#### Part 2. Anlong Ta Mei Tree Farm

#### BACKGROUND

Anlong Ta Mei Community Energy Cooperative (CEC) supported by SME Cambodia (NGO) in Battambang Province supplies biomass gasification electricity to about 70 cooperative members since February 2005. Anlong Ta Mei CEC only uses purchased *Leucaena leucocephala* wood planted by CEC members as the fuel for electricity generation. The details of Anlong Ta mei CEC activities are well described in JICA (2005a). CEC members plant *L.leucocephala* trees in their fallow gardens, unused land and mix with fruits trees or other cash crops. People start to cut trees at 1 m height for the first harvest at one year after planting. Coppiced branches continuously grow after the first harvest and CEC members cut the branches two to three times a year for selling to CEC. We investigated the first year *L.leucocephala* production and sustainability of the tree farming system in Anlong Ta Mei CEC.

Anlong Ta Mei village is located about 15 km south of Battambang and the coordinates is



PHOTO 2. Biomass destructive measurement in Anlong Ta Mei *Leucaena leucocephala* tree farm. (Top left) Interviewing the farm owner. (Top right) Sorting biomass components. (Bottom left) Tree measurement. (Bottom right) Weighing stems.

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103°10' E and 13° 00' N. The altitude is about 20 m a.s.l. Average annual rainfall in Battambang between 1985 and 2001 was 1288 mm (JICA 2005b). Soil type in Anlong Ta Mei is classified as Eutric Gleysols (FAO 1974).

#### METHODS

In Anlong Ta Mei tree farms, *L.leucocephala* trees are planted densely (mainly 1 x 1 m) and the harvesting cycle is very short (< 1 year). The regression analysis method we used for Meanok Plantation (refer Part 1) is not suitable for the case of Anlong Ta Mei. Instead of establishing equations to estimate biomass of individual trees, we harvested 10 plots, total 266 m<sup>2</sup> in four sites (Table 5). Plot sizes are different at each site because of differences of farm size and planting methods. In the plots, we measured diameter at base and 1 m in height then harvested all trees at 1 m. Total 176 trees were harvested. Branches, foliage and fruits of each tree were sorted and weighed (Photo 2). Sub samples were collected and weighed for moisture content determination and chemical analysis. 25 trees were cut at ground level to determine regression of base diameter to the stem mass. The correlation coefficient (r<sup>2</sup>) of the obtained regression was 0.98. Stem weight of individual trees was estimated using the regression. Method of sample processing, chemical analysis and soil profile survey is same as the method

BOX 2. Soil profile description of Anlong Ta Mei site. Profile # 0501 Anlong Ta Mei, Bannon District, Battambang Province. Leucaena tree farm. Coordinates: 103°10' E, 13° 00' N. Altitude: 20m. Topography: flat, flooding in 1993 & 1994 (twice to date). Land form: plain. Land element: floodplain, Position: higher part. Gradient: flat. Form: complex. Micro-topography: no micro-relief. Parent material: not known. Erosion: no erosion. Land use: first year Leucaena leucocephala tree farming at abandoned orange farm. Hori Depth Color Notable features zon (cm) (moist) 0 0.5-0 Very little standing litter layer. 0-12 10YR No mottling / clay loam / no A 5/4 rock fragment / very weak fine angular blocky / firm / non sticky / non plastic / few very fine roots / clear smooth boundary 12-70 10 YR Many coarse mottling (10 B YR 3/1) / clay loam / no rock 2/3 fragment / very weak fine angular blocky / firm slightly sticky / non plastic / very few fine and very fine roots / gradual boundary С 70 +10YR No mottling / clay / no rock / 4/2verv weak fine angular blocky / firm / slightly sticky / non plastic / very few fine and very fine roots - 14 -

used in Part 1 of this report.

#### RESULTS AND DISCUSSION

#### Soil Profile

Description and a photograph of 1 m depth soil profile are shown in Box 2. Soil texture is clay loam or clay. Soil colour was blownish gray (10YR 5/4) for A horizon, blownish black (10YR 2/3) for B horizon and grayish yellow brown (10YR 4/2) for C horizon. More blackish colour in B horizon than A horizon indicates higher organic matter accumulation in B horizon. Upper part of B horizon (12-40 cm) contains higher concentrations of carbon and nitrogen than A horizon (Table 1). The reason for higher organic matter accumulation in sub soil compared to surface soil is not clear. However, the area where soil profile survey was conducted (Site 1, Table 5) was abandoned garden. Some farming activity might cause higher organic matter in the subsoil. Carbon and nitrogen contents of Anlong Ta Mei soil were much higher than the soil in Meanok (Table 1). Consequently Anlong Ta Mei is much more preferable condition for plant growth compared to Meanok.

#### **Biomass Productivity**

The results of the biomass production survey is summarised in Table 5. Among four sites we surveyed, three sites were pure L.leucocephala stands and the other one was mix planting with guava and orange trees. The mixed planting site was the only irrigated site. The spacing in the pure stands was 1 x 1 m. All stands were 10 or 12 months old. Woody biomass per tree at mixed planting site was 40 to 250% higher than other three sites. The higher wood production largely attributes to water irrigation of the mixed planting site, but compost application to the base of fruit trees might also affect the growth of L.leucocephala. Average annual woody biomass production of three un-irrigated pure stands at the first year was 8.2 Mg/ha/year. Coppicing branches of L.leucocephala grow much faster than initial planting stems. When we observed the same site three months after the survey, the coppied branches were as large as pre-harvest size. The woody biomass production of following years will probably much higher than the prospective biomass production of 10 Mg/ha/year in the Master Plan prepared by MIME and JICA (2005a). Tewari et al. (2004) reported up to 50 Mg/ha/year biomass productions of L.leucocephala in India under the similar management method with Anlong Ta Mei but productivity varied depending on management methods and site conditions (Kumar et al. 1998). The Department of Agriculture in Battambang province is conducting small scale research and recorded about 80 Mg/ha/year of L.leucocephala branches at forth year annual harvest without irrigation (Ponh, un-published data).

#### Nutrient Sustainability

Carbon and nitrogen concentrations of each biomass components are shown in Table 3. Mass and, carbon and nitrogen accumulation in 10-12 month old *L.leucocephala* is shown in Table 6. Biomass of foliage and fruits accounted for 21% of total biomass but it accounted for 55% of total nitrogen stored in trees. *L.leucocephala* foliage and fruits are nutrient rich stock feed and

		Site 1	Site 2	Site 3	Site 4
Surveyed plots		4m x 4m x 3plots	5m x 5m x 2plots	4m x 4m x 3plots	20m x 3m x 2plots
Area surveyed		48 m <sup>2</sup>	50 m <sup>2</sup>	48 m <sup>2</sup>	$120 \text{ m}^2$
Number of planted trees		48	41	52	47
Number of survi	ved trees	45	34	52	45
Planting meth spacing	od and	1 x 1m, pure stand	1 x 1m, pure stand	1 x 1m, pure stand	1m x 3m, orange and guava trees are planted between the Leucaena rows
Irrigatio	n	No	No	No	Yes
Previous status of the land		Abandoned orange garden. No fruits production last 3 years. Mango was planted with Leucaena but all died.	Abandoned orange garden. Back yard of a farmer's house. Disturbance by cows and children?	Abandoned orange garden. Chili was planted with Leucaena and grew well.	Mix planting with Orange and Guava.
Planted ti	me	May & June 2004	August 2004	August & September 2004	June 2004
Age		12 months	10 months	10 months	12 months
Branch (> 1m) biomass	(Mg/ha)	5.08	3.81	3.14	3.27
Stem (0-1m) biomass	(Mg/ha)	3.76	3.03	3.19	2.13
Total woody biomass	(Mg/ha)	8.84	6.84	6.33	5.40
Woody biomass per tree	(kg)	0.94	1.01	0.58	1.44
Annual wood production in the first year	(Mg/ha/ year)	8.86	8.20	7.55	5.45
Foliage	(Mg/ha)	1.96	1.77	1.57	1.74
Fruits	(Mg/ha)	0.04	0.26	0.30	0.52
Total above ground biomass	(Mg/ha)	10.85	8.87	8.19	7.67

TABLE 5. Summary of biomass production of *Leucaena leucocephala* tree farming in Anlong Ta Mei Community Energy Cooperative in Battambang Province. All biomass data is based on oven dry weight.

people also consume them. There is much larger impact of nitrogen budget (as well as other nutrient) in the case of whole tree harvesting compared to the case only woods are harvested. Applying organic matter and fertilized (eg. compost) would be necessary in the case of whole tree harvesting to maintain sustainable production. If 10 Mg/ha woody biomass is harvested annually as prospected in the Master Plan (JICA 2005a), about 95 kg/ha of nitrogen is exported from the site. This is only 0.8% of total nitrogen stored in 1 m depth of the soil. In addition, *L.leucocephala* has nitrogen fixing characteristics. We could conclude that nitrogen depletion

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					(kg/ha)
	Branch (> 1m)	Stem (0-1m)	Foliage	Fruits	Total
Biomass	4011.2	3326.7	1767.2	201.0	9306.1
С	1873.2	1563.5	798.8	90.9	4326.4
Ν	38.1	25.0	67.5	9.7	140.3

TABLE 6. Biomass, carbon and nitrogen contents of each biomass components in *Leucaena leucocephala* 1-year-old (10 - 12 month) stands at Anlong Ta Mei Community Energy Cooperative tree farm in Battambang Province.

would probably not occur at Anlong Ta Mei tree farming site if only woody biomass is harvested. But it is required to investigate sustainability of other important nutrient such as phosphorus, potassium, calcium and magnesium to evaluate sustainability of biomass production. Moreover, it is necessary to study the case of higher yield and whole tree harvesting.

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#### **Overall Conclusions**

In the Master Plan (JICA 2005a), tree farming by local farmers is recommended as the primary biomass fuel supply source. We have found that preferable biomass yield of *L.leucocephala* in Anlong Ta Mei CEC tree farms. Status of soil nutrient sustainability was preferable as well. It would not be very difficult to maintain sustainable biomass production without causing soil nutrient depletion. On the other hand, biomass productivity in Meanok Plantation was very poor. Soil nutrient was very low and long term sustainable high yield would not be realised under the current management practice. Species screening, fertilizer application, mixed species planting and native species natural regrowth management should be conducted or considered.

Sustainable biomass production by tree farming at clay soils of Eutric Greysols (Anlong Ta Mei type) is likely to be achieved. On the other hand, species selection, biomass productivity and appropriate management methods should be studied for tree farming at sandy soil of Ferric Acrisols and Gleyic Acrisols (Meanok type). There are many other different kinds of soils in the country. Intensive research should be carried out to establish localised appropriate methods of biomass fuel production for each region in the country.

Sustainable tree farming or tree plantation management is one of the most important key issues for biomass electricity generation. Biomass electricity is a very useful tool for rural electrification and clean energy supply. But the renewable energy production system is only realised when biomass fuel is produced under sustainable manner. The data we collected in this presented study is very limited. Long term productivity and nutrient cycling of tree farm and plantation is exceedingly needed.

#### REFERENCES

- Ahmad, T. (1996). Eucalyptus in Pakistan. In M. Kashio & K. White (Eds.), *Reports submitted* to the regional expert consultation on eucalyptus. Volume II. Bangkok: FAO.
- Beadle, C. L. (1997). Dynamics of leaf and canopy development. In E. K. S. Nambiar & A. G. Brown (Eds.), *Management of soil, nutrients and water in tropical plantation* (pp. 169-205). Canberra: ACIAR.
- Brady, N. C., & Weil, R. R. (1999). *The nature and properties of Soils* (12 ed.). New Jersey: Prentice-Hall.
- FAO-Unesco. (1974). Soil map of the world. Paris: Unesco.
- FAO. (1979). Eucalypts for planting. Rome: FAO.
- FAO. (1990). Guidelines for soil description (3 ed.). Rome: FAO.
- JICA. (2005a). Interim report for the master plan study on rural electrification by renewable energy in the Kingdom of Cambodia. JICA. Phnom Penh.
- JICA. (2005b). Weather observation data. JICA. Phnom Penh.
- Lic, V., & Shima, T. (2005). *Plantation and natural re-growth forests: the growth and use by local villagers*. Phnom Penh.
- Kimmins, J. P. (1997). Predicting sustainability of forest bioenergy production in the face of changing paradigms. *Biomass & Bioenergy.*, 13(4-5), 201-212.
- Kumar, B. M., George, S. J., Jamaludheen, V., & Suresh, T. K. (1998). Comparison of biomass production, tree allometry and nutrient use efficiency of multipurpose trees grown in

woodlot and silvopastoral experiments in Kerala, India. Forest Ecology & Management, 112(1-2), 145-163.

- Ministry of Environment, Kingdom of Cambodia. (2002) Cambodia's initial national communication under the United Nations framework convention on climate change. MOE. Phnom Penh.
- Research Council for Agriculture, Forestry and Fisheries. (1997). *Standard soil color charts*. Research Council for Agriculture, Forestry and Fisheries.
- Tewari, S. K., Katiyar, R. S., Ram, B., & Misra, P. N. (2004). Effect of age and season of harvesting on the growth, coppicing characteristics and biomass productivity of Leucaena leucocephala and Vitex negundo. *Biomass & Bioenergy*, 26(3), 229-234.

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# **APPENDIX-D**

Environment

#### THE MASTER PLAN STUDY ON RURAL ELECTRIFICATION BY RENEWABLE ENERGY IN THE KINGDOM OF CAMBODIA

#### FINAL REPORT VOLUME 5 : APPENDICES

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# Appendix-D Environment

## 1. APPENDICES TO CHAPTER 2 OF PART 3 IN VOL 2

#### Table AP-D.1.1 Illustrative List of Sensitive Sectors, Characteristics, and Areas

Note: The projects that belong to sensitive sectors, have sensitive characteristics, and/or are located in sensitive areas, shown below may have potential significant negative impacts on the environment and society. Each of such projects will be categorized as "Category A".

