owner	More than 100B/month	5
	40-100B/month	19
	Less than 40B/month	2
Kerosene	60B/month	1
	50B/ month	1
	30B/ month	18

Battery Charging Fee

Type		Riel
6V		500-800
12V	40A	2,000
	50A	2,500
	70A	2,500
	100A	3,000

3.3.5 Establishment of CEC

There are several candidate operators who are repairmen in every commune. There are such people who have a little knowledge and experience of machine because there are cars, motorbikes and own generators. It seems that they can be an operator if they have training but it is difficult for them to repair in case of large trouble.

Some candidate operators have their own agricultural land. There was a question whether they can be an operator through a year in the workshop. Participants discussed and resulted that family members of the operator can work for the field and in case of not enough other community members can cooperate for the work.

There are candidate accountants in every commune same as operator. They are business men, school teachers, students, and so on. It seems, however, that they cannot calculate and set a tariff.

3.3.6 Ability to Pay for Initial Cost

Only the participants in Samlout commune answered to be able to pay 50$ as an initial cost, while the participants in other communes answered less than 50$. The participants in Ta Sanh commune chose REE instead of CEC because they have no ability to pay for initial cost.

Ability to Pay for Initial Cost

Commune Name	Amount of ability to pay for Initial Cost (US$)	Remarks
1. Ou Samrel	25	
2. MeanCheay	12.5	
3. Samlout	50	
4. Sung	37.5	
5. Ta Sanh	-	Prefer REE due to difficulty of payment

3.3.7 Demand Power Amount and Charge

Six (6) types of demand power amount and its charges were shown in the workshop. Participants chose the types, which they want to use and can afford to pay the charge as shown in the table below.

Most of the participants in all communes except for Samlout commune chose the type No.3, which is “20W lighting: 2 : 4 hours use per day Black & White TV(40W) or Fan (40W) : 1:4 hours use per day.” This means most of them can afford to pay 4.6 $ per month. The participants in Samlout commune chose the type No.4, which is more than 4.6$.

Demand Power Amount and Charge

No.	Amount of Daily Use	Watt	monthly amount	Estimated Monthly Charge	No.					
			kWh	Riel	Ou Samrel	Mean Cheay	Samlout	Sung	Ta Sanh	Total
1	10W lighting : 1: 3 hours use per day	10	0.9	900	0	0	0	0	0	0
2	20 W lighting: 2 : 4 hours use per day	40	4.8	8,600	0	0	9	0	0	9
3	20W lighting: 2 : 4 hours use per day Black & White TV(40W) or Fan (40W) : 1:4 hours use per day	80	9.6	18,200	22	22	4	6	20	74
4	20W lighting: 2 : 4 hours use per day Color TV (80W) : 1:4 hours use per day	120	14.4	27,800	1	1	9	1	0	12
5	20W lighting: 2 : 4 hours use per day Color TV (80W) : 1:4 hours use per day Fan (40W) : 1:4 hours use per day	160	19.2	37,400	0	0	1	0	0	1
6	20W lighting: 3 : 4 hours use per day Color TV (150W) : 1:4 hours use per day	210	25.2	49,400	0	0	0	0	1	1
Total					23	23	23	7	21	97

3.3.8 Planting Biomass Fuel Wood

It was confirmed that every commune can have necessary land to plant biomass fuel wood. The participants of all communes prefer to plant in every household instead of contract planting. Because they expect an additional income and this opportunity should be shared all households equally.

Some households, however, do not have enough land. In this case the idea was proposed that the community owned land can be used for those households so as to have equal opportunity.

It was confirmed that people strongly expect biomass generation instead of diesel generator because diesel price has been increased recently and the fuel cost of biomass can circulate in the commune as a inter communal economy.

3.3.9 Feasibility of CEC in Samlout

In terms of ability to pay, the communes except for Samlout commune is a little difficult to operate by CEC. Especially in Ta Sanh commune, it is difficult to prepare initial charge because of poorer than the other communes. It seems, however, that other commune except for Ta Sanh commune cannot be impossible by saving with some time. There are micro credit activities in the communes by NGO support. It can be possible to prepare initial charge if all members can have strong will to establish CEC and share objective of saving.

In terms of human resources and technology, it is confirmed that there are candidate operators and accountants, however, appropriate training are necessary for them.

In terms of operation, all communes except for Ta Sanh prefer CEC instead of REE. They thought that there is a risk of running away in case REE, however, there is no such a risk in case of CEC. It is essential to advise and support communes what kind of machine they should buy, how to operate CEC by operational and technical instruction.

Therefore electrification by CEC is not impossible if support agency educates and enlightens the community members to understand and share objective of establishing CEC, give trainings for operator and accountants, and guides operation and technical matters.

3.4 DEMAND FORECAST

3.4.1 Demand for 1st Phase Development

Based on demand size estimated in Table 2.1, and also referring to field survey results and community workshop results, demand patterns are assumed as follows.

1) Night Time Demand is from 17:00 to 22:00 (5 hours)

2) Several years after electrification, Day Time Demand is assumed to be 50% of Night Time Demand considering other electrified villages. In addition, power demand for irrigation pump is also considered.

Table 2.4 shows estimated demand for 1st Phase.

Table 2.4 Energy Demand Estimate for 1st Phase

Households to be electrified: 774	Monthly Unit Energy Sold (kWh/hh)	Monthly Energy Sold (MWh)	Annual Energy Sold (MWh)	Station Use, Losses etc. (MWh)	Annual Energy Generated (MWh)		
Nighttime domestic demand	15.0	11.6	139.3	13.9	153.3	Night	**159.4**
Street light demand	0.6	0.5	5.6	0.6	6.1		
Industrial demand	7.5	5.8	69.7	7.0	76.6	Day	**138.7**
Irrigation pump demand	6.1	14.1	56.4	5.6	62.1		
Total	29.2	32.0	271.0	27.1	**298.1 MWh**		

Details are given in Appendix-H
Source: JICA Study Team

3.4.2 Demand for 2nd Phase Development

It is expected that electrification of 1st phase development may function as a pilot project to promote electrification of 2nd phase development area. Based on demand size estimated in Table 2.1, estimated demand including both 1st and 2nd phases is calculated as shown in Table 2.5.

Table 2.5 Energy Demand Estimate for 1st and 2nd Phases

Households to be electrified: 4,216	Monthly Unit Energy Sold (kWh/hh)	Monthly Energy Sold (MWh)	Annual Energy Sold (MWh)	Station Use, Losses etc. (MWh)	Annual Energy Generated (MWh)		
Nighttime domestic demand	15.0	63.2	758.9	75.9	834.8	Night	**870.2**
Street light demand	0.6	2.7	32.2	3.2	35.4		
Industrial demand	7.5	31.6	379.4	37.9	417.4	Day	**755.6**
Irrigation pump demand	6.1	76.9	307.4	30.7	338.2		
Total	29.2	174.4	1,478.0	147.8	**1,625.8 MWh**		

Details are given in Appendix-H
Source: JICA Study Team

Table 2.6 summarizes demands shown in Tables 2.4 and 2.5.

Table 2.6 Annual Energy Generated for 1st and 2nd Phases

	Nighttime	Daytime	Total
1st Phase	**159.4 MWh**	**138.7 MWh**	**298.1 MWh**
1st and 2nd phases	**870.2 MWh**	**755.6 MWh**	**1,625.8 MWh**

It should be noted that during the 1st phase development, it is highly possible that the 2nd phase development area's demand will increase. It is necessary to re-assess night time and day time demand before formulation of the 2nd phase development.

3.5 SANGKE MICRO HYDRO POWER STATION

3.5.1 Result of Map Study

As a result of map study using 1:50,000 and 1:100,000 scale maps, two potential sites for micro hydro power were identified in the upper reach of Sangke River. Potential site is about 100 km from river mouth and about 50 km from provincial town of Battambang. Figures 2.4 and 2.5 show location and catchment area of map study results.

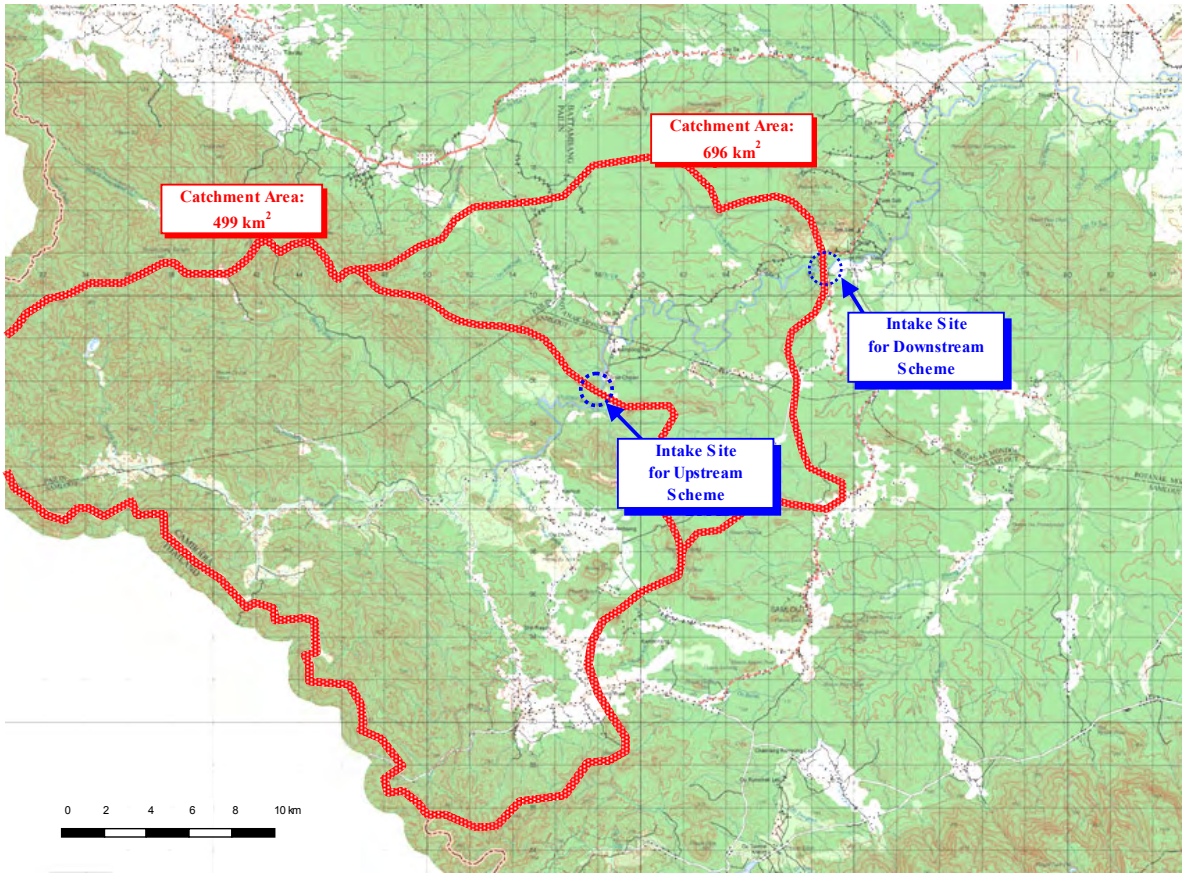


Figure 2.4 Potential sites for Micro Hydro Power in the upper reach of Sangke River (from the result of map study)

Site	Name of nearest Village	Head	Catchment Area	Waterway Lengh
(1) Downstream Potential Site	Phlov Meas	20m (EL. 60m ~ 40m)	696 km^2	About 2 km
(2) Upstream Potential Site	Kampong Tuk	20m (EL. 100m ~ 80m)	499 km^2	About 1.5km