- 1. Illustrative list of large-scale projects in sensitive sectors
- (1) Mining development
- (2) Industrial development
- (3) Thermal power (including geothermal power)
- (4) Hydropower, dams and reservoirs
- (5) River/erosion control
- (6) Power transmission and distribution lines
- (7) Roads, railways and bridges
- (8) Airport
- (9) Ports and harbors
- (10) Water supply, sewage and wastewater treatment
- (11) Waste management and disposal
- (12) Agriculture involving large-scale land clearing or irrigation
- (13) Forestry
- (14) Fisheries
- (15) Tourism
- 2. Illustrative list of sensitive characteristics
- (1) Large-scale involuntary resettlement
- (2) Large scale groundwater pumping
- (3) Large-scale land reclamation, land development and land clearing
- (4) Large-scale logging
- 3. Illustrative list of sensitive areas, including their vicinity

(1) National parks, nationally designated protected areas (coaster areas, areas for ethnic minorities or indigenous people and cultural heritage, etc. designated by national government), wildlife sanctuary and natural protected areas

- (2) Areas where the national or local government believe to require careful considerations
- a. Natural environment
  - Primary forests or natural forests in tropical areas
  - Habitats with important ecological value (coral reefs, mangrove wetlands, tidal flats, etc.)
  - Habitats of rare species requiring protection under domestic legislation, international treaties, etc.)
  - Areas in danger of large scale salt accumulation or soil erosion
  - Areas with a remarkable tendency towards desertification
- b. Social environment
  - Areas with unique archeological, historical or cultural value
  - Areas inhabited by ethnic minorities, indigenous people or nomadic people with traditional ways of life and other areas with special social value

Source: JICA Guidelines for Environmental and Social Considerations, April 2004

(A check list for proposed rural electrification projects)					
1. General Information					
1.1 Name of the proposed project:					
1.2 Name of Project owner/proponent Project Execution Organization					
Project Execution Organization :					
Name of contact persons:					
Address:					
E-mail:					
Tel/Fax No.:					
Cell phone no.: Nome of outborized person(a) responsible for the project					
Name of authorized person(s) responsible for the project					
Position:					
Address:					
E-mail:					
Tel/Fax:					
Signature:					
1.3 Information regarding the project site					
Name of the village, commune, district and province					
Address:					
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 /year					
(3) Land reclamation, land development and land cleaning					
Yes Scale: hectors					
No					
(4) Logging					
Yes Scale: hectors					
2.2 Description of the project					
2.2 Description of the project Main design specifications:					
2.3 Is the project consistent with the higher program/policy?					
Yes					
No					
2.4 Any alternatives considered before the project ?					
Ves (outline of the alternatives)					
No					

#### Table AP-D.1.2Environmental Screening Format

2.5	Did the masie of many		talahaldana duning tha masiant alamaing 9
2.5	Did the project prop	onent nave meetings with related st	takenoiders during the project planning ?
		(mark the corresponding stakend	blders)
	Vac		
	1 05	Local residents/villager	8
		NGUS	
		Others (to specify)	
	N		
	NO		
2.6	Are any of the follow	wing areas located inside or around	the project site ?
		(mark related items listed below	
		National park, wildlife	sanctuary, protected area designated by the government
		Virgin forests, tropical	forests
		Ecological important ha	abitat areas
		Habitat of valuable spe	cies protected by domestic laws or international treaties
	Yes	Likely salt cumulus or	soil erosion areas on a massive scale
		Remarkable desertificat	tion trend areas
			1 1/ 1 1 1
		Archaeological, historic	cal or cultural valuable areas
		Living areas of ethnic, i	indigenous people or nomads who have a traditional
	N.	Infestyle or specifically	valuable areas
	INO		
27	My the project have	notantial nagative impacts to the e	nvironment and local communities?
2.1	wig the project have	(brief description of the potentia	l negative impacts)
	Ves	(biter description of the potentia	in negative impacts)
	105		
	No		
	Not ide	entified	
2.8	Mark the related pote	ntial environmental and social impa	acts and describe briefly the contents of the impacts, if any.
	Items of	f 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/o	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 featu	res	Gender issue
	Bottom sediment		Children's rights
	Biota and ecosystem	n	Natural and/or cultural heritages
	Potential conflict of	n water use rights	Infectious diseases such as HIV/AIDS, etc.
	Public health and h	ygiene	Others if any
	Global warming		
	Involuntary resettle	ment	
0	utline of related impa	cts marked as above:	
	(1)	(2)	)
	(3)	(4)	)
2.9	Key Results of the Er	ivironmental Screening	

Source: JICA Study Team

Table AP-D.1.3	A Generic "Scope of Work Ite	ems for Conducting an IEIA and/or EIA"
----------------	------------------------------	--

		Scope of Work Items	Remarks
L	Stud	v on contents and rationale of proposed project	
	1.	Project site location	
	2	Project rationale	
	3	General layout of project facilities	
	4	Principal design features	
	5	Description by project phases	
		a Pre-construction activities	
		b Construction activities	
		c. Project operation activities	
II.	Stud	v on natural environmental conditions	
	1.	Physical environment	
		a Geology	
		b. Topography	
		c. Soil characteristics	Composition, heavy metals, etc. For Category II or Category C projects.
			this item will not be required.
		d. Meteorology	
		e. Hydrology	
		f. Air quality	
		g. Water quality	Parameters are temperature, pH, turbidity, DO, BOD, COD, Ca, Mg, Zn,
		i) concerned river	total P, total N, Cyanides, heavy metals, phenol, etc. For Category II or
		ii) groundwater	Category C projects, this item will not be needed.
		h. Sediments of concerned river	Sediment transport, particle size distribution, seasonal variation,, etc. For
			Category II or Category C projects, this item will not be required.
	2.	Biological environment	
		a. Terrestrial flora and fauna	
		b. Aquatic flora and fauna	
		c. Rare, endangered or protected species in the project area and its	
		vicinity	
III.	Stud	y on socio-economic and cultural environment	
	1.	Demographics and population characteristics	
	2.	Community structures	
	3.	Employment and labor market, economic activities, main income sources	
		and income levels	
	4.	Agriculture, forestry, livestock breeding and fisheries	
	З. 6	Dublic health and husiane	
	7		
	/. 0	Pagrantian	
	0.	Cultural properties and heritages	
	10	Indigenous people and their communities	
IV.	Stud	v on future environmental conditions without project	
		*	
V.	Envi	ronmental impact assessment	During construction and operation phases
	1.	Potential impacts on physical environment	
		a. Study on each item of II.1 above	
		b. Study on noise conditions	
	2.	Potential impacts on biological environment	
		a. Study on each item of II.2 above	
	3.	Potential impacts on socio-economic environment	
		a. Impacts on livelihood of concerned villagers and communities	
		b. Impacts on agricultural/industrial activities	
		c. Impacts on employment and labor market	
		d. Impacts on land use	Land acquisition and others
		e. Impacts on water uses	
		f. Impacts on public health and hygiene	
		<ul> <li>g. Impacts on recreation, cultural properties and heritages</li> </ul>	
VI.	Rese	ttlement Issues	If resettlement is required.
	1.	Number of households and people to be resettled	
	2.	New locations (host area) for resettlement	
	3.	Resettlement and compensation plan	
VII	4.	Livelihood improvement plan for resettled people	
VII.	Envi	ronmentai wanagement Pian	I have not be required for the projects of Category II or Category
	1	Impact avoidance and mitigation measures	<u> </u>
	1.	a Measures for physical environmental impacts	
		b. Measures for biological environmental impacts	
		c. Measures for socio-economic impacts	
		d Programs for implementing measures	
	2.	Environmental Monitoring Plan	
		a. During construction phase	
		b. During operation phase	
	3.	Institutional responsibilities and agreements for implementation of the	
		Environmental Management Plan	
VIII.	Com	parison between with and without project	

Source: JICA Study Team

#### Table AP-D.1.4 Environmental Screening for "Bay Srok" MHP Project

		_	(A check list for proposed MHP project)
1.	General In	formation	
	<ul><li>Name of</li><li>Name of</li></ul>	the propos Project ow	ed project: <b>Bay Srok MHP Project</b> vner/proponent: not decided yet
	• Pro	ject Execu	tion Organization : not decided yet
	• Nai	me of auth	orized person(s) responsible for the project : not decided yet
	• Inform	nation rega	rding the project site
	• Nai	me of the v	illage, commune, district and province :
	Bay	y Srok Vill	age, Bay Srok Commune, Lamphat District, Rattana Kiri Province
	• Oth	ter informa	tion regarding the village(s) the project site area belongs :
	Site	e".	arated document titled The Results of Interview and Field Survey of Bay Stok MHP Project
2.	Outline of t	the Propos	ed Project
2.1	Information	on project	characteristics
	(1) Ne	eds involu	ntary resettlement
		Yes	Scale: households, persons
		No	
	(2) Gr	oundwater	pumping
		Yes	Scale: m <sup>3</sup> /year
		No	
	(3) La	nd reclama	ation, land development and land cleaning
		Yes	Scale: hectors
		No	
	(4) Lo	gging	
	(4) Lo	gging Yes	Scale: about 0.5 hectors for power house space
2.2	(4) Lo	ogging Yes No of the pro	Scale: about 0.5 hectors for power house space
2.2	(4) Lo • Description • Th Po Is the project	gging Yes No of the pro Main c ne MHP wi ower is 170	Scale: about 0.5 hectors for power house space
2.2 2.3	(4) Lo (4) Lo (4) Lo (4) Lo (5) (4) Lo (5) (4) Lo (5) (5) (5) (5) (5) (5) (5) (5)	gging Yes No of the pro Main c ne MHP wi ower is 170	Scale: about 0.5 hectors for power house space         ject         lesign specifications:         Ill utilize the water head difference of the O Sien Ler Waterfall. Gross head is 23.2 m. Potentia         kW.         tt with the higher program/policy ?         (outline of the higher program/policy)         Rural electrification plans in the Province
2.2 2.3	(4) Lo • Description • Th Po Is the project	gging Yes No of the pro Main c ne MHP wi ower is 170	Scale: about 0.5 hectors for power house space         ject         lesign specifications:         ill utilize the water head difference of the O Sien Ler Waterfall. Gross head is 23.2 m. Potentia         ikW.         nt with the higher program/policy ?         (outline of the higher program/policy)         Rural electrification plans in the Province
<ul><li>2.2</li><li>2.3</li></ul>	(4) Lo • Description • Th Po Is the projec	gging Yes No of the pro Main o he MHP wi ower is 170 et consister Yes No	Scale: about 0.5 hectors for power house space         ject         lesign specifications:         Ill utilize the water head difference of the O Sien Ler Waterfall. Gross head is 23.2 m. Potentia         kW.         nt with the higher program/policy ?         (outline of the higher program/policy)         Rural electrification plans in the Province
2.2 2.3	(4) Lo • Description • Th Po Is the project • Any alterna	gging Yes No of the pro Main c ne MHP wi ower is 170 ct consister Yes No	Scale: about 0.5 hectors for power house space         ject         lesign specifications:         ill utilize the water head difference of the O Sien Ler Waterfall. Gross head is 23.2 m. Potentia         vkW.         tt with the higher program/policy ?         (outline of the higher program/policy)         Rural electrification plans in the Province
<ul><li>2.2</li><li>2.3</li><li>2.4</li></ul>	(4) Lo (4) Lo (4) Lo (5) (4) Lo (5) (4) Lo (5) (6) (6) (7) (7) (7) (7) (7) (7) (7) (7	gging Yes No of the pro Main c ne MHP wi ower is 170 ct consister Yes No	Scale: about 0.5 hectors for power house space         ject         lesign specifications:         ill utilize the water head difference of the O Sien Ler Waterfall. Gross head is 23.2 m. Potentia         ikW.         nt with the higher program/policy ?         (outline of the higher program/policy)         Rural electrification plans in the Province         dered before the project ?         (outline of the alternatives)
2.2 2.3 2.4	(4) Lo (4) Lo (4) Lo (5) (4) Lo (5) (4) Lo (5) (5) (5) (5) (5) (5) (5) (5)	gging Yes No of the pro Main c me MHP wi ower is 170 ct consister Yes No tives consi Yes	Scale: about 0.5 hectors for power house space         ject         lesign specifications:
2.2 2.3 2.4	(4) Lo (4) Lo (4) Lo (5) (4) Lo (5) (4) Lo (5) (4) Lo (5) (5) (5) (5) (5) (5) (5) (5)	gging Yes No of the pro Main of the MHP with ower is 170 et consister Yes No tives consi	Scale: about 0.5 hectors for power house space         ject         lesign specifications:         Ill utilize the water head difference of the O Sien Ler Waterfall. Gross head is 23.2 m. Potentia         vkW.         it with the higher program/policy ?         (outline of the higher program/policy)         Rural electrification plans in the Province         dered before the project ?         (outline of the alternatives)         O Ka Tieng MHP and other few candidate MHPs are also under consideration.
2.2 2.3 2.4	(4) Lo (4) Lo (4) Lo (4) Lo (5) (4) Lo (5) (4) Lo (5) (5) (5) (5) (5) (5) (5) (5)	gging Yes No of the pro Main C ne MHP wi ower is 170 ct consister Yes No tives consi Yes No	Scale: about 0.5 hectors for power house space         ject         lesign specifications:         ill utilize the water head difference of the O Sien Ler Waterfall. Gross head is 23.2 m. Potentia         ht with the higher program/policy ?         (outline of the higher program/policy)         Rural electrification plans in the Province         dered before the project ?         (outline of the alternatives)         O Ka Tieng MHP and other few candidate MHPs are also under consideration.
<ul><li>2.2</li><li>2.3</li><li>2.4</li><li>2.5</li></ul>	(4) Lo (4) Lo (4) Lo (4) Lo (5) (4) Lo (6) (6) (6) (6) (6) (6) (6) (6)	gging Yes No of the pro Main c ne MHP wi ower is 170 ct consister Yes No tives consi Yes No	Scale: about 0.5 hectors for power house space         ject         lesign specifications:         ill utilize the water head difference of the O Sien Ler Waterfall. Gross head is 23.2 m. Potentia         vkW.         nt with the higher program/policy ?         (outline of the higher program/policy)         Rural electrification plans in the Province         dered before the project ?         (outline of the alternatives)         O Ka Tieng MHP and other few candidate MHPs are also under consideration.         ent have meetings with related stakeholders during the project planning ?
<ul><li>2.2</li><li>2.3</li><li>2.4</li><li>2.5</li></ul>	(4) Lo (4) Lo (4) Lo (4) Lo (5) (4) Lo (6) (6) (6) (6) (6) (7) (6) (7) (7) (7) (7) (7) (7) (7) (7	gging Yes No of the pro Main c me MHP wi ower is 170 et consister Yes No tives consi Yes No	Scale: about 0.5 hectors for power house space         ject         lesign specifications:         Ill utilize the water head difference of the O Sien Ler Waterfall. Gross head is 23.2 m. Potentia         0 kW.         nt with the higher program/policy ?         (outline of the higher program/policy)         Rural electrification plans in the Province         dered before the project ?         (outline of the alternatives)         O Ka Tieng MHP and other few candidate MHPs are also under consideration.         ent have meetings with related stakeholders during the project planning ?
<ul><li>2.2</li><li>2.3</li><li>2.4</li><li>2.5</li></ul>	(4) Lo (4) Lo (4) Lo (4) Lo (5) (4) Lo (5) (4) Lo (5) (4) Lo (5) (5) (5) (5) (5) (5) (5) (5)	gging Yes No of the pro Main of he MHP wi ower is 170 et consister Yes No tives consi Yes No	Scale: about 0.5 hectors for power house space         ject         lesign specifications:         Ill utilize the water head difference of the O Sien Ler Waterfall. Gross head is 23.2 m. Potentia         0 kW.         nt with the higher program/policy ?         (outline of the higher program/policy)         Rural electrification plans in the Province         dered before the project ?         (outline of the alternatives)         O Ka Tieng MHP and other few candidate MHPs are also under consideration.
<ul><li>2.2</li><li>2.3</li><li>2.4</li><li>2.5</li></ul>	(4) Lo (4) Lo (4) Lo (4) Lo (5) (4) Lo (5) (4) Lo (5) (4) Lo (5) (5) (5) (5) (5) (5) (5) (5)	gging Yes No of the pro Main o Me MHP wi ower is 170 et consister Yes No tives consi Yes No Yes	Scale: about 0.5 hectors for power house space         ject         lesign specifications:         Il utilize the water head difference of the O Sien Ler Waterfall. Gross head is 23.2 m. Potentia         v kW.         nt with the higher program/policy ?         (outline of the higher program/policy)         Rural electrification plans in the Province         dered before the project ?         (outline of the alternatives)         O Ka Tieng MHP and other few candidate MHPs are also under consideration.         ent have meetings with related stakeholders during the project planning ?         (mark the corresponding stakeholders)         Image: Administrative body/local government         Local residents/villagers
<ul><li>2.2</li><li>2.3</li><li>2.4</li><li>2.5</li></ul>	(4) Lo • Description • The Po Is the project • Any alternat • Did the proj	gging Yes No of the pro Main of he MHP wi ower is 170 et consister Yes No tives consi Yes No ject propor	Scale: about 0.5 hectors for power house space         ject         lesign specifications:         Ill utilize the water head difference of the O Sien Ler Waterfall. Gross head is 23.2 m. Potentia         kW.         nt with the higher program/policy ?         (outline of the higher program/policy)         Rural electrification plans in the Province         dered before the project ?         (outline of the alternatives)         O Ka Tieng MHP and other few candidate MHPs are also under consideration.         ent have meetings with related stakeholders during the project planning ?         (mark the corresponding stakeholders)         Administrative body/local government         Local residents/villagers
<ul><li>2.2</li><li>2.3</li><li>2.4</li><li>2.5</li></ul>	(4) Lo • Description • The Po Is the project • Any alternat • Did the proj	gging         Yes         No         of the pro- Main of the MHP with ower is 170         ct consister         Yes         Yes         No         tives consi         Yes         No         tives consi         Yes         No         tect propor         Yes	Scale: about 0.5 hectors for power house space         ject         lesign specifications:         III utilize the water head difference of the O Sien Ler Waterfall. Gross head is 23.2 m. Potentia         vkW.         nt with the higher program/policy ?         (outline of the higher program/policy)         Rural electrification plans in the Province         dered before the project ?         (outline of the alternatives)         O Ka Tieng MHP and other few candidate MHPs are also under consideration.         ent have meetings with related stakeholders during the project planning ?         (mark the corresponding stakeholders)         Administrative body/local government         Local residents/villagers         NGOs         Others (to specify)
<ul><li>2.2</li><li>2.3</li><li>2.4</li><li>2.5</li></ul>	(4) Lo • Description • Th Po Is the project • Any alternat • Did the proj	gging       Yes       No       of the pro- Main control       Main control       Main control       Wer is 170       ct consister       Yes       No       tives consi       Yes       No       ect propor       Yes       Yes       Yes       Yes	Scale: about 0.5 hectors for power house space         ject         lesign specifications:         II utilize the water head difference of the O Sien Ler Waterfall. Gross head is 23.2 m. Potentia         ikW.         nt with the higher program/policy ?         (outline of the higher program/policy)         Rural electrification plans in the Province         dered before the project ?         (outline of the alternatives)         O Ka Tieng MHP and other few candidate MHPs are also under consideration.         ent have meetings with related stakeholders during the project planning ?         (mark the corresponding stakeholders)         Administrative body/local government         Local residents/villagers         NGOs         Others (to specify)

2.6	Are any of the follow	ing areas located inside or around th	e project site ?
		(mark related items listed below)	
		National park, wildlife sa	anctuary, protected area designated by the government
		Virgin forests, tropical for	prests
		Ecological important has	pitat areas
		Habitat of valuable speci	es protected by domestic laws or international treaties
	Yes	Likely salt cumulus or so	nil erosion greas on a massive scale
		Discrysal cultures of se	
		Remarkable desertification	on trend areas
		Archaeological historica	l or cultural valuable areas
		Living areas of ethnic in	digenous people or nomads who have a traditional
			shighly areas
		lifestyle or specifically v	aluable areas
	No		
2.7	My the project have p	otential negative impacts to the env	ironment and local communities?
		(brief description of the potential	negative impacts)
	Vec	(orier description of the potential	negative inipides)
	1 05		
	• No		
	Not ide	entified	
	<u>.</u>		
28	Mark the related note:	ntial environmental and social impa	cts and describe briefly the contents of the impacts if any
2.0	Items of	notential impacts	Items of notential impacts
		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/o	r solid)	Poverty issue
	Causing noise and y	vibration	Ethnic and /or indigenous people
	Ground subsidence	lotation	Misdistribution of honofite
	Offensive odors		Local conflict of interests among villagers
	Geographical featur	es	Gender issue
	Bottom sediment		Children's rights
	Biota and ecosystem	n	Natural and/or cultural heritages
	Potential conflict or	n water use rights	Infectious diseases such as HIV/AIDS, etc.
	Public health and hy	vgiene	Others if any
	Global warming	y Bielle	ould bit uny
	Involuntary resettle	ment	
Rem	arks: No any negative	e impacts would be caused to such it	ems as listed above.
2.9	Key results of the env	rironmental screening :	
(1)	The candidate project	ct site is located outside of any "Pro	tected Area".
$\dot{\alpha}$	The MHP will utiliz	e the head difference of the O Sien	Ler Waterfall having seven (7) cascades existing along O Sien
(-)	Ler River The loca	tion is in the area of Bay Srok Villa	ge Bay Srok Commune Rattana Kiri Province
( <b>3</b> )	The 7 cascades wate	with its in the urea of Buy Stok Ving	rovincial Pural Development Committee (the Committee)
$(\mathbf{J})$	The weterfall is a ter	uniam anot	Tovincial Rural Development Committee (the Committee).
	The waterial is a to		., ,
(4)	From the above, the	following key factors should be cor	isidered:
	1) In spite that the	e project site will be outside of any l	Protected Area, carrying out IEIA is recommended. The IEIA
	must be approv	ved by the MOE.	
	<ol><li>Stakeholders m</li></ol>	neeting shall be held at various stage	e from the project planning to reflect opinions and comments
	concerned part	ies, especially those of the villagers	and the Committee.
	3) During dry sea	son operations of the MHP will be	limited during night time to mitigate impacts to the tourism
	The operationa	I scheme shall be accented by the n	arties concerned
(5)	The eres of Pay Sro	k village and its visipity is a place h	aving som stone resource. Collection and processing of som
$(\mathbf{J})$	The area of Day Sio	k village and its vicinity is a place in	aving gein sione resource. Conection and processing of gein
	stones are true major	r income sources of the villagers. A	s of January 2005, average income amount per nousenoid here
	1s about 150,000 Rie	el (US\$38) which is much higher that	in that of other villages in the Province. Therefore, population
	of the village is increased	easing, which causes electricity dem	and also being increased.
(6)	For details of the so	cial-economic conditions of the villa	age, refer to a separated document "The Results of Interview
. ,	and Field Survey of	Bay Srok MHP Project Candidate S	ite".
	Source: IICA Study	Team	
	Source. FICH Study	i cuiti	

#### Table AP-D.1.5 Environmental Screening for "O Phlai" MHP Project

	(	A ch	eck list	for prop	posed MHP	project)
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#### 1 General Information

- Name of the proposed project: O Phlai MHP Project
- Name of Project owner/proponent: Not defined yet
- Project Execution Organization : not decided ne
- 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:
- Sre Om Pum Commune, Pecher Chenda District, Mondul Kiri Province
- Other information regarding the village(s) the project site area belongs:
  - There are three (3) villages in the Commune. No waterfalls exist in the Commune area.

#### 2 Outline of the Proposed Project

#### 2.1 Information on project characteristics

(1) Ne	1) Needs involuntary resettlement					
	Yes	Scale: households, persons				
	No					
(2) Gro	oundwater	pumping				
	Yes	Scale: m <sup>3</sup> /year				
	No					
(3) Lai	nd reclama	ation, land development and land cleaning				
	Yes	Scale: hectors				
	No					
(4) Log	(4) Logging					
$\bullet$	Yes	Scale: about 0.3 hectors				
	No					

2.2 Description of the project

Main design specifications:

- (1) Gross head : 20m (another 20 m available along the O Phlai River)
- (2) Potential power : 45 kW
- 2.3 Is the project consistent with the higher program/policy ?

•	Yes	(outline of the higher program/policy)
	No	

#### 2.4 Any alternatives considered before the project ?

•	Yes	(outline of the alternatives) Bu Sra MHP, which will use the head of Bu Sra Waterfall.
	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	

		(mark related items listed below)
		• National park, wildlife sanctuary, protected area designated by the governm
	Yes	Virgin forests tropical forests
		Ecological important habitat areas
•		Habitat of valuable species protected by domestic laws or international treat
		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	
My the p	project have p	otential negative impacts to the environment and local communities ?
		(brief description of the potential negative impacts)
	Vac	
	Yes	
	Yes	
	Yes No Not ide	ntified
	Yes No Not ide	ntified
Mark the	Yes No Not ide e related poter	ntified ntial environmental and social impacts and describe briefly the contents of the impacts,
Mark the	Yes No Not ide e related poter Items of	ntified ntial environmental and social impacts and describe briefly the contents of the impacts, potential impacts Items of potential impacts
Mark the	Yes No Not ide e related poter Items of Ilution	ntified ntial environmental and social impacts and describe briefly the contents of the impacts, potential impacts Local economy, employment, livelihood, en
Mark the Air po Water	Yes No Not ide e related poter Items of Ilution pollution	ntified ntial environmental and social impacts and describe briefly the contents of the impacts, potential impacts Items of potential impacts Local economy, employment, livelihood, end Land use and utilization of local resources
Mark the Air po Water Soil po	Yes No Not ide e related poter Items of Ilution pollution	ntified ntial environmental and social impacts and describe briefly the contents of the impacts, potential impacts Local economy, employment, livelihood, et Land use and utilization of local resources Existing social infrastructures and services
Mark the Air po Water Soil pc Waste	Yes No Not ide e related poter Items of Ilution pollution Ollution (liquid and/or	ntified ntial environmental and social impacts and describe briefly the contents of the impacts, potential impacts Local economy, employment, livelihood, et Land use and utilization of local resources Existing social infrastructures and services r solid) Poverty issue
Mark the Air po Water Soil po Waste Causin	Yes No Not ide related poter Items of Ilution pollution Ollution (liquid and/on ng noise and v	ntified ntial environmental and social impacts and describe briefly the contents of the impacts, potential impacts Local economy, employment, livelihood, et Local economy, employment, livelihood, et Land use and utilization of local resources Existing social infrastructures and services r solid) Poverty issue tibration Ethnic and /or indigenous people
Mark the Air po Water Soil pc Waste Causin Groum	Yes No Not ide related poter Items of Ilution pollution Ollution (liquid and/or ng noise and v d subsidence	ntified ntial environmental and social impacts and describe briefly the contents of the impacts, potential impacts Local economy, employment, livelihood, et Land use and utilization of local resources Existing social infrastructures and services r solid) Poverty issue ibitation Ethnic and /or indigenous people Misdistribution of benefits
Mark the Air po Water Soil po Waste Causin Ground Offens	Yes No Not ide related poter Items of Ilution pollution ollution (liquid and/on ng noise and v d subsidence sive odors	ntified ntial environmental and social impacts and describe briefly the contents of the impacts, potential impacts Local economy, employment, livelihood, et Land use and utilization of local resources Existing social infrastructures and services r solid) Poverty issue vibration Ethnic and /or indigenous people Misdistribution of benefits Local conflict of interests among villagers
Mark the Air po Water Soil po Waste Causin Ground Offens Geogra	Yes No Not ide related poter Items of Ilution pollution Ollution (liquid and/on ng noise and v d subsidence sive odors aphical featur	ntified ntial environmental and social impacts and describe briefly the contents of the impacts, potential impacts Local economy, employment, livelihood, et Land use and utilization of local resources Existing social infrastructures and services r solid) Poverty issue vibration Ethnic and /or indigenous people Misdistribution of benefits Local conflict of interests among villagers es Gender issue
Mark the Air po Water Soil po Waste Causin Ground Offens Geogra Bottom	Yes No Not ide e related poter Items of Ilution pollution ollution (liquid and/or ng noise and v d subsidence sive odors aphical featur n sediment	ntified ntial environmental and social impacts and describe briefly the contents of the impacts, potential impacts Local economy, employment, livelihood, et Land use and utilization of local resources Existing social infrastructures and services r solid) Poverty issue ribration Ethnic and /or indigenous people Misdistribution of benefits Local conflict of interests among villagers es Gender issue Children's rights
Mark the Air po Water Soil po Waste Causin Ground Offens Geogra Botton Biota a	Yes No Not ide e related poter Items of Ilution pollution (liquid and/on ng noise and v d subsidence sive odors aphical feature n sediment and ecosystem	ntified ntial environmental and social impacts and describe briefly the contents of the impacts, potential impacts Local economy, employment, livelihood, et Land use and utilization of local resources Existing social infrastructures and services r solid) Poverty issue ribration Ethnic and /or indigenous people Misdistribution of benefits Local conflict of interests among villagers es Gender issue Children's rights Natural and/or cultural heritages
Mark the Air po Water Soil po Waste Causin Groun Offens Geogra Botton Biota a Potenti	Yes No Not ide e related poter Items of Ilution pollution ollution (liquid and/on ng noise and v d subsidence sive odors aphical feature n sediment and ecosystem ial conflict on	ntified ntial environmental and social impacts and describe briefly the contents of the impacts, potential impacts Local economy, employment, livelihood, et Land use and utilization of local resources Existing social infrastructures and services r solid) Poverty issue ibration Ethnic and /or indigenous people Misdistribution of benefits Local conflict of interests among villagers es Gender issue Children's rights Natural and/or cultural heritages Natural and/or cultural heritages Natural and/or cultural heritages Children's rights Children's rights Children's farme
Mark the Air po Water Soil po Waste Causin Ground Offens Geogra Botton Biota a Potenti Public Clebel	Yes No Not ide related poter Items of Ilution pollution (liquid and/on ng noise and v d subsidence sive odors aphical feature and ecosystem ial conflict on health and hy	ntified ntial environmental and social impacts and describe briefly the contents of the impacts, potential impacts Items of potential impacts Local economy, employment, livelihood, et Local economy, employment, livelihood, et Land use and utilization of local resources Existing social infrastructures and services r solid) Poverty issue ribration Ethnic and /or indigenous people Misdistribution of benefits Local conflict of interests among villagers res Gender issue Children's rights n Natural and/or cultural heritages Natural and/or cultural heritages Natural and/or cultural heritages Others if any
Mark the Air po Water Soil pc Waste Causin Ground Offens Geogra Botton Biota a Potenti Public Global	Yes No Not ide related poter Items of Ilution pollution (liquid and/on ng noise and v d subsidence sive odors aphical featur n sediment and ecosystem ial conflict on health and hy warming	ntified ntial environmental and social impacts and describe briefly the contents of the impacts, potential impacts Local economy, employment, livelihood, et Local economy, employment, livelihood, et Land use and utilization of local resources Existing social infrastructures and services Existing social infrastructures and services r solid) Poverty issue ribration Ethnic and /or indigenous people Misdistribution of benefits Local conflict of interests among villagers es Gender issue Children's rights Natural and/or cultural heritages Natural and/or cultural heritages Natural and/or cultural heritages Others if any