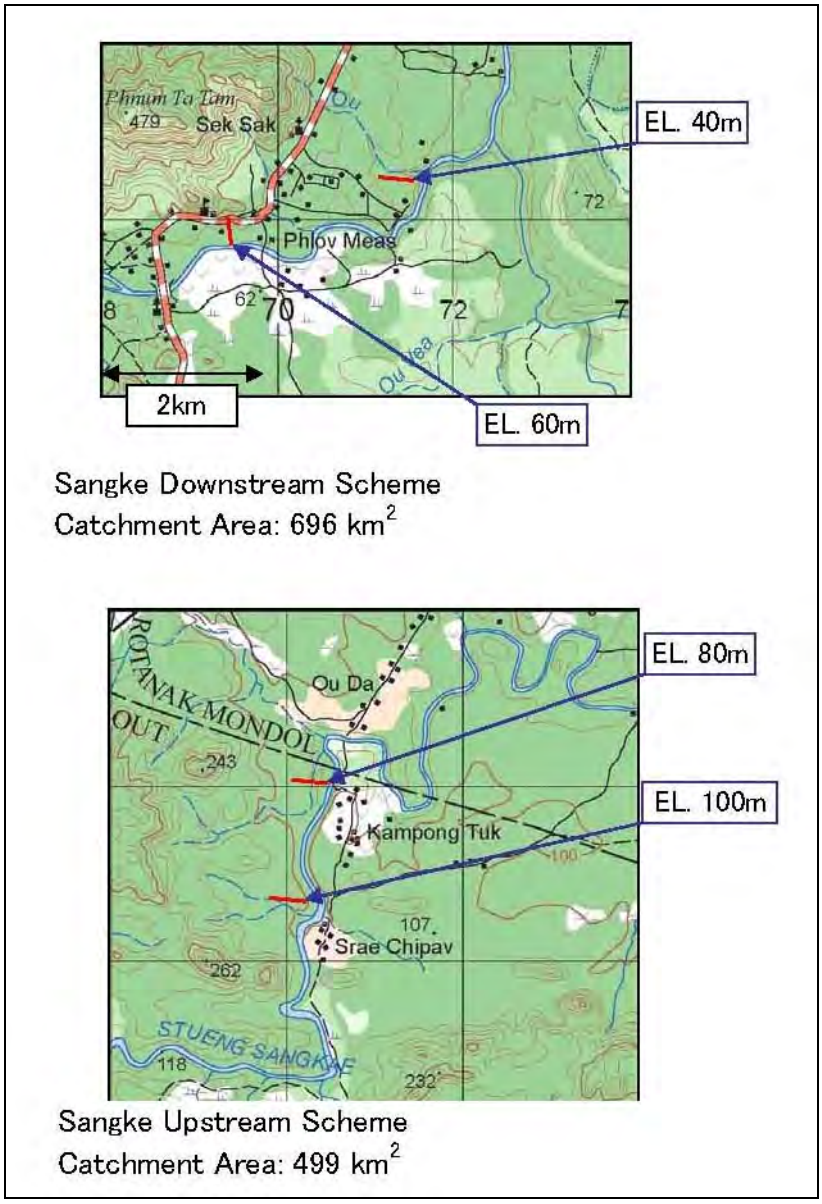


Figure 2.5 Micro Hydro Potential from the result of Map Study (Downstream Scheme and Upstream Scheme)

3.5.2 Confirmation of Potential through Field Survey

(1) Confirmation of Head by Levelling Survey (Part 1) (2nd and 3rd Field Investigation Period)

In order to confirm the result of map study, field surveys were conducted during the 2nd field investigation in February 2005 and 3rd field investigation in June 2005. Based on identified information through map study, levelling was done to confirm available head. As a result, the following differences were made clear.

	Head identified through map study	Head confirmed by levelling	Difference
Downstream Potential Site, Near Phlov Meas Village	20m	7.5m	-12.5m (-62.5%)
Upstream Potential Site, Near Kampong Tuk Village	20m	5.5m	-14.5m (-72.5%)

By applying map study results, actual potential becomes less than half of originally identified.

Until 2nd field investigation period, further potential was not identified in the downstream scheme. For upstream scheme, there supposed to be further head toward upstream of Kampong Tuk Village. Survey works were continuously conducted from Kampong Tuk Village.

During 3rd field survey, from Kampong Tuk Village another 7 to 8 km range was surveyed along riverbed using hand level. By checking heads for several series of rapids, total head accumulated more than10 m. As the area was land mine danger zone, two mine detectors with their equipment accompanied the survey team consisting of JICA study team member and MIME counter parts.

(2) Confirmation of Head by Levelling Survey (Part 2) (4th Field Investigation Period)

Further levelling survey works were conducted to confirm head between Kampong Tuk Village and upstream village of Samlout (about 8 km in total).

As a result, about 38 m head was confirmed between two villages.

In the Sangke River, in the upstream reach, both of riverbanks, especially right bank is about 20 to 30 m higher than riverbed, partially formulating cliffs. Due to such geographical conditions, not described in the map, identification of head (potential) took more than expected.

In addition, as the area is mine danger zone, only limited area, of foot path for people's daily use could be used for survey works. It is proposed to request de-mining works to CMAC (Cambodia Mine Action Center) before further detailed survey and design stage.

(3) Summary of Identified Head

Result of levelling survey from 2nd to 4th field investigation period, are as depicted in Figure 2.6. This figure shows elevation from intake candidate site (right edge) along right bank of the river toward downstream.

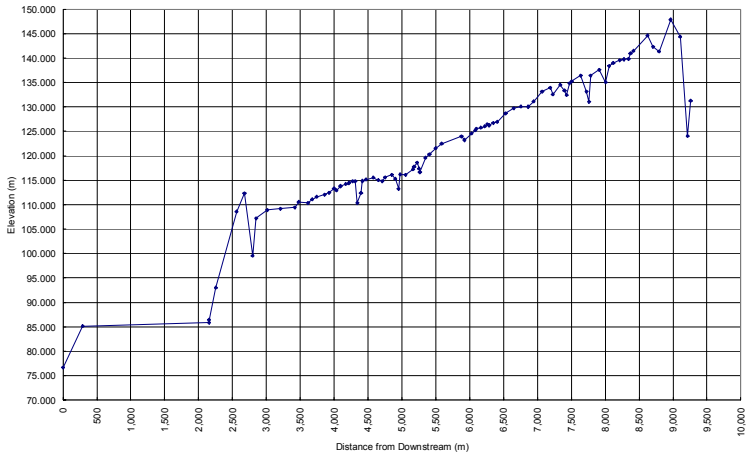


Figure 2.6 Survey Result of Sangke River

(4) Discharge Measurement

During the period from 2nd field investigation in February 2005 until December 2005 discharge measurement of Sangke River were conducted as summarized in Table 2.7.

Table 2.7 Result of Discharge Measurement of Sangke River

Date	Observed Discharge (m^3/sec)	Catchment Area (km^2)	Specific Discharge (m^3/sec./ km^2)	Converted Discharge at Intake Site (m^3/sec)
February 5, 2005	1.15	696	0.00165 (1.65 lit/sec/km km^2)	0.72
May 14, 2005	2.83	696	0.0041 (4.1 lit/sec/km km^2)	1.80
May 15, 2005	2.88	696	0.0041 (4.1 lit/sec/km km^2)	1.80
December 8, 2005	8.43	499	0.0169 (16.9 lit/sec/km km^2)	7.40

3.5.3 Water Level Measurement

On April 7, with help from MIME staffs, water level gauge was installed in Sangke River at downstream potential site near Phlov Meas Village. Catchment area at water level gauge is 696km^2. Water level record up to November 2005 is shown in Figure 2.7.

According to discharge measurement result from April to November 2005, the driest season seems to be April and May. Further measurement works will continue until February 2006.

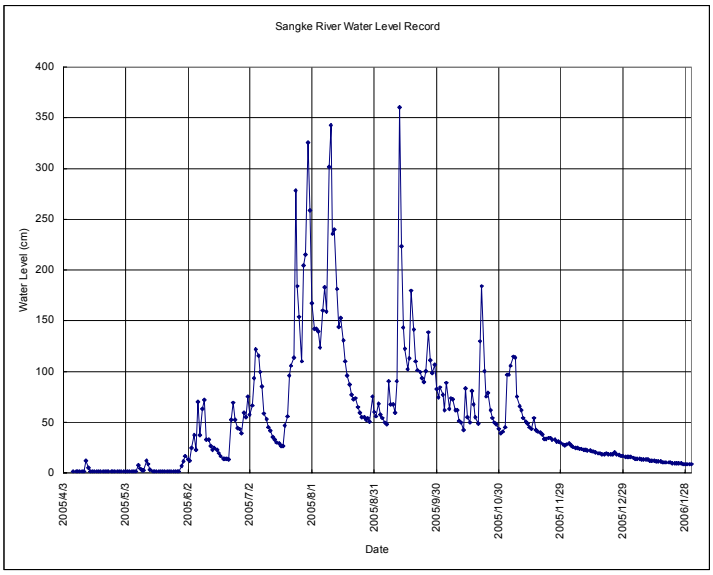


Figure 2.7 Water Level Measurement Result of Sangke River (Near Phlov Meas Village)

	
Water Level Gauge in Sangke River Installed in April 2005 (Photograph taken on December 9, 2005)	River Flow Condition at Water Level Gauge, From Left Bank Looking at Right Bank. (Photograph taken on December 9, 2005, assumed discharge: 11.7m^3/sec)

3.5.4 Evaluation on Rainfall, Dry Season Discharge, Flood, Sediment

(1) Rainfall

From isohyetal map shown in Figure 5.1.3 of Vol-1, annual rainfall of target area has annual rainfall of around 1,600 mm in downstream area and more than 2,000 mm in the upstream area.

(2) Dry Season Discharge

From water level gauge record shown in Figure 2.7, driest period is assumed to be in May. From hydrological analysis, river discharge is assumed to be 1.08 m3/sec at water level gauge point (catchment area: 696km2). By converting discharge to intake site having catchment area of 438 km2, dry season discharge at intake site is estimated as 0.68 m3/sec.

(3) Flood

From an interview with village people in Kampong Tuk Village, water level in flood season is about 5 m from riverbed. At this point, river width is about 60m. By assuming flood velocity of 3 to 5 m/sec, flood discharge is an order of 900 to 1,500 m3/sec.

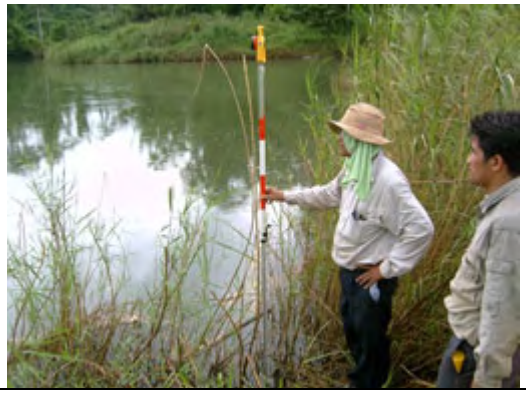
Another interview in Samlout Village near Intake Site, flood water level is 3.5 to 4 m from riverbed. At this point, river width is about 60 m. By assuming flood velocity of 3 to 5 m/sec, flood discharge is an order of 720 to 1,200 m^3/sec.

(4) Sediment

From 2nd field investigation in February 2005 up to 5th field investigation in December, 2005, totally 5 times field investigations were conducted. During these periods, river water turbidity was observed only in 4th field investigation in September. At this time, water turbidity was not so significant. Disposed rocks on the riverbed could be partially seen. For other period, there was no significant sediment transportation, wash load observed. The river discharge was so transparent as the riverbed condition could see from water surface.

As there is a deep pool of about 5 m depth just upstream of intake site, sediment inflow to intake facilities would not be a problem.

Considerations should be made on sediment inflow only for rainy season and flood season.

	
River Flow Condition Just Upstream of Intake Site,This part consists more than 5 m deep pool. (Photograph taken on September 7, 2005)	Water Turbidity in between Intake and Power Hoses Sites (Photograph taken on September 7, 2005)

3.5.5 Examination of Layout of Facilities for Micro Hydro Power Generation

From the result of levelling survey and field survey, plus counter line information from maps, layout of development plan is to be examined.