- (2) Bu Sra Waterfall will not be touched. The waterfall exists along another river called Prek Por River.
- (3) It is intended to supply the installed power only to Bu Sra Commune. This may cause problem with the villagers living in the Sre Om Pum Commune. The generated power should also be supplied the Sre Om Pum where the MHP will be located.
- (4) For details of livelihood and others of the Sre Om Pum Commune, see Interviews/Field Survey records as attached.

Source: JICA Study Team

1

#### Table AP-D.1.6 Environmental Screening for "Stung Sangke (D/S)" MHP Project

#### General Information

- (A check list for proposed MHP project)

- Name of the proposed project: Sangke (D/S) 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 ٠
- Name of the village, commune, district and province :
  - Ratanak Mondul and Samlout 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) Ne	eds involu	ntary resettlement			
	Yes	Scale: households, persons			
•	No				
(2) Gro	(2) Groundwater pumping				
	Yes	Scale: m <sup>3</sup> /year			
•	No				
(3) Lar	nd reclama	tion, land development and land cleaning			
	Yes	Scale: hectors			
$\bullet$	No				
(4) Log	gging				
•	Yes	Scale: about 0.5 hectors for power house space			
	No				

#### 2.2 Description of the project

Main design specifications:

The MHP will utilize the water flow of Stung Sangke River. Gross head is 15 m. Potential Power is 118 kW.

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

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

2.4 Any alternatives considered before the project?

•	Yes	(outline of the alternatives) O Samrel MHP, Ta Taok MHP, Kampong Lpov MHP an dothers
	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	

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

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
Local economy, employment, livelihood, etc.
Land use and utilization of local resources
Existing social infrastructures and services
Poverty issue
Ethnic and /or indigenous people
Misdistribution of benefits
Local conflict of interests among villagers
Gender issue
Children's rights
Natural and/or cultural heritages
Infectious diseases such as HIV/AIDS, etc.
Others if any

Remarks: No any negative impacts would be caused to such items as listed above.

2.9 Key results of the environmental screening :

- (1) The candidate project site is located outside of any "Protected Area".
- (2) Therefore, only the Report of the Environmental Screening would be required to be submitted to the Provincial Authority (Battambang Province) for the project approval.
- (3) Due to a lot of land mines are still remained in and around the area, detailed field surveys are still not possible. To complete a more certain report on the Environment Screening, land mine cleaning will be required in advance.

Source: JICA Study Team

1

#### Table AP-D.1.7 Environmental Screening for "Stung Sangke (U/S)" MHP Project

# (A check list for proposed MHP project)

- General Information
- Name of the proposed project: Sangke (U/S) 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 ٠
- Name of the village, commune, district and province :
- Ratanak Mondul and Samlout Districts, Battambang Province
- Other information regarding the village(s) the project site area belongs :
- 2 Outline of the Proposed Project

#### Information on project characteristics 2.1

(1) Ne	eds involu	ntary resettlement
	Yes	Scale: households, persons
•	No	
(2) Gro	oundwater	pumping
	Yes	Scale: m <sup>3</sup> /year
•	No	
(3) Lar	nd reclama	tion, land development and land cleaning
	Yes	Scale: hectors
$\bullet$	No	
(4) Log	gging	
•	Yes	Scale: about 0.5 hectors for power house space
	No	

#### Description of the project 2.2

.

Main design specifications:

- The MHP will utilize the water flow of Stung Sangke River. Gross head is 15 m. Potential Power is 118 kW.
- 2.3 Is the project consistent with the higher program/policy ?

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

2.4 Any alternatives considered before the project ?

•	Yes	(outline of the alternatives) O Samrel MHP, Ta Taok MHP, Kampong Lpov MHP an dothers
	No	

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

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

	(mark related items listed below)
	National park, wildlife sanctuary, protected area designated by the government
	Virgin forests, tropical forests
	Ecological important habitat areas
	Habitat of valuable species protected by domestic laws or international treaties
Yes	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 My the project have potential negative impacts to the environment and local communities ?

Yes	(brief description of the potential negative impacts)
No	
Not ider	ntified

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: No any negative impacts would be caused to such items as listed above.

2.9 Key results of the environmental screening :

(1) The candidate project site will be located on the boundary of Samlot Protected Area (Protected Landscape).

(2) Therefore, carrying out IEIA will be required, and the report shall be submitted to the MOE for review and approval.(3) Due to a lot of land mines are still remained in and around the area, detailed field surveys are still not possible. To carry

out an IEIA, land mine cleaning will be required in advance.

Source: JICA Study Team

#### Table AP-D.1.8 Environmental Screening for "Stung Tatai (D/S)" MHP Project (A check list for proposed MHP project) General Information 1 Name of the proposed project: Tatai (D/S) MHP Project Name of Project owner/proponent: Not defined 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: Kokir Chrum and Trapeang Chuetrav Villages, Thmabang District, Koh Kong Province • Other information regarding the village(s) the project site area belongs: This project site is outside of any Protected Area. It is accessible by vehicle. There are about 140 households in the villages. 2 Outline of the Proposed Project 2.1 Information on project characteristics (1) Needs involuntary resettlement Yes Scale: households, persons No . (2) Groundwater pumping m<sup>3</sup>/year Yes Scale: No ٠ (3) Land reclamation, land development and land cleaning Yes Scale: hectors No (4) Logging about 0.3 hectors . Yes Scale: No Description of the project 2.2 Main design specifications: (1) Gross head : 32 m (along Stung Tatai River) (2) Potential power : 62 kW 2.3 Is the project consistent with the higher program/policy ? (outline of the higher program/policy) Yes National Rural Electrification Plan No 2.4 Any alternatives considered before the project ? (outline of the alternatives) Yes Tatai (U/S) MHP, O Sla (D/S) MHP, Chhay Areng (D/S) MHP, etc. 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 are	eas located inside or around the	e project site ?								
(mai	rk related items listed below)	1 3								
	National park, wildlife sa	nctuary, protected area designated by the government								
	Virgin forests, tropical for	rests								
	Ecological important habitat areas									
Yes	Habitat of valuable species protected by domestic laws or international treaties									
	Likely salt cumulus or soil erosion areas on a massive scale									
	Remarkable desertificatio	n trend areas								
	Archaeological, historical	or cultural valuable areas								
	Living areas of ethnic, inc lifestyle or specifically va	digenous people or nomads who have a traditional								
• No										
·										
2.7 My the project have potenti	al negative impacts to the envi	ironment and local communities ?								
(brie	ef description of the potential r	negative impacts)								
Yes										
• No										
Not identified	1									
Not identified										
2.8 Mark the related potential er	vironmental and social impac	ts and describe briefly the contents of the impacts, if any.								
Items of potent	tial 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	on	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: No any negative enviro	onmental impacts would be cau	used to such items as listed above.								

2.9 Key Results of the Environmental Screening:

(1) The project site is located outside of any Protected Area. Therefore, only the Environmental Screening Report would be required. The Report shall be submitted to the Provincial Authority (Koh Kong Province) for its review and approval.

Stakeholders meetings will be required on every stage from the project planning to reflect opinions, comments and desires of the concerned parties, especially those of the villagers. Project information shall be made available to the concerned parties.

Source: JICA Study Team

# **APPENDIX-E**

Economic and Financial Analysis

#### THE MASTER PLAN STUDY ON RURAL ELECTRIFICATION BY RENEWABLE ENERGY IN THE KINGDOM OF CAMBODIA

#### FINAL REPORT VOLUME 5 : APPENDICES

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# Appendix-E Economic and Financial Analysis

# 1. FINANCIAL ANALYSIS

# 1.1 FINANCIAL ANALYSIS AT EDC

#### Summary

Electricity sales and power generation have increased along with the increase in the number of customers. However, the gross profits decreased from Riel 32.0 billion in 2002 to Riel 24.4 billion in 2003 due to high electricity production cost and insufficient electricity tariffs. The EdC's liquidity and financial operation remains unsatisfactory and would continue to remain so way as long as (i) electricity supplies are based almost entirely on costly imported fuel; (ii) EdC is unable to recover costs through tariff increase; and (iii) outstanding Government and Municipalities' arrears remain large. Consequently, EdC will not be able to earn sufficient profits to provide any significant investment for rehabilitation or expansion through self-finance. In order to obtain revenues to cover no less than their operating expenses and debt service requirements, EdC needs to improve their expense profit structure by (i) reduction of electricity production costs; (ii) rationalization of insufficient electricity tariffs; and (iii) reduction of overdue arrears.

#### 1.1.1 Past Financial Performance and Present Financial Position

Electricity sales and power generation have increased along with the increase in number of customers (Figure AP-E.1.1 and AP-E.1.2). However, gross profit and net operating income decreased in 2003 (Figure AP-E.1.3) due to: 1) high electricity production cost, 2) insufficient electricity tariffs.

- 1) Sales growth rate were 14.0% in 2002, 14.8% in 2003 (Figure AP-E.1.1).
- Cost of Sales/Sales (%) went up to 92.7% in 2003 from 89.1% in 2002. Therefore, gross profit decreased from Riel 32.0 billion in 2002 to Riel 24.4 billion in 2003 (Figure AP-E.1.3).
- 3) Net operating income decreased from Riel 3.4 billion in 2002 to Riel 0.9 billion in 2003 (Figure AP-E.1.3), in spite of Operation expenses/Sales (%) decrease from 9.8% in 2002 to 7.0% in 2003.
- 4) The level of system losses in PHN's decreased from 25.4% in 1999 to 12.7% in 2003 (Figure AP-E.1.5).

EdC's liquidity and financial operation remains unsatisfactory and would continue to remain that way as long as:

- 5) Electricity supplies are based almost entirely on costly imported fuel or purchased power from IPPs, both payable in US dollars. Yearly average international crude oil prices rose in 2004 following 2003.
- 6) EdC is unable to recover costs through tariff increase.
- 7) Account receivable decreased from Riel 90.9 billion in 2002 to Riel 55.4 billion in 2003 (Figure AP-E.1.7). Receivables for Government were improved, but outstanding Government arrears remain large. On the other hand, other assets increased from Riel

48.1 billion in 2002 to Riel 68.8 billion in 2003 (Figure AP-E.1.7). The greater part of other assets are import VAT on power purchases, fuel and spare parts which EDC will be reimbursed by the Government.

Consequently, EdC will not be able to earn sufficient profits (Figure AP-E.1.3) to provide any significant investment for rehabilitation or expansion through self-finance.

#### 1.1.2 Key Financial Issues and Remedial Measures

(1) High Electricity Production Cost

EdC's generation of electricity is exclusively based on imported fuel or IPP purchased power, and its cost are extremely sensitive to fuel price in the international market. The rise of the fuel price in 2003 had a strong effect on their electricity production cost, which similarly affected the purchase price from IPP. Such situation was continued to remain as it is in 2004 (Figure AP-E.1.6).

(2) Energy purchase in future

EdC is planning to reduce their purchase cost in future. EdC expects cost reduction through GMS Transmission Project funded by ADB and WB etc. EdC also have plans to purchase energy from IPPs instead of their own un-efficient generators.

#### (3) Insufficient Electricity Tariffs

The poor financial performance of EdC is largely due to inadequate tariffs to recover their electricity production cost. Moreover, average tariff decreased from 595 Riel/kWh in 2000 to 579 Riel/kWh in 2003 (Figure AP-E.1.4). In order to improve this situation, EDC applied to EAC for setting new tariffs in 2003, but they have not received permission yet, and new tariffs are not obtained.

(4) Outstanding Government and Municipalities' Arrears

Receivables for Government and Municipalities were improved, however outstanding Government arrears remain large. According to 'Aged Debtors Listing 2002 and 2003', Government's debt decreased from Riel 42.9 billion in 2002 to Riel 22.1 billion in 2003, Municipalities' debt decreased from Riel 10.0 billion in 2002 to Riel 2.7 billion in 2003.

(5) Distribution Losses in PHN's

There have been remarkable improvements in losses from 25.4% in 1999 to 12.7% in 2003 (Figure AP-E.1.5), due to : a) continuing rehabilitation and refurbishment by foreign aid, b) investigation and improvement of big customers.

(6) Power Development Plan and Financing

Neither EdC nor the Government has access to local funding and neither is in a position to provide substantial amount of counterpart funds for significant power sector expansion.

(7) Financial Action Plan

EDC is continuing efforts to improve their financial structure along with the Financial Action Plan which was approved by the Government in August 2003. Some improvements could be made, but its

progress is very slow.

i) Reduction of overdue Government and Municipalities' arrears

Receivables for Government and Municipalities were improved, but outstanding Government arrears remain large (2(4)).

ii) Reimbursement of VAT to EdC

EdC still have not received reimbursement of VAT. Other assets increased from Riel 48.1 billion in 2002 to Riel 68.8 billion in 2003 (Figure AP-E.1.7). The greater part of other assets are import VAT on power purchases, fuel and spare parts which EDC will be reimbursed by the Government.

(8) Remedial Measures

EdC should improve their expense profit structure in order to obtain revenues to cover no less than the sum of operating expenses and debt service requirements.

- i) Reduction of electricity production costs
  - Purchase cheaper energy from IPPs instead of their own un-efficient generators
  - Purchase cheaper electricity from neighbor countries. In this respect, it would be desirable to realize the GMS Transmission Project by ADB and WB at an early stage.
  - Reduction of distribution losses
- ii) Rationalization of insufficient electricity tariffs
  - In short-term, obtain a sufficient new tariff
  - In long-term, construct annually tariff setting mechanism which recover their electricity production cost and profit
- iii) Reduction of overdue arrears
  - Receivables for Government and Municipalities
  - Reimbursement of VAT from Government
  - Receivables for domestic consumers













					REE(Cost)	Battery	Charging							Battery	Charging
SOLAR	BCS			Cost Total	1,276,812,909	528,600,429	1,113,599,170	DG B	CS		Cost Total	1,232,727,320		528,600,429	1,162,866,418
	DR=	4%		NPV=	770,938,699	332,314,733	684,553,788		DR=	4%	NPV=	770,984,938		332,314,733	714,839,444
	Subsidy	39.4%	204,899,118				Unit: US\$	·	1					-	Unit: US\$
Year			REE (Solar	r)		Cus Battery	tomer	Year		T	REE (Solar)		1	Cus Battery	tomer
	Capital	O/M	Replacement	Cost	Remarks	(70Ah)	Charging		Capital	O/M	Replacement	Total Cost	Remarks	(70Ah)	Charging
2005	315,413,523			315,413,523	New installation	58,733,381	42,830,737	2005	83,874,377	7		83,874,377	installatio	58,733,381	44,725,631
2006		13,036,339		13,036,339		0	42,830,737	2006		39,166,663		39,166,663		0	44,725,631
2007		13,036,339		13,036,339		0	42,830,737	2007		39,166,663		39,166,663		0	44,725,631
2008		13,036,339		13,036,339		58,733,381	42,830,737	2008		39,166,663	7,212,642	46,379,305	DG	58,733,381	44,725,631
2009		13,036,339		13,036,339		0	42,830,737	2009		39,166,663		39,166,663		0	44,725,631
2010		13,036,339		13,036,339		0	42,830,737	2010		39,166,663		39,166,663		0	44,725,631
2011		13,036,339		13,036,339		58,733,381	42,830,737	2011		39,166,663	7,212,642	46,379,305	DG	58,733,381	44,725,631
2012		13,036,339		13,036,339		0	42,830,737	2012		39,166,663	0	39,166,663		0	44,725,631
2013		13,036,339		13,036,339		0	42,830,737	2013		39,166,663	0	39,166,663		0	44,725,631
2014		13,036,339		13,036,339		58,733,381	42,830,737	2014		39,166,663	7,212,642	46,379,305	DG Charge	58,733,381	44,725,631
2015		13,036,339	116,119,058	129,155,397	Charge controlle	0	42,830,737	2015		39,166,663	75,575,946	114,742,609	controller	0	44,725,631
2016		13,036,339		13,036,339		0	42,830,737	2016		39,166,663	0	39,166,663		0	44,725,631
2017		13,036,339		13,036,339		58,733,381	42,830,737	2017		39,166,663	7,212,642	46,379,305	DG	58,733,381	44,725,631
2018		13,036,339		13,036,339		0	42,830,737	2018		39,166,663	0	39,166,663		0	44,725,631
2019		13,036,339		13,036,339		0	42,830,737	2019		39,166,663	0	39,166,663		0	44,725,631
2020		13,036,339		13,036,339		58,733,381	42,830,737	2020		39,166,663	7,212,642	46,379,305	DG	58,733,381	44,725,631
2021		13,036,339		13,036,339		0	42,830,737	2021		39,166,663	0	39,166,663		0	44,725,631
2022		13,036,339		13,036,339		0	42,830,737	2022		39,166,663	0	39,166,663		0	44,725,631
2023		13,036,339		13,036,339		58,733,381	42,830,737	2023		39,166,663	7,212,642	46,379,305	DG	58,733,381	44,725,631
2024		13,036,339		13,036,339		0	42,830,737	2024		39,166,663	0	39,166,663	Charge	0	44,725,631
2025		13,036,339	116,119,058	129,155,397	Charge controlle	0	42,830,737	2025		39,166,663	75,575,946	114,742,609	controller	0	44,725,631
2026		13,036,339		13,036,339		58,733,381	42,830,737	2026		39,166,663	7,212,642	46,379,305	DG	58,733,381	44,725,631
2027		13,036,339		13,036,339		0	42,830,737	2027		39,166,663	0	39,166,663		0	44,725,631
2028		13,036,339		13,036,339		0	42,830,737	2028		39,166,663	0	39,166,663		0	44,725,631
2029		13,036,339		13,036,339		58,733,381	42,830,737	2029		39,166,663	7,212,642	46,379,305	DG	58,733,381	44,725,631
2030		13,036,339	403,252,803	416,289,141	PV, Charge Con., fittings	0	42,830,737	2030		0	0	0	Charge	0	44,725,631

 $\frac{1}{2}$ ECONOMIC ANALYSIS

Table AP-E.2.1

# **Economic Analysis for Solar BCS and Diesel Generator BCS**

JICA M/P Study on Rural Electrification by Renewable Energy in the Kingdom of Cambodia

AE-7

Appendix-E Economic and Financial Analysis

<u>Biomas</u> Genera	ss Gasific ation(min	ation Power i-grid)		REE(Cost)		Grid/ Connection	Annual Fee	<u>DG mi</u>	ni-grid			REE(cost)		Grid/ Connection	Annual Fee		BGPG	DG
			Cost Total	2,025,868,823		151,896,675	1,555,544,724				Cost Total	3,615,396,684		151,896,675	3,079,578,277	GWh/YR	291.6	291.6
	DR=	4%	NPV=	1,341,594,108		146,054,495	956,227,395		DR=	4%	NPV=	2,250,987,718		146,054,495	1,893,084,183	Electricity	7,583	7,583 GWh
			cost/kWh	0.288							cost/KWh	0.483				NPV	4 661	4.661 GWh
			0050 K W II	0.200			11 : 1106				0050101011	0.405			11.3 1100	141 1	4,001	4,001 0101
<u> </u>							Unit: US\$	<b>r</b>						1	Unit: US\$			
			REE (Sola	r)	-	Cu	istomer				REE (Sola	r)	-	Cu	istomer	houses	2,025,289	2,025,289
Year	Capital	O/M	Replacement	Cost	Remarks	Grid/ Conection	Annual Fee	Year	Capital	O/M	Replacemen t	Total Cost	Remarks	Grid/ Conection	Annual Fee	kWh/mos /house	12	12.0
2005	477,630,656	5		477,630,656	new.	151,896,675	59,828,643	2005	222,781,79	0		222,781,790	installation	151,896,675	118,445,318			
2006		44,377,022		44,377,022			59,828,643	2006		130,843,902		130,843,902			118,445,318			
2007		44,377,022		44,377,022			59,828,643	2007		130,843,902		130,843,902			118,445,318			
2008		44,377,022		44,377,022			59,828,643	2008		130,843,902	15,189,668	146,033,570	DG		118,445,318			
2009		44,377,022		44,377,022			59,828,643	2009		130,843,902		130,843,902			118,445,318			
2010		44,377,022		44,377,022			59,828,643	2010		130,843,902		130,843,902			118,445,318			
2011		44,377,022		44,377,022			59,828,643	2011		130,843,902	15,189,668	146,033,570	DG		118,445,318			
2012		44,377,022		44,377,022	1		59,828,643	2012		130,843,902		130,843,902			118,445,318			
2013		44,377,022	84,387,042	128,764,064	engine		59,828,643	2013		130,843,902		130,843,902			118,445,318			
2014		44,377,022		44,377,022			59,828,643	2014		130,843,902	15,189,668	146,033,570	DG		118,445,318			
2015		44,377,022		44,377,022			59,828,643	2015		130,843,902		130,843,902			118,445,318			
2016		44,377,022		44,377,022			59,828,643	2016		130,843,902		130,843,902			118,445,318			
2017		44,377,022		44,377,022			59,828,643	2017		130,843,902	15,189,668	146,033,570	DG		118,445,318			
2018		44,377,022		44,377,022			59,828,643	2018		130,843,902		130,843,902			118,445,318			
2019		44,377,022		44,377,022			59,828,643	2019		130,843,902		130,843,902			118,445,318			
2020		44,377,022		44,377,022			59,828,643	2020		130,843,902	15,189,668	146,033,570	DG		118,445,318			
2021		44,377,022	84,387,042	128,764,064	engine		59,828,643	2021		130,843,902		130,843,902			118,445,318			
2022		44,377,022		44,377,022			59,828,643	2022		130,843,902	15 100 ((0	130,843,902	DC		118,445,318			
2023		44,377,022		44,377,022			59,828,643	2023		130,843,902	15,189,668	146,033,570	DG		118,445,518			
2024		44,377,022	105 (51 403	44,377,022			59,828,643	2024		130,843,902		130,843,902			118,445,518			
2025		44,377,022	185,651,492	230,028,514	gasifier		59,828,643	2025		130,843,902	15 100 ((0	130,843,902	DC		118,445,318			
2026		44,577,022		44,377,022			59,828,643	2026		130,843,902	13,189,008	140,033,570	00		118,445,518			
2027		44,377,022		44,577,022		<u> </u>	59,828,043	2027		130,843,902		130,843,902			118,445,318			
2028		44,3/7,022	94 297 042	44,377,022	-		59,828,643	2028		130,843,902	15 190 669	150,843,902	DC		118,445,318			
2029		44,577,022	84,387,042	126,/04,064	engine		59,828,643	2029		130,843,902	13,189,008	140,033,570	DG		118,445,518			
2030		44,377,022		44,577,022	1	1	39,828,045	2030		150,845,902		150,843,902	1	1	118,445,518			

Table AP-E.2.2 Economic Analysis for Biomass Gasification Mini-grid and Diesel Generator Mini-grid

Appendix-E Economic and Financial Analysis

# Table AP-E.2.3 Cost estimate of Micro Hydro power by village size, @ 10 kWh per household per month

No	Gross	Net	Continuous	FOB Cost of Gen. Equip.	Unit Price	Nos. of house- holds h h	Lengt h of LV Lines @ L km	Length of MV Lines @ Lm km/h.h km	Cost of LV & MV Lines	Step-up Transfor mer	Distribut ion Transfor mer	Other costs	Total Cost	Per h.h. cost	Cost per Gross kW	% GE Cost to Total	Annual Energy Sold @ t- hr per day MWh	Annual Capital Cost	Fuel Consu mption	Cost for Fuel Purchase \$/vr	O&M Costs \$/vr	Annual Total Costs \$/vr	Annual Gene- ration Costs	kWh Cost with Soft Loan \$/kWh	Gene. Cost with Soft Loan \$/kWh
1	9	7	7	21,000	4,000	54	1.0	1.8	13,425	1,050	1,943	5,613	43,031	797	4,781	49%	6.6	4,060	101.7.91	0	1,480	5,540	3,760	0.844	0.573
2	11	10	10	30,000	4,000	77	1.0	2.6	17,025	1,500	2,775	7,695	58,995	766	5,363	51%	9.4	5,570		0	1,900	7,470	5,157	0.798	0.551
3	22	20	18	54,000	4,000	138	2.0	4.7	31,800	2,700	4,995	14,024	107,519	779	4,887	50%	16.8	10,150		0	2,520	12,670	8,382	0.755	0.500
4	32	30	28	84,000	4,000	215	3.0	7.3	48,825	4,200	7,770	21,719	166,514	774	5,204	50%	26.1	15,720		0	3,220	18,940	12,339	0.725	0.472
5	40	35	32	96,000	4,000	246	4.0	8.4	59,100	4,800	8,880	25,317	194,097	789	4,852	49%	29.9	18,320		0	3,680	22,000	14,102	0.736	0.472
6	70	64	60	180,000	4,000	462	7.0	15.7	107,925	9,000	16,650	47,036	360,611	781	5,152	50%	56.2	34,040		0	5,100	39,140	24,641	0.697	0.439
7	120	102	94	282,000	4,000	723	11.0	24.6	169,275	14,100	26,085	73,719	565,179	782	4,710	50%	87.9	53,350		0	6,760	60,110	37,374	0.684	0.425
8	160	140	130	390,000	4,000	1,000	15.0	34.0	232,875	19,500	36,075	101,768	780,218	780	4,876	50%	121.5	73,650		0	8,500	82,150	50,838	0.676	0.418
9	250	220	205	615,000	4,000	1,577	24.0	53.6	369,000	30,750	56,888	160,746	1,232,384	781	4,930	50%	191.7	116,340		0	11,800	128,140	78,564	0.669	0.410
														781		50%					A	verage of 3	> 200 hh	0.698	0.439

AE-9

Discount factor (C Grant (Plant, LV,MV Lines)

June 2006

Basic data

Unit consumption

Operation hour per day

Unit length of LV lines

Unit length of MV lines km cost of LV line

% of IF and installation

Unit consumption of fue

km cost of MV line

Unit fuel cost

Pd

t

L

Lm

IFI

F

FC

i

CostLV

CostMV Cost Step

Cost Dist

100 W

15 m/h.h.