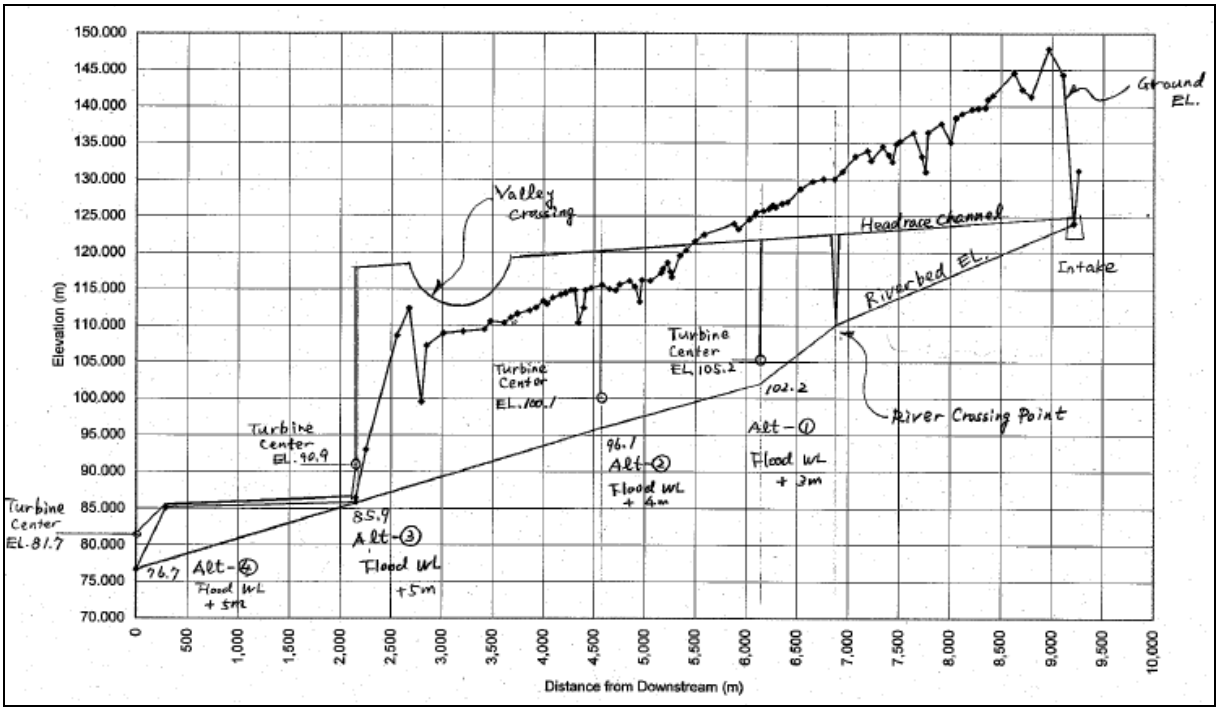


Figure 2.8 Result of Levelling Survey and Alternative Layouts of Waterway (Longitudinal Cross Section)

By setting inlet elevation at El. 125.0 m, alternative power station sites were selected from the result of field surveys. 4 locations were selected as alternative power house sites having distance from intake of 3.1 km, 4.6 km, 7.0 km and 9.2 km along levelling survey longitudinal section. For the 4th alternative having longest waterway length, countermeasures should be considered for relief of water hammer

pressure.

Comparison were made for the above four alternatives.

By estimating flood water level from the result of field survey, turbine center was decided to be above flood water level. Table 2.8 shows features of alternatives. Figure 2.9 shows alternative locations of power house in the plan.

Table 2.8 Features of Alternatives for Sangke Micro Hydro Power Station

		Altenrative-1	Altenrative-2	Altenrative-3	Altenrative-4
Intake WL	(m)	125.0	125.0	125.0	125.0
Turbine Center EL	(m)	105.2	100.1	90.9	81.7
Gross Head	(m)	19.8	24.9	34.1	43.3
Length of waterwa	(m)	4,400	5,900	8,400	10,350
Loss in waterway	(m)	4.4	5.9	8.4	10.4
Misc. Loss	(m)	0.2	0.3	0.4	0.5
Net Head	(m)	15.2	18.7	25.3	32.5
Plant Discharge	(m^3/sec)	0.8	0.8	0.8	0.8
Power Output	(kW)	83.4	102.6	138.8	178.1

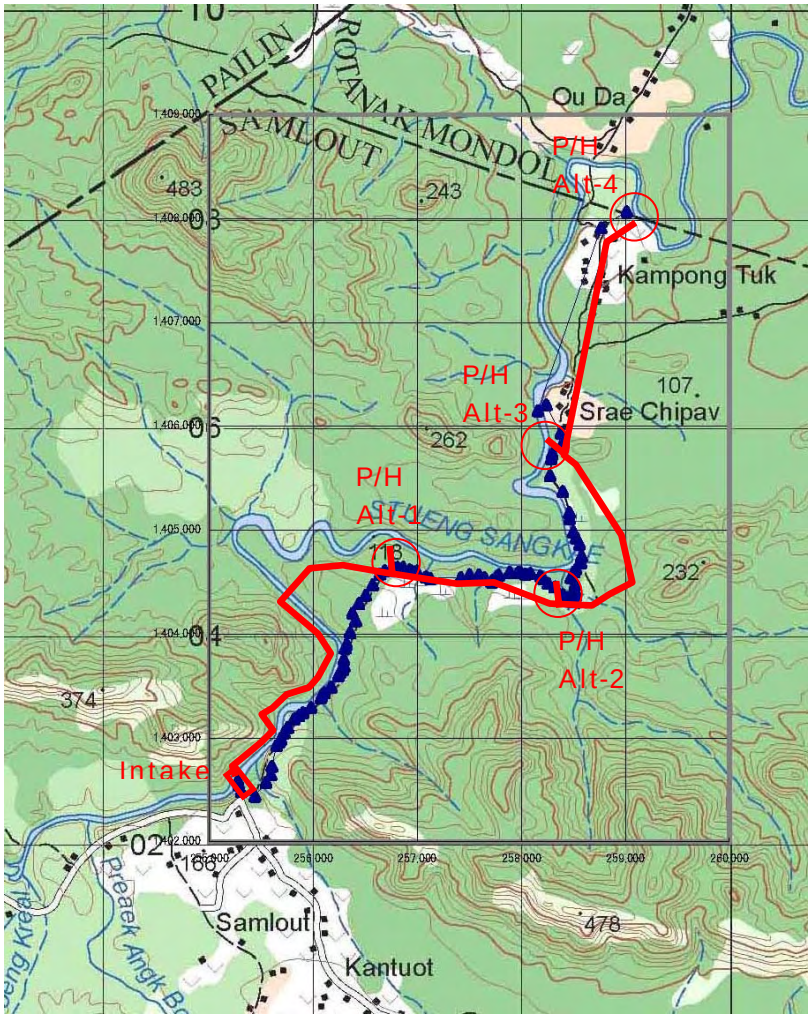


Figure 2.9 Route for Survey (blue triangle) and Waterway Layouts (red line)

Intake site was selected near Samlout Village in the upstream reach of Sangke River, where about 1 km of the proposed intake site forms deep pool, especially direct upstream consist of 5 m deep pool. Figure 2.10 shows the photographs of intake site.

Figure 2.10 Proposed Intake Site

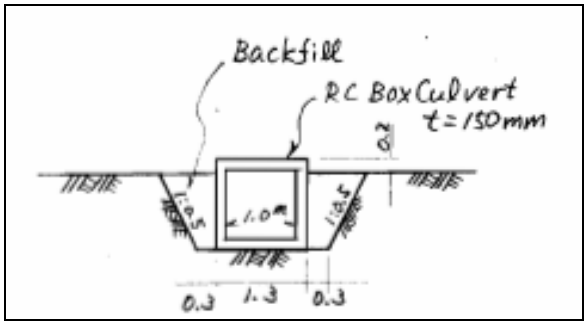


Figure 2.11 Typical Cross Section of Waterway

Waterway from intake is laid out at left bank side which has relatively gentle slope. While on the right bank, most of the parts consist of steep cliffs for about 2 km length. To install waterway on the right bank only way is to hang water pipes on the cliffs which is rather difficult for construction. Therefore, waterway goes along left bank for about 2 km with concrete channel, and crossing river with siphon, to the right bank. There seems to be a suitable place for a de-sander about 500 m from intake site. Considering sediment conditions described in the preceding section, de-sanding seems to be enough only for rainy and flood season.

After waterway crosses Sangke River to right bank, relatively flat land continues. Several parts crossing small streams will be constructed by pipe installation. Most of the waterway parts will be constructed by applying concrete box culvert with reinforcement bar. Typical cross section is as shown in Figure 2.11.

3.5.6 Comparison of Alternative Layouts

Comparisons were made for four alternative layouts.

Work quantities for alternatives were estimated based on “Guide Manual for Development Aid Program and Studies of Hydro Electric Power Projects” by NEF.

Alternative costs are as shown in Table 2.9

Table 2.9 Work Quantity by Work Items

Work Item	Unit	Alternative-1 Waterway Length= 4.4 km	Alternative-2 Waterway Length= 5.9 km	Alternative-3 Waterway Length= 8.4 km	Alternative-4 Waterway Length= 10.4 km
Excavation	m^3	25,231	30,724	35,964	37,886
Embankment/Backfill	m^3	14,953	17,683	21,169	23,416
Mass Concrete	m^3	1,124	5,693	6,126	5,854
Structural Concrete	m^3	3,523	4,569	5,002	4,730
Reinforcement Bar	ton	275.09	359.61	394.32	531.73
Gate & Screen	ton	2.72	2.72	2.72	2.72
Pipe	m	400.00	400.00	2,300.00	4,300.00
Turbine & Generator	kW	85.0	105.0	140.0	180.0

Based on above work quantity, construction costs for four alternatives are calculated using unit prices shown in part 1 of this volume.

Table 2.10 (1) Cost Estimate for Alternative-1

Construction Cost Estimate <Alternative-1> Waterway: 4.4km

Work Item	Unit		Unit Price	
Excavation	m^3	25,231	5	126,155
Embankment/Backfill	m^3	14,953	6	89,718
Mass Concrete	m^3	1,124	80	89,920
Structural Concrete	m^3	3,523	130	457,990
Reinforcement Bar	ton	275.09	700	192,563
			Sub-total	956,346
Civil Works Contingency (20% of above sub-total)				191,269
			Sub-total of Civil Works	1,147,615
Gate & Screen	ton	2.72	1200	3,264
Pipe (HDPE OD:630mm	m	400.00	138	55,200
Turbine & Generator	kW	85.0	660	56,100
			Sub-total	114,564
			Total	1,262,179
			Kilo watt cost ($/kW)	14,849

Table 2.10 (2) Cost Estimate for Alternative-2

Construction Cost Estimate <Alternative-2> Waterway: 5.9 km

Work Item	Unit		Unit Price	
Excavation	m^3	30,724	5	153,620
Embankment/Backfill	m^3	17,683	6	106,098
Mass Concrete	m^3	1,124	80	89,920
Structural Concrete	m^3	4,569	130	593,970
Reinforcement Bar	ton	359.61	700	251,727
			Sub-total	1,195,335
Civil Works Contingency (20% of above sub-total)				239,067
			Sub-total of Civil Works	1,434,402
Gate & Screen	ton	2.72	1200	3,264
Pipe (HDPE OD:630mm	m	400.00	138	55,200
Turbine & Generator	kW	105.0	660	69,300
			Sub-total	127,764
			Total	1,562,166
			Kilo watt cost ($/kW)	14,878

Table 2.10 (3) Cost Estimate for Alternative-3

Construction Cost Estimate <Alternative-3> Waterway: 8.4 km

Work Item	Unit		Unit Price	
Excavation	m^3	35,964	5	179,820
Embankment/Backfill	m^3	21,169	6	127,014
Mass Concrete	m^3	1,124	80	89,920
Structural Concrete	m^3	5,002	130	650,260
Reinforcement Bar	ton	394.32	700	276,024
			Sub-total	1,323,038
Civil Works Contingency (20% of above sub-total)				264,608
			Sub-total of Civil Works	1,587,646
Gate & Screen	ton	2.72	1200	3,264
Pipe (HDPE OD:630mm	m	2,300.00	138	317,400
Turbine & Generator	kW	140.0	660	92,400
			Sub-total	413,064
			Total	2,000,710
			Kilo watt cost ($/kW)	14,291

Table 2.10 (4) Cost Estimate for Alternative-4

Construction Cost Estimate <Alternative-4> Waterway: 10.4 km

Work Item	Unit		Unit Price	
Excavation	m^3	37,886	5	189,430
Embankment/Backfill	m^3	23,416	6	140,496
Mass Concrete	m^3	1,124	80	89,920
Structural Concrete	m^3	4,730	130	614,900
Reinforcement Bar	ton	531.73	700	372,211
			Sub-total	1,406,957
Civil Works Contingency (20% of above sub-total)				281,391
			Sub-total of Civil Works	1,688,348
Gate & Screen	ton	2.72	1200	3,264
Pipe (HDPE OD:630mm	m	4,300.00	138	593,400
Turbine & Generator	kW	180.0	660	118,800
			Sub-total	715,464
			Total	2,403,812
			Kilo watt cost ($/kW)	13,355

Unit generation costs for four alternatives are summarized as shown in Table 2.11.