34 m/h.h. 7,100 \$/km

6,000 \$/km 200 \$/kW

370 \$/kW

15% 0.00 kg/kWh 0.00 \$/ton

0.07

n 20 3.8697

CRF 0.0944 D/L CRFP 0.0944 Plant(7%,20YRS) s) 25%

3.33 = 10 kWh per hh

Table AP-E.2.4	
<b>Cost estimate of Biomass pe</b>	

per month	ost estimate of Biomass power by village size, @ 10 kWh per ho
	er househo

No	Gross	Net	Continu- ous	FOB Cost of Gen. Equip.	Unit Price	Nos. of house- holds	Lengt h of LV Lines @ L	Length of MV Lines @ Lm km/h.h	Cost of LV & MV Lines	Step-up Transfor mer	Distribut ion Transfor mer	Other costs	Total Cost	Per h.h. cost	Cost per Gross kW	% GE Cost to Total	Annual Energy Sold @ t- hr per day	Annual Capital Cost	Fuel Wood Consum ption	Cost for Fuel Purchase	O&M Costs	Annual Total Costs	Annual Gene- ration Costs	kWh Cost with Soft Loan	Gene. Cost with Soft Loan
	kWe	kWe	kWe	(\$)	\$/Pe	h.h.	km	km	\$	\$	\$	\$	\$	\$/h.h.	\$/Pg	%	MWh	\$/yr	ton/yr	\$/yr	\$/yr	\$/yr	\$/yr	\$/kWh	\$/kWh
1	9	7	7	7,875	1,500	54	1.0	0.0	5,325	1,050	1,943	2,429	18,622	345	2,069	42%	6.6	2,190	4.4	88	1,305	3,583	2,850	0.546	0.434
2	11	10	10	11,250	1,500	77	1.0	0.0	5,325	1,500	2,775	3,128	23,978	311	2,180	47%	9.4	2,880	6.2	125	1,650	4,655	3,857	0.497	0.412
3	22	20	18	20,250	1,500	138	2.0	0.0	10,650	2,700	4,995	5,789	44,384	322	2,017	46%	16.8	5,310	11.2	224	2,070	7,604	6,042	0.453	0.360
4	32	30	28	31,500	1,500	215	3.0	1.1	20,925	4,200	7,770	9,659	74,054	344	2,314	43%	26.1	8,730	17.4	348	2,520	11,598	8,700	0.444	0.333
5	40	35	32	36,000	1,500	246	4.0	1.2	26,700	4,800	8,880	11,457	87,837	357	2,196	41%	29.9	10,280	19.9	399	2,880	13,559	9,943	0.453	0.333
6	70	64	60	67,500	1,500	462	7.0	2.3	47,625	9,000	16,650	21,116	161,891	350	2,313	42%	56.2	19,010	37.4	749	3,600	23,359	16,844	0.416	0.300
7	120	102	94	105,750	1,500	723	11.0	3.6	74,775	14,100	26,085	33,107	253,817	351	2,115	42%	87.9	29,800	58.6	1,172	4,410	35,382	25,158	0.403	0.286
8	160	140	130	146,250	1,500	1,000	15.0	5.0	102,375	19,500	36,075	45,630	349,830	350	2,186	42%	121.5	41,100	81.0	1,621	5,250	47,971	33,944	0.395	0.279
9	250	220	205	230,625	1,500	1,577	24.0	7.9	163,350	30,750	56,888	72,242	553,855	351	2,215	42%	191.7	65,010	127.8	2,556	6,675	74,241	51,924	0.387	0.271
		342														43%					Ave	erage of	> 200 hh	0.416	0.300

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JICA M/P Study on Rural Electrification by Renewable Energy in the Kingdom of Cambodia

AE-10

Basic data Unit consumption Operation hour per day

km cost of LV line

Discount factor

km cost of MV line

Unit length of LV lines Unit length of MV lines

% of IF and installation Unit consumption of fue Unit fuel cost

Subsidy (Plant, LV, MV Lines)

100 W 3.33 = 10 kWh per hh 15 m/h.h. 5 m/h.h.

7,100 \$/km

stLV 7,100 \$/km tMV 6,000 \$/km Step 200 \$/kW Dist 370 \$/kW IFI 15% F 1.50 kg/kWh FC 20.00 \$/ton i 0.07

0.07 20

CRFP 0.1424 Plant(7%,10YRS) ines) 25%

Pd t

L Lm

i n 3.8697 CRF 0.0944 D/L

CostLV

CostMV Cost Step

Cost Dist

	Table AP-E.2.5
per month	Cost estimate of Diesel power by village size, @ 10 kWh per household

No	Gro ss	Net	Continu- ous	FOB Cost of Gen. Equip.	Unit Price	Nos. of house- holds	Lengt h of LV Lines @ L	Length of MV Lines @ Lm km/h.h	Cost of LV & MV Lines	Step-up Transfor mer	Distribut ion Transfor mer	Other costs	Total Cost	Per h.h. cost	Cost per Gross kW	% GE Cost to Total	Annual Energy Sold @ t- hr per year	Annual Capital Cost	Diesel Oil Consum ption	Cost for Fuel Purchase	O&M Costs	Annual Total Costs	Annual Gene- ration Costs	kWh Cost with Soft Loan	Gene. Cost with Soft Loan
	kWe	kWe	kWe	(\$)	\$/Pe	h.h.	km	km	\$	\$	\$	\$	\$	\$/h.h.	\$/Pg	%	MWh/yr	\$/yr	KL/yr	\$/yr	\$/yr	\$/yr	\$/yr	\$/kWh	\$/kWh
1	9	7	7	2,625	500	54	1.0	0.0	5,325	1,050	1,943	1,641	12,584	233	1,398	21%	6.6	1,390	2.0	1,378	1,035	3,803	2,969	0.579	0.452
2	11	10	10	3,750	500	77	1.0	0.0	5,325	1,500	2,775	2,003	15,353	199	1,396	24%	9.4	1,740	2.8	1,965	1,250	4,955	4,009	0.529	0.428
3	22	20	18	6,750	500	138	2.0	0.0	10,650	2,700	4,995	3,764	28,859	209	1,312	23%	16.8	3,250	5.0	3,522	1,590	8,362	6,540	0.499	0.390
4	32	30	28	10,500	500	215	3.0	1.1	20,925	4,200	7,770	6,509	49,904	232	1,560	21%	26.1	5,540	7.8	5,488	1,940	12,968	9,649	0.496	0.369
5	40	35	32	12,000	500	246	4.0	1.2	26,700	4,800	8,880	7,857	60,237	245	1,506	20%	29.9	6,630	9.0	6,279	2,260	15,169	11,077	0.507	0.370
6	70	64	60	22,500	500	462	7.0	2.3	47,625	9,000	16,650	14,366	110,141	238	1,573	20%	56.2	12,160	16.8	11,792	2,700	26,652	19,251	0.475	0.343
7	120	102	94	35,250	500	723	11.0	3.6	74,775	14,100	26,085	22,532	172,742	239	1,440	20%	87.9	19,080	26.4	18,454	3,170	40,704	29,080	0.463	0.331
8	160	140	130	48,750	500	1,000	15.0	5.0	102,375	19,500	36,075	31,005	237,705	238	1,486	21%	121.5	26,270	36.5	25,524	3,650	55,444	39,486	0.456	0.325
9	250	220	205	76,875	500	1,577	24.0	7.9	163,350	30,750	56,888	49,179	377,042	239	1,508	20%	191.7	41,630	57.5	40,252	4,325	86,207	60,837	0.450	0.317
														230		21%					Ave	erage of >	> 200 hh	0.475	0.343
Basic data     Pd     100 W     100 W       t     3.33     = 10 kWh per hh       L     15 m/h.h.       Lm     5 m/h.h.       CostLV     7,100       Skm       CostStpi     200       SkW       Cost Dist     370       SkW       Cost Dist     370       F     0.30       IFI     15%       F     0.30       SkB       38697       38697       CRFF     0.944       D/L(7%,20YRS)       CRFP     0.1627       Plant(10%,10YRS)       25%																									

JICA M/P Study on Rural Electrification by Renewable Energy in the Kingdom of Cambodia

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June 2006
# **APPENDIX-F**

Supporting System

# THE MASTER PLAN STUDY ON RURAL ELECTRIFICATION BY RENEWABLE ENERGY IN THE KINGDOM OF CAMBODIA

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1.		REF Project Cycle and Application Form for REF Investment Grants	AF-1
	1.1	Project Cycle	AF-1
	1.2	Application Form	AF-4

# Appendix-F Supporting System

# 1. REF PROJECT CYCLE AND APPLICATION FORM FOR REF INVESTMENT GRANTS

# 1.1 PROJECT CYCLE

# Approval of subsidy award contract: flow chart



# **Criteria for Approval of Investment Grants**

Criteria CI1: Criteria for Formal Check on Application for Investment Grant

- 1. Is the application form fully and correctly filled out or is any information missing
- 2. Is copy of the feasibility report attached
- 3. Is copy of the application to EAC for the generation/distribution license attached; and or copy of the license itself
- 4. Is copy of the letter of intent for project loan attached by the bank connection of developer
- 5. Are copies for all relevant approval documents attached; or if, not yet processed, of the applications for approval
- 6. Is the project eligible for REF-grant support, falling into one of the following categories:
  - Isolated grid project with diesel generator
  - Isolated grid project served by micro-hydro (possibly with diesel generator as back-up)
  - Isolated grid project served by biomass/biogas -fueled generator (possibly with diesel generator as back-up)
  - Micro- or mini-hydroplant connected to the national grid
  - Biomass/biogas fueled generator connected to the national grid
  - Solar Home System based project may include institutional systems like pagodas, schools etc.

# Criteria CI2: Criteria for Approval of Investment Grant

As the license approval process by EAC covers issues 1-4, the review is performed in close consultation with the EAC-officer in charge of processing the license application. For maximum productivity, EAC and REFS formally decide on a division of labor and/or form for the mutual consultation process; including the evaluation criteria to be used.

# (a) Criteria that apply to all categories of REF-supported projects

- 1. Compliance with regulatory conditions:
  - All needed local planning approvals have been obtained
  - An EIA, if required, has been performed and approved by the pertinent authorities
  - EAC has issued a license for the project, or, received a license application
  - No other party applied to EAC for a license for the same project in response to the publication by EAC of the license application, within the time limit established by the Electricity Act and EAC regulations
- 2. Compliance with technical conditions:
  - The technical norms and standards for rural electrification and for renewable energy are fulfilled; the least cost design is used (confirmed by consultant contracted by REFS to review the feasibility study)
  - The cost of individual major investment items is in line with the level of local costs according to the data bank on rural electrification costs established by REFS or EAC
- 3. Financial viability of the project

- there is strong evidence of financial closure;
- the commercial bank for providing the debt finance for the project has agreed to finance the project and finalized its due diligence assessment (copies of the draft loan agreement and the bank's project appraisal document are attached)
- the evaluation confirms the bank's assessment of financial viability and ability of the project's cash flow in early years to service the debt payments.
- 4. Institutional viability of the project
  - is the project applicant a legal person; or actively engaged in becoming registered as a legal person (sponsors initiating RE projects need to establish a legally recognizable entity such as a co-operative or a company to qualify for grant awards)
  - projects are not to be managed or majority-owned by the public sector and must demonstrate local community support.
- 5. Compliance with World Bank standards for social and environmental safeguards

# (b) Criteria specific for distribution projects

- The tariff calculation formula, used to established the tariff schedule submitted to EAC for approval, takes the REF-investment subsidy into account
- potential consumers have expressed their interest in the project by paying a deposit

(c) Criteria specific for grid-connected hydropower or biomass/biogas-fueled power plants

EdC has signed a PPA with the developer or a letter of intent.

# **Subsidy Rates for Investment Grants**

	Subsidy per connection	Subsidy per kW
Isolated grid project with diesel generator	US\$45	n.a.
Isolated grid project served by micro-hydro	US\$45	US\$400
(possibly with diesel generator as back-up)		
Isolated grid project served by biomass-fueled	US\$45	US\$400
generator (possibly with diesel generator as back-		
up)		
Micro-hydroplant connected to national grid	n.a.	US\$400
Mini-hydroplant connected to national grid	n.a.	US\$400
Biomass/biogas fueled generator connected to	n.a.	US\$400
national grid		

Rates Schedule for Investment Grants, RI<sup>1)</sup>

1) Rates for 1rst year of operation. To be adjusted in the following years in response to the balance between the supply of funds and the demand for funds

# 1.2 APPLICATION FORM

# I. Forms for Investment Grants

# Application: Investment Grant to Renewable Energy Generation Project selling Power to the National Grid or Connected to Local Mini-Grids

# PART 1 - APPLICATION

Name and address of Applicant:

Bank account number for transfer of grant:

Name of Co-financing Bank:

Business Form for Investing Entity

- Private joint stock company.....:
- Community joint stock company ...:
- Community cooperative .....