Table 2.11 Comparison of Unit Generation Cost for Four Alternatives

	Alternative-1 Waterway: 4.4 km	Alternative-2 Waterway: 5.9 km	Alternative-3 Waterway: 8.4 km	Alternative-4 Waterway: 10.4 km
Construction Cost（$）	1,262,179	1,562,166	2,000,710	2,403,812
Power Output（kW）	85.0	105.0	140.0	180.0
Unit Generation Cost（$/kW）	14,849	14,878	14,291	13,355

From above table, Alternative-4 with the largest installed capacity of 180 kW has the lowest unit generation cost. To maximize the role of micro hydro power station as 24 hour electricity supply, in wide-area mini-grid, the largest installed capacity should be considered for development. Further, it is rather difficult to expand installed capacity in the future for micro hydro, installation with possible largest capacity is recommendable. More detailed alternative study considering daytime demand should be made in the next stage.

3.6 OU SAMREL BIOMASS POWER STATION

Ou Samrel Biomass Power Plant is to supply electricity to the whole Samlout regional mini-grid. In the 1st phase, 774 households are to be electrified by biomass gasification power with 120 kW installed capacity.

3.6.1 Biomass Fuel Supply

Tree farming will be conducted by CEC members for fuel wood production. Farmed fuel wood will be purchased by CEC. Appropriate purchasing price is assumed to be around $20/t. In Samlout District, grassland and shrubland per household differs commune to commune and it varies from 0.36 ha/household to 5.85 ha/household. All commune have much more than required land for tree planting for supplying enough fuel wood for commune based electricity generation. In case of Samlout project, Ou Samrel or Ta Sanh Commune is proposed to generate electricity for whole district. Total required land for tree planting is 87 ha. There is 2179 ha grassland and shrubland in Ta Sanh and 281 ha in Ou Samrel Commune. Both commune have enough land and fuel wood can be produced outside of commune as well. Average annual rainfall in Battambang between 1985 and 2001 was 1288 mm (JICA 2005). Most of fast growing tree species commonly planted for wood chip and fuel wood production in tropical region is likely to grow moderately under such amount of annual precipitation. Minimum 10 t/ha/year biomass production is assumed to be obtained. Following tree species are recommended for planting.

Short term coppicing wood production in and around gardens: Leucaena leucocephala, Gliricidia sepium (Leguminosae)

Longer term stem wood production: Acacia spp. (Leguminosae), Eucalyptus spp. (Myrtaceae), Casuarina equisetifolia (Casuarinaceae)

3.6.2 Construction Cost for Biomass Gasification Power Station

Construction cost for power generation facilities for biomass gasification is estimated based on an installed capacity. 5% of contingency is considered. Construction cost for each phase is as follows.

Table 2.12 Construction Cost for Biomass Gasification Power Plant for Each Phase

（Unit: US$）

	1st Phase	2nd Phase	Total
Power Generation Facilities	329,200	1,253,200	1,582,400
Distribution Facilities	229,800	1,112,200	1,342,000
Total	559,000	2,365,400	2,924,400

Details are given in Appendix-H

Source: JICA Study Team

3.7 DISTRIBUTION LINE

Electrification is done in two stages as described below.

Figure 2.12 shows distribution line layout and for the 1st phase and the 2nd phase.

<1st Phase>

1) Construction of Ou Samrel Biomass Gasification Power Station (Installed Capacity: 120 kW)
2) Construction of Medium Voltage Line (Total Length: 10 km)

<2nd Phase>

1) Construction of Sangke Micro Hydro Power Station (Installed Capacity: 180 kW)
2) Construction of Additional Medium Voltage Line (Total Length: 76.5 km)
3) Expansion of Ou Samrel BGP Station (Additional Installed Capacity: 282 kW)

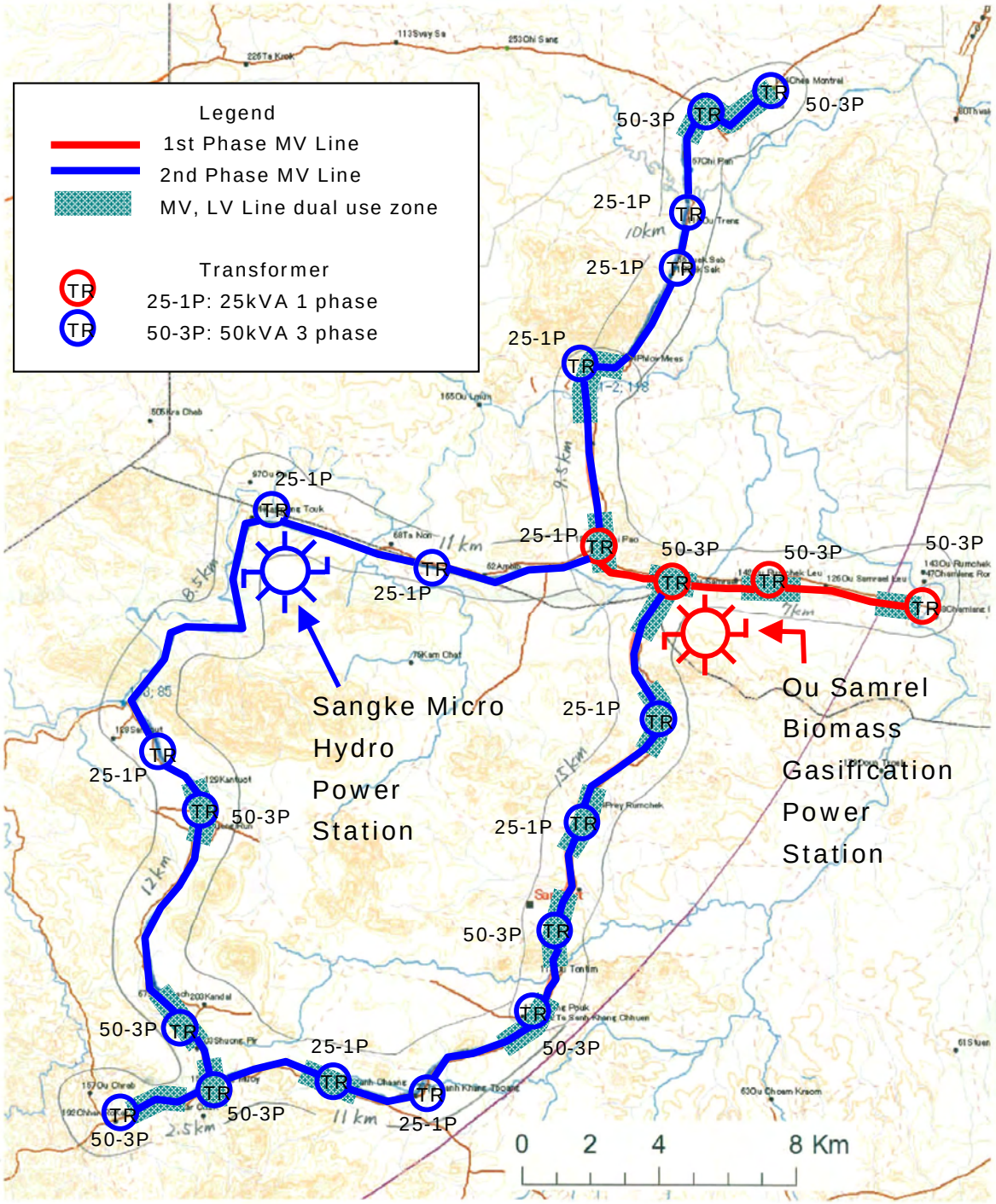


Figure 2.12 Layout of Power Stations, Medium Voltage Lines, and Transformers for Samlout Electrification Plan

For those areas where household distribution is dense along trunk road, MV Lines and LV Lines will use the same transmission pole (dual use) to save costs (as shown in Figure 2.12 as marked in green). For the size of transformer, typical type of 25 kVA and 50 kVA were selected considering the number of households to be electrified. In case village demand size is relatively large as daytime demand is expected, three-phase transformer is adopted.

For the 2nd phase electrification area, review and re-estimate of demand and modify the number of transformers, distribution area etc. Low voltage line, is constructed by REE or CEC and after getting distribution license from EAC, they can supply electricity to people who need electrification.

3.8 COST ESTIMATE

3.8.1 Overall Cost Estimate for Electrification

By applying unit cost shown in Part 1, construction costs are estimated as follows.

Table 2.13 Construction Cost by Phases

	1st Phase	2nd Phase	Total
Biomass Gasification Power	$559,000	$2,365,400	$2,924,400
Micro hydro Power	-	$2,403,800	$2,403,800
Total	$559,000	$4,769,200	$5,328,200

3.8.2 Annual Operation and Maintenance Cost

(1) 1st Phase Development

1) Operation and Maintenance Cost of Biomass Gasification Power Station (Installed Capacity: 120 kW)

Operation and Maintenance cost for biomass gasification power station is estimated as follows. Details are given in Appendix-H.

a) Operation and Periodical Maintenance Cost

Operation Cost for engine generator and gasifier was estimated as shown in Table 2.14.

Table 2.14 Annual Operations and Maintenance Cost for 1st Phase Biomass Gasification Power Station

	Work Items	Cost
1	Personnel costs for CEC staff (Salary for operators etc.)	$3,240
2	Maintenance costs of gasifier and engine generator	$13,410
	Total	$16,650

b) Fuel Cost

For the 1st phase development, planned electricity supply amount of 298 MWh per year is fully supplied by biomass. Estimated fuel cost is calculated as follows.

298 MWh × 0.03 $/kWh × 1,000 = $8,943

Therefore, annual operations and maintenance cost will be as follows.

Table 2.15 Annual Cost for 1st Phase Biomass Gasification Power Station

Item	Annual Cost
Operations and Maintenance Cost	$16,650/year
Fuel Cost	$8,943/year
Total	$25,593/year

2) Operations and Maintenance Cost for Distribution Lines, Transformers

Major works for maintenance of distribution lines are to cut leaves or branches of trees, or glass which may touch and cause electrical problem. Such works should be done before and after rainy season. In case of operation by CEC, such works can be done by community's work force contribution. For estimate purpose, maintenance cost is tentatively calculated as 0.5% of construction cost, referring to samples in other developing countries.

$131,397 × 0.5% = $657/year = $700/year (rounded-up)

(2) 2nd Phase Development

1) Operations and Maintenance Cost for Micro Hydro Power (MHP) Station (Installed Capacity: 180 kW)

Operations and maintenance cost for MHP station is estimated as follows.

Table 2.16 Annual Operations and Maintenance Cost for 2nd Phase Micro Hydro Power Station

	Work Item	Cost Breakdown	Cost
1	Periodical Maintenance for Whole Power Station	2 persons, Once a year, $500/time	$500
2	Operator's Salary	4 persons x $40 x 12 months	$1,920
3	Maintenance of Civil Structures	$60 x 12 months	$720
		Total	$3,140/year
		Rounded up	$3,200/year

2) Operations and Maintenance Cost for BGP Station after 2nd Phase Development

Annual operation and maintenance cost for BGP after 2nd phase development is estimated as follows.

a) Operations and Maintenance Cost

Operations cost for engine generator and gasifier is estimated including 1st phase cost as follows.

Table 2.17 Annual Operations and Maintenance Cost for 1st and 2nd Phases Biomass Gasification Power Station

	Work Items	Cost
1	Personnel costs for CEC staff (Salary for operators etc.)	$14,280
2	Maintenance costs of gasifier and engine generator	$65,010
	Total	$16,650

b) Fuel Cost

After 1st and 2nd phase development, estimated electricity supply amount is 1,642.4 MWh per year.

Operation of MHP station should be maximized to save fuel cost for biomass, as far as necessary river discharge is available. Therefore, electricity supply by BGP is calculated as total demand minus supply amount by MHP. For dry season period from January to May, there would be a shortage of river discharge for MHP power generation. During such period, river course storage would be considered for night time power generation. For rainy season, MHP can operate for 24 hours a day.

Above operation rules are applied, however, to estimate fuel cost, usage ratio of 30% for micro-hydro, and 70% for biomass are applied for calculation. Thus, electricity supply by biomass is calculated as follows.

1,625.8 MWh x 70% = 1,138.1 MWh

From above, electricity supply by BGP is estimated to be 1,138.1 MWh, and fuel cost would be as follows.

1,138.1 MWh x 0.03 $/kW x 1,000 = $34,143

Annual operations and maintenance cost is as follows.

Table 2.18 Annual Operations and Maintenance Cost for BGP for 1st and 2nd Phases

Item	Annual Cost
Operations and Maintenance Cost	$79,290/year
Fuel Cost	$34,143/year
Total	$113,433/year

3) Operations and Maintenance Cost for Distribution Lines, Transformers

Annual operation and maintenance cost, for distribution lines and transformers installed up to 2nd phase, is tentatively calculated as 0.5% of construction cost, referring to samples in other developing countries as follows.