Copy of legal person registration, or active application for forming the legal person attached as Annex 6

Location of Project:

- Province :
- District :
- Commune :

Project finance			
		<u>USD</u>	
Equity from investor		:	
Loan (amount, maturity, int	terest rate) *)	:	
Requested Grant from REF	Ϋ́S	:	
Grants from other sources		:	
TOTAL		·····	
*) Proof of commen	rcial bank debt financing incl	uding copies of the draf	t loan agreement and
the banks project ap	praisal document, attached as	Annex 5	
Name of equity investors /	Name	2	Ownership %
ownership percentage			

Project Description: (provide brief summary of project)

Yes:	No:	Attached as Annex 2
Yes:	No:	Attached as Annex 3
Yes:	No:	Attached as Annex 4
Yes:	No:	Attached as Annex 4
	Yes: Yes: Yes: Yes:	Yes: No: Yes: No: Yes: No: Yes: No:

Compliance with technical conditions	
Technical norms and standards are in accordance with national rules and regulations	Included in feasibility study and to be
REF least cost design principles have been applied	confirmed by consultant contracted
If there are deviations from norms and design recommendations, please justify	by REFS to review the feasibility study
REF least cost design principles have been applied If there are deviations from norms and design recommendations, please justify	consultant contracted by REFS to review the feasibility study

Key project data	Capacity in kW	Expected annual GWh output				
Mini/micro-hydro power plant	:					
Biomass fueled power plant	:					
Length of MV line connecting plant to national	grid : km					
of MV-lines connecting villages covered by distribution	on license km					
of LV distribution lines km						
Number of household connections No.						
Demand Profile (if distribution included)	year kWh /	1 year 10 year (kWh / year)				
Electricity sales to households						
Electricity sales to private productive / comi uses	nercial					
Electricity sales to private productive / commuses Electricity sales to public institutions (kWh / y	nercial ear)					

USD
USD

Financial viability of the project over a 10 year period	
Sales forecast Operational cost break-down Profitability calculations Cash-flow projection	Included in feasibility study and to be confirmed by consultant contracted by REFS to review the feasibility study
	%

Calculation of subsidy grants	Investment grant USD
Renewable energy generationkW of USD 400	

PART 2 – SUPPORTING ANNEXES			
Annex 1:	Copy of feasibility study		
Annex 2:	Documentation that all required local planning approvals have been obtained		
Annex 3	Environmental assessment report, if required		
Annex 4	Generation license application to ECA		
Annex 5	Proof that the commercial bank for providing the debt finance for the project has agreed to finance the project and finalized its due diligence assessment, including copies of the draft loan agreement and the banks project appraisal document		
Annex 6	Copy of legal person registration or active application for forming the legal person		

# PART 3 – APPROVAL AND TRANSFER ORDER (APP2)

Conditions for receiving investment grant have been confirmed and found in order.

A project investment grant of USD is approved to be allocated for the project in accordance with the guidelines for grant disbursement

The grant will be transferred to the applicants account no:

Date of approval:

Name of approving officer:

# **APPENDIX-G**

Rural Development Bank Proposal on Soft Loans

# THE MASTER PLAN STUDY ON RURAL ELECTRIFICATION BY RENEWABLE ENERGY IN THE KINGDOM OF CAMBODIA

# FINAL REPORT VOLUME 5 : APPENDICES

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1.	The Eligibility Criteria for Participating REEs/CECs in the Implementation of	
	Rural Electrification by Renewable Energy	AG-1
2.	Financial Options by Electrification Types	AG-2
3.	Proposed Lending Terms and Conditions	AG-2
4.	Proposed Support Structure for Service Providers (REE and CEC)	AG-3

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Table AP-G.2.1	Financial Options	by Electrification	Types		AG-2
Table AP-G.3.1	Lending Terms a	and Conditions	of Rural	Electrification	by
	Renewable Energy.	r			AG-2

# Appendix-G Rural Development Bank Proposal on Soft Loans

# 1. THE ELIGIBILITY CRITERIA FOR PARTICIPATING REES/CECS IN THE IMPLEMENTATION OF RURAL ELECTRIFICATION BY RENEWABLE ENERGY

Participating REEs/CECs will need to meet the following eligibility criteria to receive loans from RDB under the project: (i) technical certificate on rural electrification from REF/MIME; (ii) willingness to deliver rural electrification services to the Project target group; (iii) a good accounting record/system on their electrification activities; (iv) a good management structure, including a board of directors, a chief executive, all with experience of rural electrification; (v) licensed at EAC; and (vii) equity at least 15% of project cost.

The REEs/CECs will submit the following items in support of any applications for a loan: (i) Articles of Association; (ii) information on their debt situation; (iii) feasibility study for the proposed use of the loan funds showing the financial feasibility of the proposal; (iv) report on the rural electrification activities of the past years (if any); (v) copy of their electrification license; (vi) copy of the ID of the Managing Director; (vii) minutes of the resolution agreeing to approach RDB; and (viii) collateral, such as land, building, equipment ...etc.

In case of REEs/CECs have not sufficient capacity to get loan from RDB, RDB will need guarantee funds from REF in term of 50% of total loans for those REEs/CECs.

# 2. FINANCIAL OPTIONS BY ELECTRIFICATION TYPES

	Tuble III Gizil Thundail Options by Dicect Incardon Types								
Type of Electrification	Scope of Work	Ownership	Funding N	Aodality of					
<b>51</b>		- · · · · · <b>F</b>	Capita	l Costs					
			REE	CEC					
1. Extension of REE	Rehabilitation of	REE	Subsidy (25%),	-					
grid	Distribution lines and		Equity (15%),						
	Extension of an existing		Soft Loan (60%)*						
	mini grid systems								
2. Renewable Energy	Generation and	REE/CEC	Subsidy (25%),	Subsidy (50%),					
new mini grid	distribution		Equity (15%),	Equity (10%),					
(Hydro)			Soft Loan (60%)	Soft Loan (40%)					
3. Renewable Energy	Generation and	REE/CEC	Subsidy (25%),	Subsidy (25%),					
new mini grid	distribution		Equity (15%),	Equity (15%),					
(Biomass)			Soft Loan (60%)	Soft Loan (60%)					
4. Diesel new mini grid	Generation and	REE/CEC	Subsidy (25%),	Subsidy (25%),					
_	distribution		Equity (25%),	Equity (25%),					
			Soft Loan (50%)	Soft Loan (50%)					
5. Solar system	SHS,BCS	REE/CEC	Subsidy (25%)	Subsidy (95%),					
			Equity (15%),	Equity (5%),					
			Soft Loan (60%)	Soft Loan (0%)					
	Remote & Social	Public (Owned by a	Grant (95%), Equit	y (5%)					
	electrification by solar	Renewable Energy							
	power	Center (REC)							

# Table AP-G.2.1 Financial Options by Electrification Types

# 3. PROPOSED LENDING TERMS AND CONDITIONS

Lending Terms and Conditions shall be determined in the Subsidiary Loan Agreement between Ministry of Economy and Finance and Rural Development Bank, and in the Subsidiary Financing Agreement between RDB and REEs/CECs.

Flow of Fund	USD	KHR
Donors (WB, JBIC)	In SDR/USD 0.75% p.a. with 30 years	N.A.
to Government	repayment including a 10 years grace	
	period	
The Government to	2-3% p.a. with Government bearing the	6-7% p.a. with Government bearing the
RDB	foreign exchange risk (SDR to USD)	foreign exchange risk (SDR to USD and
	and with repayment 30 years with 10	USD to Riel) and with repayment 30
	years grace period.	years with 10 years grace period.
<b>RDB</b> to <b>REEs/CECs</b>	7-10% p.a. with repayment 10-15 years	11-14% p.a. with repayment over 10
	with 2-5 years grace period (period	years with 2-5 years grace period (period
	construction place). The repayment will	construction place). The repayment will
	start from operation year.	start from operation year.

Table AP-G.3.1	Lending Terms and	<b>Conditions of Rural</b>	Electrification by	<b>Renewable Energ</b>	ţу
----------------	-------------------	----------------------------	--------------------	------------------------	----

# 4. PROPOSED SUPPORT STRUCTURE FOR SERVICE PROVIDERS (REE AND CEC)



# Our Suggestion during the project implementation:

- 1- Two vehicles
- 2- Four computers (Two: Desktop, and Two: Laptop)
- 3- One photocopy machine
- 4- Camera/video camera.

# **APPENDIX-H**

Evaluation Sheet for Biomass Pilot Projects

# THE MASTER PLAN STUDY ON RURAL ELECTRIFICATION BY RENEWABLE ENERGY IN THE KINGDOM OF CAMBODIA

# FINAL REPORT VOLUME 5 : APPENDICES

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H-5	Average Size Project in Cambodia	AH-54
H-6	Kampong Kor Project, Phase 2	AH-68
H-7	Samlout Project, Phase 2	AH-80

No.	Project	Phase	Nos. of House-	Tan Nighttim \$/k	riff Daytime Wh	F internal	TIRR w/subsidy	• EIRR %	Short- term	Saving at 10th milli	Deposit at 30th	– Total Costs - \$	Equity	Financial I Tax	Resources Subsidy	Soft \$	Su
1	Kampong Kor	1	886	0.350	0.300	5.2%	9.3%	30.9%	5,000	0.18	3.93	689,100	97,100	42,100	161,700	388,200	mma
2	Samlout	1	774	0.335	0.275	5.5%	9.8%	27.4%	5,000	0.18	3.86	626,300	87,600	42,100	146,100	350,500	ry
3	Pramaoy	1	145	0.400	0.340	5.0%	8.9%	33.3%	2,000	0.03	0.59	86,000	11,800	7,000	19,800	47,400	
4	Samraong	1	470	0.270	0.250	4.9%	9.3%	37.3%	3,000	0.10	1.77	219,300	29,500	22,500	49,200	118,100	
	Total		2,275							0.49	10.15	1,620,700				904,200	

Summary of Economic and Financial Analyses, Phase 1

## Note:

Loan conditions: @ 3%/yr with 3-yr grace followed by 12-yr repayment

FIRR including tax and excluding CER revenue.

AH-1

H-0

AH-2

					Sumn	nary of	Economi	c and F	inancial	Analyses	, Phases 1	and 2				
			Nos. of	Та	riff	F	IRR	EIDD	Short-	Saving	, Deposit	- Total Costa		Capita	al Costs	
No.	Project	Phase	Househol ds	Nighttim \$/k	Daytime Wh	internal %	w/subsidy	%	term \$	at 10th mill	at 30th lion \$	= Total Costs \$	Equity \$	Tax \$	Subsidy \$	Soft Loan \$
1	Kampong Kor	1+2	4882	0.310	0.270	5.2%	9.4%	35.6%	30,000	0.96	19.88	3,275,600	457,600	224,700	762,700	1,830,600
2	Samlout	1+2	4216	0.305	0.275	5.6%	9.8%	26.0%	30,000	0.86	19.45	3,397,100	480,600	193,100	801,000	1,922,400
3	Pramaoy	1+2	334	0.375	0.340	5.0%	8.8%	34.5%	4,000	0.07	1.34	193,200	26,600	15,800	44,400	106,400
4	Samraong	1+2	1230	0.380	0.320	5.9%	10.5%	32.8%	10,000	0.27	6.07	1,093,000	154,500	63,100	257,500	617,900
1	Total		10,662							2.16	46.74	7,958,900				4,477,300

# Note:

Loan conditions: @ 3%/yr with 3-yr grace followed by 12-yr repayment

FIRR including tax and excluding CER revenue.

June 2006

Community Electrication Project, Kampong Kor, Phase 1, soft loan @ 3% - 15 yr including 3-yr grace

# Table A1 Principal Features of Electrification Plan

## (1) Generating Equipment Planning

Items	Unit	Q'ty	Remarks
Nos. of households	h.h.	886	80% of the total 1,107 households
Unit nighttime domestic demand	W/hh	100	
Nighttime domestic demand	kW	88.6	
Street light demand	kW	4.0	1 light per 40 m of LV lir 200 street lights
Reserve capacity	kW	26.6	30% of nighttime domestic demand, allocated for station use + reserved power + distribution losses
Required capacity	kW	119.2	
Adopted capacity	kW	120.0	

### (2) Energy Generation Planning for 8th Year Onward

Items	Monthly Unit Energy Sold	Monthly Energy Sold	Annual Energy Sold	Station Use, Losses, etc. (10%)	Annual Energy Generated	Annual Plant Factor	Annual Operation Hours	Remarks (refer to Table A2 for demand growth rates)
	kWh/hh	MWh	MWh	MWh	MWh	%	hr	
Nighttime domestic demand $\underline{1}$ /, $\underline{2}$	15.0	13.3	159.5	15.9	175.4	16.7%	1,462	100% from 8th year onward
Street light demand	0.7	0.6	7.2	0.7	7.9	0.8%	66	100% from the 1st year
Industrial demand 3/	7.5	6.6	79.7	8.0	87.7	8.3%	731	100% from 8th year onward
Irrigation pump demand 4/	1.2	3.2	12.9	1.3	14.2	1.4%	118	in 4 dry months, 100% from 8th year onward
Total energy	24.4	23.8	259.3	25.9	285.3	27.1%	2,377	100% from 8th year onward

### Note:

1/ Typical consumption level of existing mini-grids in rural villages as of 2005 was 10 kWh (= 100W / 1,000 \* 5hrs \* 30 days \* 67%) and assumed to be realized from 2nd year.

2/ Average consumption of existing REE mini-grids supplying to rural towns as of 2005 was 15 kWh (= 100 W / 1,000 \* 7.5hrs \* 30days \* 67%) and was assumed to be realized in 7th year.

<u>3</u>/ Power demand of BCS, rice-mills, water supply stations, ice factory, workshop of boat engines, etc. Assumed to be 50% of the nighttime demand based on the actual demand of existing Anlong Ta Mey mini-grid (700 kWh at nighttime, 300 kWh for BCS at daytime) and potential daytime users in the villages shown in Table A3.

 $\underline{4}$  see Table A3 for irrigation power demand.