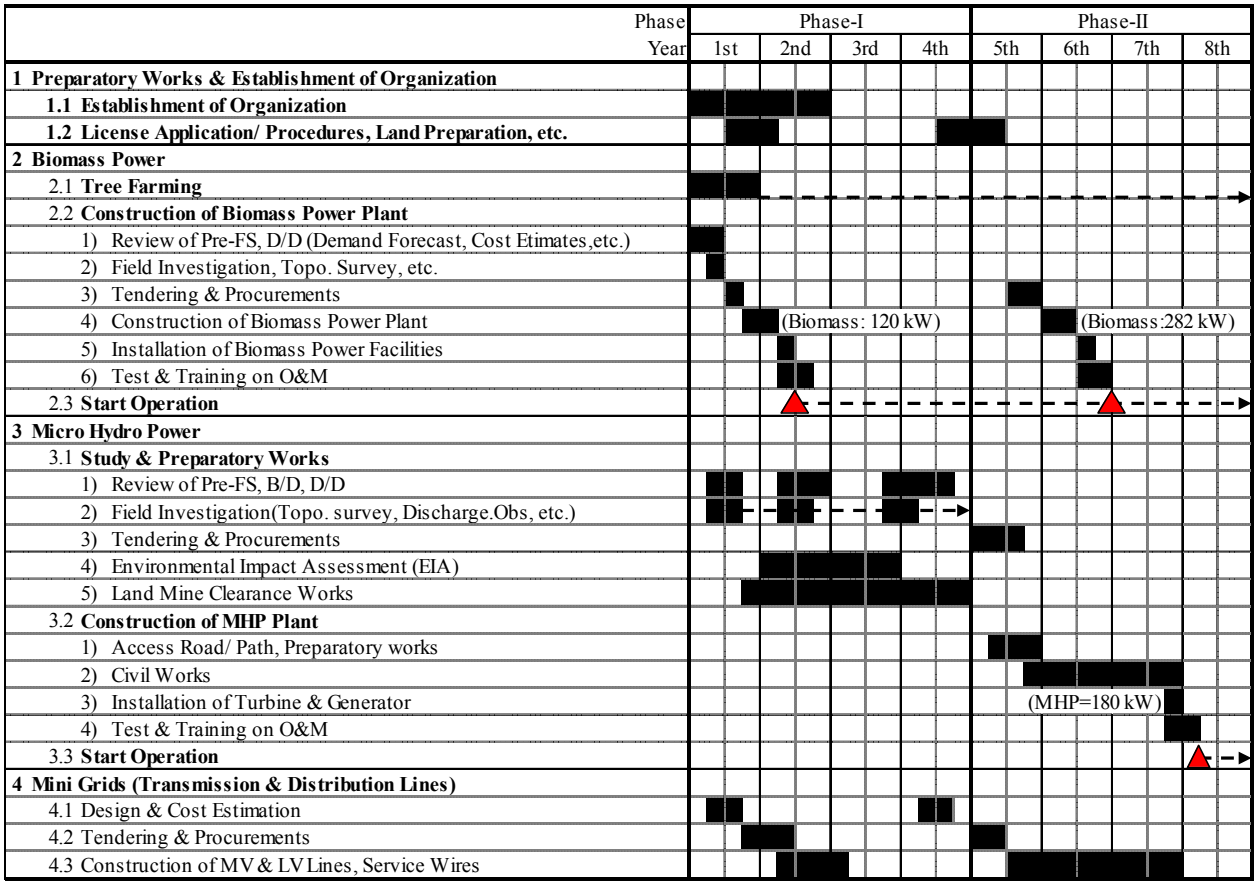
$1,396,620 x 0.5% = $6,983/year = $7,000/year (rounded-up)

Table 2.19 Operations and Maintenance Cost for 1st and 2nd Phase Distribution Lines and Transformers

Phase	Construction Cost	O & M Cost (0.5% of Const. Cost)
1st Phase	$131,397	$900/year
2nd Phase	$790,356	$4,000/year
Total	$921,753	$4,900/year

3.9 CONSTRUCTION SCHEDULE

Figure 2.13 shows Proposed Construction Schedule of Samlout Electrification Plan for 1st and 2nd Phases.



(Prepared by JICA Study Team)

Figure 2.13 Proposed Construction Schedule of Samlout Electrification Plan for 1st and 2nd Phases

4. ECONOMIC AND FINANCIAL EVALUATION, TARIFF SETTINGS

To evaluate benefits for 1st and 2nd phases, costs of alternative diesel power plant for supplying the estimated electricity amount are calculated. Economical and financial evaluation results are summarized as follows. Details are given in Appendix-H.

	EIRR	FIRR	Tariff
1st Phase	27.4%	5.6%	$0.335/kWh
1st and 2nd Phases	26.0%	5.6%	$0.305/kWh

For 1st and 2nd phases case, it was assumed that all target households be electrified by biomass. In case of micro-hydro and biomass hybrid, EIRR becomes rather low as 8%. However, it is recommendable to develop as hybrid scheme, because micro-hydro can easily correspond to fluctuation of load.

Table 2.20 Calculation Result of Economic Analysis for Samlout Electrification Scheme

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	19	20	21	22	29	30	Total
(Economic costs)																				
Initital costs																				
Economic costs	447,976											178,308				178,308				804,592
Supports to CEC	22,275	7,425																		
Operation and maintenance costs	0	7,348	12,028	13,672	14,682	15,794	17,016	17,804	17,968	17,968	17,968	17,968	17,968	17,968	17,968	17,968	17,968	17,968	17,968	
Personenel costs		2,916	2,916	2,916	2,916	2,916	2,916	2,916	2,916	2,916	2,916	2,916	2,916	2,916	2,916	2,916	2,916	2,916	2,916	87,480
O&M of biomass gasification power plant		3,685	7,909	9,393	10,305	11,308	12,412	13,123	13,271	13,271	13,271	13,271	13,271	13,271	13,271	13,271	13,271	13,271	13,271	373,369
Maintenance of distribution lines, etc.		350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	10,500
Biomass fuel cost		397	853	1,013	1,111	1,219	1,338	1,415	1,431	1,431	1,431	1,431	1,431	1,431	1,431	1,431	1,431	1,431	1,431	40,257
EAC license fee @ Riel 1.6/kWh		27	58	69	76	83	91	96	98	98	98	98	98	98	98	98	98	98	98	2,745
Monitoring of CEC by DIME		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residual value											-17,831				-17,831				-44,798	-80,459
Total expenditure	470,251	14,800	12,086	13,741	14,758	15,877	17,107	17,901	18,065	18,065	235	196,373	18,065	18,065	235	196,373	18,065	18,065	-26,732	1,268,183
(Economic benefits as costs of alternative diesel mini-grid)																				
Initital costs																				
Economic costs	305,374											91,308				91,308				487,990
Supports to CEC	22,275	7,425																		
Operation and maintenance costs	0	21,725	43,262	50,828	55,477	60,591	66,217	69,842	70,596	70,596	70,596	70,596	70,596	70,596	70,596	70,596	70,596	70,596	70,596	
Personenel costs		2,592	2,592	2,592	2,592	2,592	2,592	2,592	2,592	2,592	2,592	2,592	2,592	2,592	2,592	2,592	2,592	2,592	2,592	77,760
O&M of diesel power plant		1,651	3,545	4,210	4,619	5,068	5,563	5,881	5,948	5,948	5,948	5,948	5,948	5,948	5,948	5,948	5,948	5,948	5,948	167,334
Maintenance of distribution lines, etc.		350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	10,500
Fuel cost		17,132	36,776	43,676	47,916	52,581	57,712	61,019	61,706	61,706	61,706	61,706	61,706	61,706	61,706	61,706	61,706	61,706	61,706	1,736,053
EAC license fee		27	58	69	76	83	91	96	98	98	98	98	98	98	98	98	98	98	98	2,745
Payment for technical supports		2,304	2,304	2,304	2,304	2,304	2,304	2,304	2,304	2,304	2,304	2,304	2,304	2,304	2,304	2,304	2,304	2,304	2,304	69,120
Residual value											-9,131				-9,131				-30,537	-48,799
Benefits from CER sales		685	1,470	1,745	1,915	2,101	2,306	2,439	2,466	2,466	2,466	2,466	2,466	2,466	2,466	2,466	2,466	2,466	2,466	69,381
Total benefits	327,649	32,166	47,094	54,946	59,772	65,080	70,918	74,682	75,463	75,463	66,333	166,771	75,463	75,463	66,333	166,771	75,463	75,463	44,926	2,601,783
(Net benefits)	-142,602	17,366	35,008	41,205	45,013	49,203	53,811	56,781	57,398	57,398	66,098	-29,602	57,398	57,398	66,098	-29,602	57,398	57,398	71,658	1,333,600
EIRR	**27.4%**																			

(Prepared by JICA Study Team)

By using economic costs for the development and economic costs for alternative diesel, economic evaluation was made for 1st phase development. As a result of economic analysis, Economic Internal Rate of Return (EIRR) shows as high as 27.4%, which means that this project has high economic viability.

As for financial analysis, by assuming tariff level at $0.335/kWh, Financial Internal Rate of Return (FIRR) becomes 5.5%. This tariff level was calculated based on 25% subsidy.

5 ENVIRONMENTAL CONSIDERATIONS

For the environmental considerations, JICA's Environmental Guidelines and Checklist has been used for defining project Category (A,B or C) and conducting the environmental assessment. On the other hand, "Annex of Sub-Decre No.72 ANRK. BK." dated August 11, 1999, that is the "List of the Project Require an IEIA and/or EIA", and other concerned environmental regulations of the MOE of Cambodia have also been referred and applied.

It is also noted here that formal guidelines for preparing an Initial Environmental Impact Assessment (IEIA) Reports have not been defined by the MOE. Therefore, the IEIA of the project schemes has been conducted based on the requirements of "Guideline for conducting Environmental Impact assessment (EIA) Report" stipulated by the "Prakas on Guidelines for preparing EIA Report", No.49 BST.SSR dated March 9, 2000.

Samlout Electrification Project (the Project) is a hybrid project which will be composed of Sangke MHP and Ou Samrel biomass power plants. Environmental assessments have been conducted for the both power projects. The results of the environmental screening and the IEIA are described in detail below.

5.1 ENVIRONMENTAL SCREENING FOR SANGKE MHP PROJECT

Table 2.21 shows the details and results of the environmental screening for the Sangke MHP project. Key results and findings of the environmental screening are summarized below.

(1) Considering the following factors, carrying out IEIA(IEE) will be required.

i) The upstream candidate project site will be located at the boundary of Samlot Protected Area (Protected Landscape).

ii) Therefore, it is judged that the project belongs to Environmental Category B of "JICA Guidelines for Environmental and Social Consideration". Considering both the JICA Guidelines and also the MOE environmental regulations, carrying out an IEIA will be required for the MHP project.

Project owner/implementing organization will have to conduct the IEIA and/or EIA and prepare the reports for submittal to the MOE for review and approval.

(2) Details of results and findings of the Environmental Screening

1) Potential natural and social environmental impacts

a. Sangke MHP project site will be located at the boundary of a Protected Landscape (area of the Protected Landscape is about 60,000 ha) designated by the MOE. Because the project will be a micro-hydro power and will utilize underground waterway, there will be no impact to the Protected Landscape. On the other hand, through interview conducted on September 6, 2005 with representatives of concerned Commune, villagers and the forest ranger of a NGO, it was known that there are no any protected wildlife inhabited or found in the project area. Therefore, it can be concluded that there will be no negative impacts to be caused on the wildlife, nor to ecological system of the project site area.

b. Because this is a MHP project, there will be no negative impacts to the air and water quality in and around the project site area.

c. There will be no negative impacts to groundwater of the project area and its vicinity.

2) Environmental issues in connection with the plant design and construction activities

a. Because water intakes for irrigation along the river section between the power plant intake weir and the power house are not existing, there will be no negative impacts to the agriculture of the project site and its vicinity.

b. Because a small scale weir and underground waterway will be used, there will be no negative impact to the landscape of Sangke MHP project site area.

c. There will have the following positive impacts to the villagers in and around the project site.

i) Electrification of the rural area

ii) Create employment opportunity for the villagers as labor force during plant management, operation and maintenance

iii) Create business opportunity to the villagers during project construction

d. Turbid river water and dust could be generated by construction work. Minimize river bed work to avoid high turbidity of the river water. Generating dust will be minimized by spraying water.

3) Potential environmental impacts during plant operation

a A water reduction section could be generated in the river section between the weir and the power house, if little water would be flown in the river during dry season. Drying out the river section would have negative impacts to flora and fauna in the section area. To protect wildlife and ecology, keep at least 10% of the river flow as of the end of dry season to avoid drying out the water reduction section.

b In spite of protected/rare wildlife not being found in the project site area and its vicinity, a certain protection measure, such as barrier fence/nets, will be set around outdoor electrical equipment and distribution facilities, where necessary, to protect wildlife against suffering electric shock.

c There will be no negative impacts to agriculture of the project site area and its vicinity.

5.2 ENVIRONMENTAL SCREENING FOR SAMLOUT BIO-MASS POWER PROJECT

Table 2.22 shows the details and results of the environmental screening of Ou Samrel Biomass Power Project. Key results and findings of the environmental screening are summarized below.

(1) Considering the following three factors, carrying out IEIA will not be required.

1) The project will belong to Category C of JICA Environmental Guidelines.

2) The project output capacity will be 402kW is less than the limit which will need IEIA or EIA defined by the MOE (5MW).

3) The bio-mass project site will be located outside of any Protected Area designated by the MOE.

Therefore, only the environmental screening result will be enough for the project.

Based on the new Decree of the MOE regarding environmental regulatory reform, the project owner/implementing organization will have to make project license application to the concerned Province, if the project cost will be less than 2 million US dollars. For the application, it is considered that IEIA will not be needed.

(2) Details of results and findings of the Environmental Screening

1) Potential natural and social environmental impacts

a The project site area is located outside of any Protected Area. Through interviews conducted on September 6, 2005 with the representatives of concerned Communes and some villagers, it was known that there are no any protected wildlife inhabit in the project area. Therefore, it is concluded that there will be no negative impacts to be caused on the wildlife, nor to ecological system of the project site area.

b About 112 ha fuel tree farming land in total will be required for the bio-mass project. Acquiring the land might cause conflicts with interests of the land owners. Project owner will have to acquire the land which will not cause such conflicts. During the interview conducted with the Secretary of the Commune Chief of Sung Commune, he expressed that there will be about 100 ha land available by the Commune for the project. Therefore, the project proponent/owner should consult again with the concerned Commune in advance for the land acquisition.

c Because this is a small scale project, there will be no negative impacts to the air and water quality in and around the project site area.

d There will be no negative impacts to groundwater of the project area and its vicinity.

2) Environmental issues in connection with the plant design and construction activities

a There will be no negative impacts to the agriculture of the project site and its vicinity.

b There will have the following positive impacts to the villagers in and around the project site.

i) Electrification of the rural area

ii) Create employment opportunity for the villagers as labor force source

iii) Create business opportunity for villagers during construction.

c Dust generation could be generated by construction work. Generating dust will be minimized by spraying water.

3) Potential environmental impacts during plant operation

a In general, illegal logging of outside forests or purchase of large amount of fuel wood from market might be happened when fuel wood would become insufficient. All of fuel wood needed for the project will be planted, and supplemental fuel wood trees will be in store. In order to assure the fuel wood supplying plan to be implemented well, preparation of the power plant operational management rules will be required. By positive implementation of the fuel wood trees planting program, and securing the supplemental fuel wood in storage by whole concerned villages, negative impacts to the forests surrounding the project area can be avoided.

b A certain amount of air polluting fine particles could be generated from the power plant. The amount would be much less than the case of D/G plants. However, using some kind of dust filter is recommended if such fine particulates would become more than expected. To avoid air pollution to be caused to the villages by such fine particulates, the power plant site will be located far away from the residential areas of the villages.

c A certain amount of liquid waste could be generated during plant operation. For the liquid waste, will conduct closed cycle treatment before being discharged to outside environment.

d There will be no negative impacts to agriculture of the project site area and its vicinity.

5.3 INITIAL ENVIRONMENTAL IMPACT ASSESSMENTS (IEIA) FOR STUNG SANGKE MHP PROJECT

(1) Project Summary

Sangke MHP and Ou Samrel Biomass Power Hybrid Project (the Project) will be located at Rotanak Mondol, Samlout Districts, Battambang Province. Sangke MHP will have output capacity of 180kW. In the same site area, there will be a biomass power plant, which will have output capacity of 402 kW. The Project in total will provide electricity to 4,216 households. It is about 80% of the total households in the Districts.

It is noted that Sangke MHP site will be located at the boundary of a Protected Area called Samlout (Protected Landscape). Because of utilizing a small scale weir and a underground waterway, there will be no impacts on the landscape of the site area and its vicinity.

Through various investigations and studied as mentioned above, it is clear that the project will be within the framework of Cambodia's national and international environmental laws and legislation standards.

(2) Purpose of the Project

The purpose of the Project, including the bio-mass plant project, will be to supply electricity to 4,216 households (HHs) in the Samlout Districts. It is about 80% of total number of HHs.

(3) Project Description

- Project alternatives:

There are many rural areas which need electricity in Battambang Province. Through careful study by using GIS, it was found that there are about six(6) MHP potential sites for rural electrification.

Considering the demand size, investment efficiency, possible extension of electric distribution line and accessibility of site area for construction machinery, etc., the Project has been selected.

- Details of the quantity and quality of wastes to be disposed will have to be estimated under feasibility of the project.

(4) Description of Environmental Resources

a Physical resources

1) Because of no any pollutant sources such as industrial facilities being existed, air quality of the project site area and its vicinity is very good. The climate in Cambodia is tropical and the climate condition of the project site area is similar to other places in the country in average, i.e. there are a wet season and a dry season in a year. The wet season starts from June until the end of October. Other months are in dry season.

2) Same as the case of air quality, water quality of river water quality is in good condition. At this moment, there is no any existing data available. Because this is a micro-hydropower project and using closed cycle liquid waste treatment system for the bio-mass power plant, any negative impact to water quality is not anticipated

3) Through field survey and interviews with the villagers, it was known that there are no any protected wildlife being inhabited or found in the project site area and its vicinity.

4) Most of the forests existing in the site area and its vicinity are secondary forests (about 80%).

b Socio-economical resources

1) As of September 6, 2005, total population of concerned 4 Communes (Ou Samrel, Tashanh, Sung and Samlout Communes) is 19,826. Total number of households is 4,146. There are no minority people living in the concerned Communes.

2) In Ou Samrel Commune, all households have batteries. There are 2 BCS in the Commune. In Tashanh Commune, only about 20% HHs have batteries. There are one D/G for supplying electricity to about 40 HHs. In Sung Commune, about 80% HHs are using batteries. There are 2 BCS. In Samlout Commune, about 80% HHs are using batteries. There are 50 BCS.

3) Through discussions with the representatives of the Communes, most of the housing lots are private lands and have been entitled with their land ownership.

4) In Ou Samrel Commune, there is one Health Center. There are 5 health care takers. In Tashanh Commune, There is one Health Center, with about 30 caretakers including nurses. In Sung Commune, there is no Health Center. In Samlout Commune, there is one Health Center, with 13 care takers and nurses.

5) In Ou Samrel Commune, there are 6 primary schools, but no Junior high school. In Tashanh Commune, there are 11 primary school and one junior high school. In Sung Commune, there are 4 primary school and one junior high school. In Samlout Commune, there are 6 primary school, but no junior high school.

6) For the 4 Communes, average monthly income of a household is about US$26/hh/month. of which the main income source is agriculture. About 80% of income is from agriculture. Main crops are rice and beans. Breeding pigs and poultry is for self-sufficiency. Motorcycle taxi service is also a source of income.

(5) Public Participation

1) For the purpose of natural and socio-economic field survey and also for consultations with concerned villagers, a DIME engineer, a MOE staff member and JICA Study Team members visited the concerned Communes. During the visit, they conducted interviews with the representatives of the Communes and villagers. Through the interviews, it was known that they all need more reliable electricity for the villages. On the other hand, improvement of communication road and water supply are also essential.

2) There is a NGO carrying out a project called "Maddox Jolie Project". Through consultations with the NGO conducted during the Pre-FS stage, mutual cooperation has been confirmed. Before implementing the Project, it is desirable to make adjustment between the Project and most current conditions of the rural development plan of the NGO to maximize synergy effect.

(6) Initial Environmental Impact Analysis

1) Potential natural and social environmental impacts

a. Sangke MHP project will be located on the boundary of a Protected Landscape area. The Stung Sangke River to be used for the project is the boundary of this protected area. To avoid impacts to the protected landscape, the waterway will be installed underground along the right bank of the river, which is outside of the protected area.

b. To maintain ecological environment of the river, the "minimum maintaining flow" will be kept to be at least 10% of the flow as of the end of dry season.

c. From the above mitigation measures, there will be no negative impacts to be caused on flora and fauna, nor to ecological system of the river and project site area.

d. Therefore, it will not generate any accumulative environmental impacts.

e. There will be no negative impacts to the watershed of the river.

f. Because of the small scale MHP project, there will be no negative impacts to the air and water quality in and around the project site area.

g. There will be no negative impacts to groundwater of the project area and its vicinity.

2) Environmental issues in connection with the plant design and construction activities

a. There will be no negative impacts to the agriculture of the project site and its vicinity.

b. There will be no conflicts with existing river water rights.

c. There will have the following positive impacts to the villagers in and around the project site.

i) Electrification of the rural area

ii) Create employment opportunity for the villagers as labor force source for power plant management , operation and maintenance

iii) Create business opportunity to the villagers during construction.

d. May have negative impacts to river water quality due to liquid effluents from worker' camp. Prepare sewage treatment facility to mitigate this impact.

e. Dust generation shall be minimized during construction activities. Water spray will be used for this purpose.

3) Potential environmental impacts during plant operation

a. During dry season, a water reduction section could be occurred in the river section between the weir and the power house. To avoid negative impact to the ecology of the water reduction section by operating the MHP, keeping at least 10% of water flow as of the end of dry season as the minimum maintaining flow will be needed.

b. There will be no negative impacts to the downstream river water quality.

c. There will be no negative impacts to agriculture of the project site area and its vicinity.

d. Outdoor electrical equipment and distribution facilities may cause electric shock to the wildlife which would come occasionally into the facility sites. To avoid such impact, a certain kind of protection measures, such as barrier fence/nets will be set around the facilities.

Details of the initial environmental impact analysis results have also been summarized in the Table IEIA-

1. For details, refer to the table.

(7) Environmental Impact Mitigation Measures

Details of the Environmental Impact Mitigation Measures have also been shown in the same Table IEIA-1. The measures have also been described in item (2)-10 “Environmental Management Plan” below.

As mentioned above, Sangke U/S project will be located at the boundary of a Protected Landscape area. The Stung Sangke River to be used for the project is the boundary of this protected area. To avoid impacts to the protected landscape, the waterway will be installed underground along the right bank of the river, which is outside of the protected area.

To maintain ecological environment of the water reduction section of the river, the “minimum maintaining flow” will be kept to be 10% of the flow as of the end of dry season.

(8) Economic Analysis and the Environmental Value

The Project in total will provide electricity to 4,216 households. It is about 80% of the total households in the Districts. By the electrification, the expenditure of battery charging and replace to be needed for villagers can be reduced or even would not be required, and the villagers can obtain high quality electricity and bright lighting instead. In addition, the Project will also be able to supply power for pumping river water for domestic use and irrigation activity.

(9) Environmental Management Plan

A. Environmental Protection Measures

Environmental Issue	Mitigating Measure	Implementation Responsibility
Construction		
Loss of tree resources	Trees to be cleared will be limited to the waterway, penstock and generator facility. The lost trees will be supplemented by reforestation in the surrounding area.	Project IO/operator and contractor(s) (see Remarks for IO)
Air/river water quality	Air dust will be minimized by spraying water. Proper wastewater treatment will be conducted before discharge to the river. Water supply and waste disposal facilities will be established for workforce camps.	Project IO/operator and contractor(s)
Loss of rare and endangered species	Identify critical habitats and prepare habitat protection plan	Project IO/operator and contractor(s)
Impacts to the landscape of Protected Area	Waterway will be installed underground along right bank of Stung Sangke river. The right bank is located outside of the Protected Landscape.	Project IO/operator and contractor(s)
Hazardous materials	Proper storage of chemicals and fuels	Project IO/operator and contractor(s)
Worker/public health and safety	Health care and safety center will be established.	Project IO/operator and contractor(s)
Operation		
Protection of wildlife	Establish barrier nets around the outdoor electrical equipment and distribution facilities	Project IO/operator

Change in water quality (upstream and downstream)	Remove upstream pollution sources.	Project IO/operator
Potential impacts to ecology of the river	Keep "minimum maintaining flow" to be 10% of the flow of the end of dry season.	Project IO/operator
Sediment transport/erosion	Prepare sediment bypass system	Project IO/operator
Introduction of exotic pest species	Reduce water residence time	Project IO/operator
Public safety	Proper measures to avoid villagers entering the facility areas.	Project IO/operator

B. Environmental Monitoring Program

Monitoring Parameter	Monitoring Technique	Monitoring Location	Monitoring Frequency	Monitoring Responsibility
Construction				
Loss of tree resources	Observation of conditions of reforestation	Site surrounding area used for reforestation	Once per month	Project IO/operator and contractor(s)
Air/river water quality	Observation, turbidity meter	Project site area	Once per week	Project IO/operator and contractor(s)
Loss of rare and endangered species	Observation	Project site area	Once per month	Contractor(s)
Hazardous materials	Observation	Construction site	Once per month	Constructor(s)
Worker/public health and safety	Observation	Whole area of the project site	Every day	Project IO/operator and contractor(s)
Operation				
Wildlife protection	Observation	Outdoor electrical equipment and distribution facilities	Once per week	Project IO/operator
Reforestation condition	Observation	Site surrounding area used for reforestation	Once per six months	Project IO/operator
Change in river water quality	Observation, pH, COD, TSS, etc.	Project site area	Once per three months	Project IO/operator
Sediment transport/erosion	Turbidity meter	Upstream and downstream	Once per month	Project IO/operator
Keeping minimum river water flow	Observation and/or measurement	Water flow reduction section	Monthly during dry season	Project IO/operator
Introduction of exotic pest species	Observation	Upstream and downstream	Quartery	Project IO/operator
Public safety	Observation	Whole area of the project site	Once per week during tourism season	Project IO/operator

Remarks: IO stands for Implementing Organization.

(10) Situation without the Project

Four concerned Communes in and around the project area were surveyed. Those are Ou Samreul, Tashanh, Sung and Samlout Communes. The following show the percentage of HHs having electrified by Batteries:

i) Ou Samrel : 80%

ii) Ta sanh : 30%

iii) Sung ; 80%

iv) Samlout : 85%

In average, about 68% of HHs have batteries for electrification. However, BCSs are not enough to provide charging service to remote villagers.

The urgent needs of the concerned Communes are 1) rehabilitation of communication roads, 2) water supply for households and irrigation, and 3) electricity. However, obtaining water from river and brooks will need electricity.

On the other hand, all of the villagers have no enough income to obtain enough foods. About 30% to 50% of HHs are in such situation. To improve the situation, to increase income from agriculture is essential.

The above situation would be improved by establishment of irrigation system, for which electric power will be needed.

(11) Institutional Capacity

The project implementing organization/operator and contractor(s) shall be trained and responsible for conducting EIA. In addition, the project implementing organization/operator and contractor(s) shall be responsible for preparation and implementation of the Environmental Management Plan. For this purpose, the project implementing organization/operator and contractor(s) shall establish an internal organization to be in charge of the whole environmental assessment activities. Training staff members of the organization will also be needed.

(12) Conclusion and Recommendations

1) Because the Project is a hybrid scheme of a MHP and a bio-mass power, there will be no environmental impacts on the protected landscape of the project site area and its vicinity.

2) On the other hand, the need of electrification of concerned villagers is very high. This Project, including the bio-mass power portion, will be able to provide electric power to irrigation facility in daytime, and therefore should also be beneficial to resolving poverty issue of the villages.

3) Employment opportunity should be given to the villagers as labor force during project construction.

4) It is recommended that the Project Implementing Organization will materialize in early stage the contents of the Environmental Protection Measures and Environmental Monitoring Program as shown in the Item (9) Environmental Management Plan (the Plan) above, so that the Plan can be surely implemented.

5) It is desirable that EIA will be conducted for the Project, so that the potential impacts to the ecology of the project site area and its vicinity would be understood in more detail.

Table 2.23 shows the results of the IEIA.

Table 2.21 Environmental Screening for Stung Sangke MHP Project (The check list for the proposed MHP project.)

1. General Information

Name of the proposed project: **Stung Sangke MHP Project**
Name of Project owner/proponent: not decided yet
Project Execution Organization : not decided yet
Name of authorized person(s) responsible for the project : not decided yet

Information regarding the project site
Name of the village, commune, district and province :
45 villages, Ou Samrel and other Communes, Samlot and Rotonak Mondol Districts, Battambang Province
Other information regarding the village(s) the project site area belongs :

2. Outline of the Proposed Project

2.1 Information on project characteristics

(1) Needs involuntary resettlement		
	Yes	Scale: households, persons
●	No	
(2) Groundwater pumping		
	Yes	Scale: m^3/year
●	No	
(3) Land reclamation, land development and land cleaning		
	Yes	Scale: hectors
●	No	
(4) Logging		
●	Yes	Scale: about o.5 hectors for power house space
	No	

2.2 Description of the project

Main design specifications:
The MHP will be composed of upstream (U/S) and downstream (D/S) projects of Stung Sangke River. U/S project will have about 110kW output capacity and D/S project will have about 35kW output capacity.

Considering possible fuel tree farming in this area, an independent biomass power plant could be constructed here to increase total power supply capacity. As th first step, this biomass project will have 100kW output capacity, for which about 20ha fuel tree farming land would be utilized. The output capacity of the biomass project could be increased more if more area of fuel tree land would become available.

From the above, total installed capacity would become about 700kW, which will be able to supply electricity to about 5,430 households.

Therefore, the project as a whole will become a hybrid system.

2.3 Is the project consistent with the higher program/policy ?

●	Yes	(outline of the higher program/policy) Rural electrification plans of MIME in the Province
	No	

2.4 Any alternatives considered before the project ?

		(outline of the alternatives)

●	Yes	Tributary Stung Cra Nhung MHP in Battambang Province. However, this project would be to supply electricity to about 675 households. Installed capacity will be about 88kW. Comared with the Stung Sanke project, it will be less cost benefit.
	No	

2.5 Did the project proponent have meetings with related stakeholders during the project planning ?

●	Yes	(mark the corresponding stakeholders)	
		●	Administrative body/local government
		●	Local residents/villagers
			NGOs
			Others (to specify)
	No		

2.6 Are any of the following areas located inside or around the project site ?

●	Yes	(mark related items listed below)	
		●	National park, wildlife sanctuary, protected landscape, and other protected areas designated by the government
			Virgin forests, tropical forests
			Ecological important habitat areas
			Habitat of valuable species protected by domestic laws or international treaties
			Likely salt cumulus or soil erosion areas on a massive scale
			Remarkable desertification trend areas
			Archaeological, historical or cultural valuable areas
			Living areas of ethnic, indigenous people or nomads who have a traditional lifestyle or specifically valuable areas
	No		

Remarks: The Sanke MHP project site will be located at the boundary of a Protected Area as marked above.

2.7 My the project have potential negative impacts to the environment and local communities ?

	Yes	(brief description of the potential negative impacts)
●	No	
	Not identified	

Remarks: As mentioned above, the Sanke U/S project site will be located at the boundary of a Protected Area, which is a "Protected Landscape". Due to small scale of the project and its underground waterway design, it is considered that there will be no negative impact to the landscape of the area.

2.8 Mark the related potential environmental and social impacts and describe briefly the contents of the impacts, if any.

Items of potential impacts		Items of potential impacts	
●	Air pollution		Local economy, employment, livelihood, etc.
	Water pollution		Land use and utilization of local resources
	Soil pollution		Existing social infrastructures and services
●	Waste (liquid and/or solid)		Poverty issue
	Causing noise and vibration		Ethnic and /or indigenous people
	Ground subsidence		Misdistribution of benefits
	Offensive odors		Local conflict of interests among villagers
	Geographical features		Gender issue
	Bottom sediment		Children's rights
	Biota and ecosystem		Natural and/or cultural heritages
	Potential conflict on water use rights		Infectious diseases such as HIV/AIDS, etc.
	Public health and hygiene		Others if any

	Global warming		
	Involuntary resettlement		

Remarks: 1) Dust would be generated during construction work. To avoid air pollution by the dust, water spray will be used to mitigate such impact.
2) During construction, liquid waste would be generated from worker's camps. Proper treatment will be taken before discharge to outside environment.

Key results and findings of the environmental screening:

(1) The upstream project site will be located at the boundary of Samlot Protected Area (Protected Landscape).
(2) Considering both the environmental regulations of JICA and the MOE, carrying out an IEIA(IEE) will be required, and the report shall be prepared and submitted by project owner to the MOE for review and approval.
(3) For more details, refer to Section 4.1 above.
(4) Due to a lot of land mines are still remained in and around the area, attentions should be paid during carrying out detailed field surveys and construction work.

Table 2.22 Environmental Screening of Ou Samrel Biomass Power Project (The check list for the power project.)

1. General Information

Name of the proposed project: Ou Samrel Biomass Power Project
Name of Project owner/proponent: not decided yet
Project Execution Organization : not decided yet
Name of authorized person(s) responsible for the project : not decided yet

Information regarding the project site
Name of the village, commune, district and province :
Ou Samrel, Tashanh, Sung and Samlot Communes, Samlout Districts, Battambang Province

2. Outline of the Proposed Project

2.1 Information on project characteristics

(1) Needs involuntary resettlement		
	Yes	Scale: households, persons
●	No	
(2) Groundwater pumping		
	Yes	Scale: m^3/year
●	No	
(3) Land reclamation, land development and land cleaning		
	Yes	Scale: hectors
●	No	
(4) Logging		
●	Yes	Scale: about o.5 hectors for power house space
	No	

2.2 Description of the project

Main design specifications:
This is a Biomass gasification power plant project. The project will utilize farmed trees as fuel wood. The trees will be cultivated continuously after each cut. Generating capacity will be about 562 kW, for which about 112 ha of fuel tree farming land will be needed.

2.3 Is the project consistent with the higher program/policy ?

●	Yes	(outline of the higher program/policy) Rural electrification plans of MIME in the Province
	No	

2.4 Any alternatives considered before the project ?

●	Yes	(outline of the alternatives) Svay Bakav Community Forest (CF) potential power site in Kampong Chhnang Province, and others. However, the more urgent need of electricity is in the concerned Communes.
	No	

2.5 Did the project proponent have meetings with related stakeholders during the project planning ?

		(mark the corresponding stakeholders)	
		●	Administrative body/local government

●	Yes	●	Local residents/villagers
			NGOs
			Others (to specify)
	No		

2.6 Are any of the following areas located inside or around the project site ?

	Yes	(mark related items listed below)	
			National park, wildlife sanctuary, bio-diversity conservation, and other protected areas designated by the government
			Virgin forests, tropical forests
			Ecological important habitat areas
			Habitat of valuable species protected by domestic laws or international treaties
			Likely salt cumulus or soil erosion areas on a massive scale
			Remarkable desertification trend areas
			Archaeological, historical or cultural valuable areas
			Living areas of ethnic, indigenous people or nomads who have a traditional lifestyle or specifically valuable areas
●	No		

2.7 May the project have potential negative impacts to the environment and local communities ?

	Yes	(brief description of the potential negative impacts)
●	No	
	Not identified	

2.8 Mark the related potential environmental and social impacts and describe briefly the contents of the impacts, if any.

Items of potential impacts		Items of potential impacts	
●	Air pollution		Local economy, employment, livelihood, etc.
	Water pollution		Land use and utilization of local resources
	Soil pollution		Existing social infrastructures and services
●	Waste (liquid and/or solid)		Poverty issue
	Causing noise and vibration		Ethnic and /or indigenous people
	Ground subsidence		Misdistribution of benefits
	Offensive odors		Local conflict of interests among villagers
	Geographical features		Gender issue
	Bottom sediment		Children's rights
	Biota and ecosystem		Natural and/or cultural heritages
	Potential conflict on water use rights		Infectious diseases such as HIV/AIDS, etc.
	Public health and hygiene		Others if any
	Global warming		
	Involuntary resettlement		

Remarks:

1) A certain amount of fine suspended particulates could be generated from the plant. The amount will be much less than that of the case of D/G facility.
2) The liquid waste would be generated during construction by worker's camp at site. Such wastes must be treated before discharge to the environment.
3) In addition, a certain amount of liquid waste might also be generated during plant operation, which will be treated by closed cycle treatment method.

2.9 Key results and findings of the environmental screening :

Considering the following three factors, carrying out IEIA(IEE) will not be required.

1) The project will belong to Category C of JICA Environmental Guidelines.

2) The project output capacity (562kW) is less than the limit which will need IEIA or EIA defined by the MOE (5MW).

3) The bio-mass project site will be located outside of any Protected Area designated by the MOE.

Therefore, only the environmental screening result will be enough for the project.

For more details, refer to Section 4.2 above.

Table 2.23 (1/3) Results of Initial Environmental Impact Assessment of Sangke MHP Project

Environmental Factors	Potential Negative Impact	Mitigation Measures	Potential Environmental Impacts				Remarks
			Positive Impacts	Negative Impacts			
				Non, not significant or minor (C)	Moderate Impacts (B)	Significant Impacts (A)	
I. Natural and Social Environmental Impacts							
1. Watershed erosion and silt runoff/sedimentation	No negative impact			Non			
2. Encroachment upon Precious ecology	No negative impact			Non			
3.Impact on migration fish species	No migration fish species			Non			
4. Effects on groundwater hydrology	No negative impact			Non			
5. Change of river morphology	No negative impact			Non			
6. Change of riverside vegetation	Small impact to water reduction section			Not significant			Keep 10% flow during dry season
7. Resettlement	Not needed			Non			
8. Impacts on tourism (potential) area	May have impact by Stung Sangke D/S site	Avoid plant operation during day time during tourism season			●		Need to consult with the resort facility owner in advance.
9. Encroachment upon natural/cultural heritages	No such heritages being existed			Non			
10. Impairment of navigation	No river navigation			Non			
11.Impairment of landscape of site area	It shall be noted that the U/S site is located at the boundary of Samlot Protected Area, which is a protected landscape. Due to very small scale of the facility, no negative impact on the landscape will be incurred.	Small scale weir and underground wateryay will be used.		Not signuficant			
12. Inundation of agricultural and/or pasture lands	No inundation will occur by the weir.			Non			
13. Water right conflicts	No conflicts			Non			
14. Other potential impacts	Not found			Non			
15. Held stakeholder meetings to inform and discuss on the project plan, and points of opinions and comments received	Found no negative impacts through interviews made with the Commune representatives and stakeholder meeting on September 6, 2005.			Non			

Table 2.23 (2/3) Initial Environmental Impact Assessment of Sangke MHP Project (continued)

Environmental Factors	Potential Negative Impact	Mitigation Measures	Potential Environmental Impacts				Remarks
			Positive Impacts	Negative Impacts			
				Non, not significant or minor (C)	Moderate Impacts (B)	Significant Impacts (A)	
II. Environmental Issues in connection with project design and construction activities							
1. Held stakeholder meetings to inform and discuss on the project design and construction activities.Points of opinions and comments received.	No negative impacts. But need to improve communication/access road conditions.	Improve communication/access road conditions.	Yes				Improvement of access road will be much welcome by the concerned villagers.
1. Negative impacts to existing communication road/system of concerned villages	No impacts to existing communication road, but need rehabilitation. .	Improve road conditions before starting construction activities.		Not significant			Communication road will be improved.
2. Soil erosion/silt runoff	No negative impact			Non			
3. Noise during construction activities	Minor due to remote from villages			Non			
4. Air pollution during construction activities	Minor impact to the air around the site area.	Spray water to the dust generating work.		Minor			
5. River water pollution due to Construction activities	May have impact on the turbidity of downstream river water.	Minimize river bed work		Not significant			
6. River water pollution due to waste water discharged from workers' camp	May have impacts on the river water quality	Prepare sewage treatment system			●		
7. Air and/or water borne diseases	May cause such diseases to workers and the villagers	Prepare sanitary measures.			●		
8. Impacts by quarry sites	Not much quarry will be needed.			Minor			
10.Odors to be generated	No such impacts			Non			
11.Employment of local villagers	Will create employment as construction workers		Yes				

Table 2.23 (3/3) Initial Environmental Impact Assessment of Sangke MHP Project (continued)

Environmental Factors	Potential Negative Impact	Mitigation Measures	Potential Environmental Impacts				Remarks
			Positive Impacts	Negative Impacts			
				Non, not significant or minor (C)	Moderate Impacts (B)	Significant Impacts (A)	
III. Potential Environmental Impacts during Operation							
1. Downstream river water pollution	No such pollution			Non			
2. Downstream river bed erosion or sedimentation	No such impacts			Non			
3. Eutrophication of reservoir	No such impacts due to small weir.			Minor			
4. Air/water borne diseases	May cause such impacts	Avoid long term stagnation of reservoir water		Minor			
5. Protection of wildlife	May cause electric shock if wildlife would come into the plant facilities	Set barrier nets around outdoor electrical equipment and distribution facilities.		Minor			
5. Impacts on downstream fisheries	No such impacts due to no fisheries being existed			Non			
6. Increase of insect vector diseases	May have such impacts	Avoid long term stagnation of reservoir water		Minor			

Remarks: 1) Negative impact (A) stands for having "Significant impacts".
2) Negative impact (B) stands for having "Moderate impacts"
3) Negative impact (C) stands for having "Non, not significant or minor impacts".

6 ORGANIZATION FOR MANAGEMENT

6.1 PROJECT IMPLEMENTATION ARRANGEMENT

The type of institutional arrangements suitable to individual communities varies depending on characteristics of projects (size, component, scope, and area coverage, etc) and preference and resources of communities concerned. We use the following options for designing institutional arrangements for the candidate projects for our pre-F/S.

a. It is basically recommended that a commune or plural villages form a community electricity company (**CEC**) that runs generation, transmission and distribution businesses in case of reliable REEs not showing up.

b. If a common generation plant and a MV line system serve widespread and scattered villages, an alternative to the above a) might be considered to form a commune-owned power company (running generation and MV line businesses) which is a kind of a regional power company (**RPC**) and several village-owned LV supply companies (**CECs**) separately, in case the communities concerned prefer to do so.

c. If a common generation plant and a MV line system serve several communes, it is suggested to form an inter-commune-owned or a district-owned power company as **RPC** and several commune-owned LV supply companies (**CECs**) separately, in case the communities concerned prefer to do so.

d. It is recommended for the **RPC** to contract out the operation and management of the power facilities to the private sectors (REEs or NGOs) as far as such arrangement leads to better electricity services than its own operation.

The Samlout project covers ultimately two districts (Samlout and Rotanak Mondol) comprising 7 communes (Ou Samrel, Ta Sanh, Mean Cheay, Samlout, Sung, Phlov Meas, and Traeng) holding 6,300 households. The project will be developed stage-wise depending on density of affordable households and magnitude of power demand as discussed in Chapter xxx.

Discussions with local representatives concerned, including the director of DIME Battambang, the director of Samlout district office, commune chiefs concerned, revealed the following options are recommended for the project implementation arrangements.

i) To separate the generation & MV line maintenance and LV supply & power sales: the former will be run by the RPC and the latter, by the CEC of each commune.

ii) To let the biomass-based PRC to the private sector (REEs) under competitive bidding for DBFO (design, build, finance and operate) contract.

iii) To let the micro-hydro-based PRC to the private sector (REEs) under competitive bidding for DBO (design, build and operation) with government financing. (This is based on the consideration of availability of ODA funds which requires the owner of the ODA-financed facilities to be government and public organization[1].)

[1] However, in reality, there are no private entities that can design and construct such micro-hydro power station as this scheme. There are no experienced engineers of micro-hydro in MIME. JICA Study Team recommends that such micro-hydro power project be implemented by force account system with technical and financial assistance, aiming at human resources development.

6.2 OPERATION AND MAINTENANCE ORGANIZATIONS

The operation and maintenance organizations are worked out separately for the CEC and RPC. The RPC is further divided into the power plant division and the transmission/distribution system as follows.

Commune-based CEC

The CEC will be organized for each commune or a group of villages. Its main task is to maintain the LV lines and collection electricity tariffs.

Manager: 1 person
Accountant: 1 person
Line man: 1 person each for approx. 10-15 km of LV lines
Tariff collector: Combine with accountant. In Cambodia, it is quite common that beneficiaries go to an REE office to pay for electricity tariff. To save personnel costs, this method is also applied here.

Regional Power Company (RPC)

The RPC will be composed of the headquarter, the micro-hydro power station, the biomass power station, and the transmission/distribution system. The main task of the RPC is to produce electricity, operate and maintain the MV/LV systems, and supply it to each CEC at appropriate delivery points to individual communes/villages (distribution transformers).

(i) Headquarter
Manager : 1 person
Secretary : 1 person
Accountant : 1 person
Assistant Accountant : 1 person

(ii) Micro-hydro power station (100 kW class)
Operator (Civil/Mechanical) : 1 person
Operator (Electrical) : 1 person

(iii) Biomass power station (300-400 kW class)
Generator operator : 2 persons
Biomass fuel collector : 1 person

(iv) Transmission/distribution system
Line man : 1 person each for approx. 20 km of MV lines

7 CONCLUSIONS AND RECOMMENDATIONS

It is recommended to implement electrification into two phases.

The 1st Phase will electrify Ou Samrel commune area, where people have relatively high willingness to pay and willingness to electrify. 120 kW capacity biomass gasification power (BGP) station will be installed for the 1st phase. Medium voltage (MV) line will be extended for 10 km. BGP station and MV lines will be managed by regional power company (RPC). CEC will buy electricity after obtaining

distribution license from EAC. CEC will purchase electricity from RPC.

The 2nd Phase will electrify the rest of Samlout District and a part of Rotanak Mondol District by construction of Sangke micro hydro power station and additional installation of BGP at Ou Samrel. Further extension of 76.5 km MV line is scheduled to cover whole target area to formulate a regional mini-grid.

■ Appropriateness of the MHP and Bio Model

Demand

The Samlout project target area is newly settled and integrated to the country after the war and mine clearance. Thus, growth rate of household is much higher than other area. While richer households showed interest to buy energy consuming devices such as rice cooker, the demand of majority of the residents will be lighting and TVs due to their financial capacity. Yet, there is not many clues for potential industry needs during the daytime although impact of border trade will be anticipated.

Ability to Pay

The villagers already consumed the available energy such as kerosene and car battery, and generator. Existing credit and saving organization can be utilized for encouraging villagers to save for the connection fees required for the future.

Benefit anticipated

The socioeconomic study also revealed the benefit they anticipated after electrification as above. They appreciated primarily about electricity service for health centre and education.

Our life will be better if our village is electrified	-	-	-	-	-	-	8	15.7	43	84.3
It is important for information (TV, radio)	-	-	-	-	-	-	16	31.4	35	68.6
Children can study at night	-	-	-	-	-	-	12	23.5	39	76.5
Working at night make cash income	-	-	-	-	10	19.6	24	47.1	17	33.3
Some electric appliances reduce work loads	-	-	-	-	2	3.9	24	49	25	49
Food can be better preserved	-	-	3	5.9	2	3.9	31	60.8	15	29.4
Reduction in door air pollution caused by lamps	1	2	-	-	1	2	23	45.1	26	51
Fan prevent malaria and make good sleep	-	-	-	-	2	3.9	23	45.1	26	51
Electricity is important for better water supply	-	-	1	2	3	5.9	23	45.1	24	47.1
Electricity is important for our health center	-	-	-	-	-	-	6	11.8	45	88.2
It will improve security at night	-	-	-	-	-	-	25	49	26	51
It will improve social relations between neighbors	-	-	-	-	2	3.9	28	54.9	21	41.2
It will create work-time for productive endeavor	-	-	-	-	11	21.6	20	39.2	20	39.2
It will provide more time for family gatherings	-	-	-	-	-	-	30	58.8	21	41.2
I want to start business after electrified	2	4	1	2	7	14	23	46	17	34

■ Demonstration Effect

The current accessibility of Samlout is not satisfactory especially during the rainy season. Once electricity is available by MHP and biomass fuel, the other industries such as **semi-processing industry for targeting the border market** might be promoted as located in boarder area to Thailand. Development pattern utilizing electricity will be demonstrated.

■ Challenges for the Sustainable Operation

This project site is newly settled area after mine clearance. The social mobilization rate is much higher than other area, which hampers to confirm social structure and their wealth level. The land allocation, so far is organized, yet special attention needs to be paid for verifying the land for biomass fuel. Watershed

management is important for sustainable water discharge, as this is border area where illegal logging was the issue.