H-1

JICA M Renewa			Com	munity	Electric	ation Pr	oject, K Tal	Campon ole A2	g Kor, I Energ	Phase 1, <b>gy and</b>	soft loa CER	n @ 3% Sold	5 - 15 yr	includii	ng 3-yr g	grace					
l/P S ble ]			1	2	3	4	5	6	7	8	9	10	11	12	19	20	21	22	29	30	Total
tudy on Rural Energy in the ]	(Annual energy sold) Demand growth Domestic Street lights Industrial Irrigation	Growth rate 1.10 0.00 1.10 1.10	50% 100% 0% 0%	67% 100% 50% 50%	73% 100% 67% 67%	81% 100% 73% 73%	89% 100% 81% 81%	98% 100% 89% 89%	100% 100% 98% 98%	100% 100% 100% 100%	100% 100% 100%	100% 100% 100% 100%									
ΣΞ	Energy sold (MWh/yr)	Demand																			
ectrification ngdom of Ca	Domestic Street lights Industrial Irrigation Total	159.5 7.2 79.7 12.9 259.3	79.7 7.2 0.0 0.0 86.9	106.3 7.2 39.9 6.5 159.9	117.0 7.2 53.2 8.6 185.9	128.6 7.2 58.5 9.5 203.8	141.5 7.2 64.3 10.4 223.5	155.7 7.2 70.8 11.5 245.1	159.5 7.2 77.8 12.6 257.1	159.5 7.2 79.7 12.9 259.3	4,556 216 2,198 356 7,327										
lin g	Unit energy sold (kWh per house	hold per mo	onth)																		.,
v bodia	Domestic Street lights Industrial Irrigation Total	15.0 0.7 7.5 1.2 24.4	7.5 0.7 0.0 0.0 8.2	<b>10.0</b> 0.7 3.8 0.6 15.0	11.0 0.7 5.0 0.8 17.5	12.1 0.7 5.5 0.9 19.2	13.3 0.7 6.1 1.0 21.0	14.6 0.7 6.7 1.1 23.1	<b>15.0</b> 0.7 <b>7.3</b> <b>1.2</b> 24 2	15.0 0.7 7.5 1.2 24 4	15.0 0.7 7.5 1.2 24 4	15.0 0.7 7.5 1.2 24.4	15.0 0.7 7.5 1.2 24.4	15.0 0.7 7.5 1.2 24 4	15.0 0.7 7.5 1.2 24.4	15.0 0.7 7.5 1.2 24.4	15.0 0.7 7.5 1.2 24.4	15.0 0.7 7.5 1.2 24 4	15.0 0.7 7.5 1.2 24.4	15.0 0.7 7.5 1.2 24 4	
AE	(Operating revenue from electricit	y sales, \$) Tariff																			
I-4	Domestic Street lights Industrial Irrigation Total	\$0.35 \$0.35 \$0.30 \$0.30	27,909 2,520 0 30,429	37,212 2,520 11,961 1,938 53,631	40,933 2,520 15,948 2,584 61,985	45,027 2,520 17,543 2,843 67,932	49,529 2,520 19,297 3,127 74,473	54,482 2,520 21,227 3,440 81,668	55,818 2,520 23,349 3,783 85,471	55,818 2,520 23,922 3,876 86,136	1,594,724 75,600 659,531 106,868 2,436,724										
	(Monthly tariff, \$ per household) Domestic Street lights Industrial Irrigation Total		2.63 0.24 0.00 0.00 2.86	3.50 0.24 1.13 0.18 5.04	3.85 0.24 1.50 0.24 5.83	4.24 0.24 1.65 0.27 6.39	4.66 0.24 1.82 0.29 7.00	5.12 0.24 2.00 0.32 7.68	5.25 0.24 2.20 0.36 8.04	5.25 0.24 2.25 0.36 8.10											
	(Tariff receivable, \$/yr)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	(CER saleable) (to-CO (\$/yr) ]	kg-CO <sub>2</sub> /kWh 2) 1.3	113 791	208 1,455	242 1,692	265 1,855	290 2,033	319 2,230	334 2,340	337 2,360	9,525 66,676										
	Fuel tree consumed (ton per month Land required to supply fuel trees Nos. of fuel tree farmers (0.2 ha per Payment to fuel tree farmers (\$/fa	n) (ha) er farmer) rmer/month	10.9 13.0 65 3.3	20.0 24.0 120 3 3	23.2 27.9 139 3 3	25.5 30.6 153 3.3	27.9 33.5 168 3 3	30.6 36.8 184 3 3	32.1 38.6 193 3.3	32.4 38.9 195 3 3	32.4 38.9 195 3 3	32.4 38.9 195 3.3	32.4 38.9 195 3 3	32.4 38.9 195 3 3	32.4 38.9 195 3.3	32.4 38.9 195 3 3	32.4 38.9 195 3 3	32.4 38.9 195 3 3	32.4 38.9 195 3 3	32.4 38.9 195 3.3	916
June 2	Total payment to fuel tree farmers	s (\$/yr)	2,608	4,796	5,578	6,114	6,704	7,353	7,714	7,780	7,780	7,780	7,780	7,780	7,780	7,780	7,780	7,780	7,780	7,780	219,811

June 2006

Ratio of tariff collected and billed= 100%

Note: 1/ Assumed at %4/ton-CO<sub>2</sub>/yr deducting costs required for prepration of PDD, application and monitoring.

# Appendix-H Evaluation Sheet for Biomass Pilot Projects

# Community Electrication Project, Kampong Kor, Phase 1, soft loan @ 3% - 15 yr including 3-yr grace Table A3 Potential Daytime Users and Demand

		Diesel	Electricity	Operation	Unit Power	Nos. of		Total Demar	hd
No.	Demand	Consumption	Demand	Hour	Demand	Customers		Total Della	Id
		liter/month	kWh/month	hr/month	kW		kW	kWh/month	Load Factor
1	BCS	200	600	50	12.00	5	60.00	3,000	6.9%
2	Water supply	60	180	15	12.00	10	120.00	1,800	2.1%
3	Rice-mill	30	90	30	3.00	30	90.00	2,700	4.2%
4	Ice factory	30	90	30	3.00	1	3.00	90	4.2%
5	Workshop	25	75	60	1.25	1	1.25	75	8.3%
6	Café	115	345	296	1.17	1	1.17	345	41.1%
Ν	fonthly total	460	1,380	481	-	48	120.00	8,010	9.3%
1	Annual total	5520	16,560	5,772	-	-	120.00	96,120	9.3%

Source: The potential daytime users above are candidates in Kampong Kor for reference purpose.

# Potential irrigation demand in the dry season

Unit land to irrigate	0.1	ha/hh
Ratio of irrigation hh	50.0%	
Total land area to irrigate	44.3	ha
Depth of irrigation	500	mm
Total irrigation water	0.222	mcm/yr
Irrigation period	4	month
Daily operation hour	8	hr/day
Total pump discharge	0.064	m <sup>3</sup> /s
Pumping head	15.0	m
Combined efficiency	0.70	
Total power required	13	kW
Total energy required	13	MWh

### Community Electrication Project, Kampong Kor, Phase 1, soft loan @ 3% - 15 yr including 3-yr grace Table A4 Cost Estimate

Table A4	Cost Estimate	;				
Construction Costs	Unit Price (\$)	Q'ty	Unit	Amount(\$)	Total (\$)	%ショ
Power Station						
Biomass gasification power generating equipment (FOB)	1,300	120	kW	156,000		
Ocean freight & insurance (FOBx8%)	104	120	kW	12,480		
Inland transportation & installation (FOB x (2%+5%))	91	120	kW	10,920		
Switching equipment, main transformer		150	kVA	61,000	240 400	40.4
Civil and substation works					240,400	40.4
Road improvement works for dry season use	24	2.50	km	60 000		
to be further improved to all weather road in Phase 2 Land powerhouse water tank etc. (10%FOB)	130	120	kW	15 600		
Land, powernouse, water tank, etc. (10701 OB)	150	120	K VV	15,000	75,600	
Fuel tree preparation for 2nd year demand						
Scarified seeds of Leucaena of 0.4-0.5 kg/ha and \$15/kg	8	24	ha	180		
Nursery	1	240	m <sup>2</sup>	240		
Watering of nursery for the first 3 months	100	3	month	300		
Bush clearing	80	24	ha	1,918		
Land preparation	80	24	ha	1,918		
Transplanting	80	24	ha	1,918		
Maintenance for initial 6 months @ \$60/ha/mon	360	24	ha	8 632		
				-,	15 106	
Sub-total of power station and fuel preparation					331,106	55.6
Miscellaneous of power station (5%, consumables, gas detector,	,			12,000	551,100	55.0
Derven station sub total (before tor)					242 106	57 -
Containing the MATE (CIT = 250())	251	120	1.337	42 120	343,100	57.7
Customs & VA1 (CIF x 25%)	351	120	ĸw	42,120	205 226	(1)
Power station sub-total (including tax)					385,226	64.
Distribution Facilities						
MV lines	6,000	2.5	km	15,000		
MV-LV lines	10,700	6.0	km	64,200		
LV lines	7,100	2.0	km	14,200		
Pole-mounted distribution transformers						
15 kVA-1P	6,200		set	0		
25 kVA-3P	7,300	4	set	29,200		
50 kVA-3P	8,100	1	set	8,100		
Distribution line - transformer sub-total (including tax)	.,			.,	130,700	22.0
Miscellaneous (5% street lights etc.)				6.535	,	
Distribution line - transformer sub-total (including tax)				0,000	137 235	23.1
Service wire etc				44 300		7 /
Domestic cutomers	50	222	hb	44,500		/.4
Davtime customers (to be fixed individually)	50	000	customere	44,500		
Distribution line - transformer - service wires, etc. sub-total	0		customers	0		
(including tax)					181,535	30.5
Sub-total					566.761	
Contingery (5%)					28 329	
contingety (570)					20,000	
Construction costs total					595,099	100.
Costs for CEC supports	Unit Price (\$)	Q'ty	Unit	Amount(\$)		
Costs for CEC supports and training				33,000		
2.1 Facilitation for CEC setting up and management	500	12.00	MM	6,000		
2.2 Technical supports	500	18.00	MM	9,000		
2.3 Vehicles and lodging	1,000	18.00	month	18,000		
Operation and maintenance costs						
		Nos. of				

Personnel costs of CEC staff	Salary (\$/mon)	Nos. of	MM	Amount(\$)	Total (\$)
Operation Chief	\$80	1	12.00	960	
Operator	\$40	2	12.00	960	
Fuel preparation workers	\$30	1	12.00	360	
Director and accountant	\$40	2	12.00	960	
Personnel costs sub-total					\$3,240
Maintenance costs of gasifier and engine-generator	CIF (\$)		Ratio of O&M Costs	Amount (\$)	Total (\$)
Gasifier and engine-generator costs (CIF)	240,400				
5% of engine-generator set	80,133		5.0%	4,010	
Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/every one year, 4-6%)	160,267		5.0%	8,010	
Replacement of lamp of street lights, office stationery and				1,080	
Consumables Maintenance costs of powerhouse (% of powerhouse)	15 600		2.0%	310	
Maintenance costs of powerhouse (10 of powerhouse)	15,000		2.070	510	13,410
Operation and maintenance costs sub-total					16,650
Payment for technical supports (\$/yr for 15 years from 1st year)					2,930
Items	Unit fuel cost (\$/kWh)	Energy	unit		Fuel costs (\$)
Annual fuel costs	0.03	285	MWh/yr		8,558
Operation, maintenance and fuel costs sub-total					25,208
Maintenance costs of distribution facilities					
Maintenance costs (0.5% of construction costs)					700

A N	Table	A5 Econ	omic Cost	S		
I/P		Foreign	Local	Financial	Economi	
Str	Items	Currency	Currency	Costs	c Costs	Remarks
ıdy		\$	\$	\$	\$	
010	1. Hard costs	285,910	309,189	595,099	490,062	SCF
R	1.1 Generating equip. excl. tax	168,480	10,920	179,400	178,308	0.90
ura	1.2 Customs & VAT	0	42,120	42,120	0	LCF
Ε	1.3 Road and powerhouse		75,600	75,600	37,800	0.50 <u>1/</u>
lec	1.4 Growing fuel trees	180	14,926	15,106	7,643	
tri	1.5 Swichyard equip.		61,000	61,000	54,900	
fica	1.6 Powerhouse miscellaneous		12,000	12,000	10,800	
atic	1.7 Distribution lines	87,569	43,131	130,700	126,387	
)n l	1.8 Service wires, etc.	29,681	14,619	44,300	42,838	
y	1.9 Distri. Lines miscellaneous		6,535	6,535	5,882	
	1.10 Contingency (5%)		28,338	28,338	25,504	
	2. CEC facilitation costs	0	33,000	33,000	29,700	
А	Project Costs Total	285,910	342,189	628,099	519,762	
H-	O&M	12,020	13,888	25,908	17,744	
L	1. Personnel costs	0	3,240	3,240	2,754	
	2. Biomass gasifier generator	12,020	1,390	13,410	13,271	
	3. Fuel		8,558	8,558	1,369	0.16 <u>2</u> /
	4. Distribution lines	0	700	700	350	

Note: 1/ Economic conversion factor for seasonal jobless labors

	Foreign	Local	Financial	Economic	
Items	Currency	Currency	Costs	Costs	Remarks
	\$	\$	\$	\$	
1. Hard costs	158,999	278,412	437,411	367,820	
1.1 Diesel generator excl. tax	81,480	10,920	92,400	91,308	770 \$/kW
1.2 Customs & VAT		23,100	23,100		
1.3 Road & land preparation		52,400	52,400	26,200	
1.4 Powerhouse & fuel tank (10%)		9,240	9,240	8,316	
1.5 Swichyard equip.		61,000	61,000	54,900	
1.6 Powerhouse miscellaneous (5%)		11,907	11,907	10,716	
1.7 Distribution lines	77,519	38,181	115,700	111,882	
1.8 Service wires, etc.		44,300	44,300	39,870	
1.9 Distri. Lines miscellaneous		6,535	6,535	5,882	
1.10 Contingency (5%)		20,829	20,829	18,746	
2. CEC facilitation costs	0	33,000	33,000	29,700	
Project Costs Total	158,999	311,412	470,411	397,520	
O&M	5,387	69,816	75,203	67,942	
1. Personnel costs	0	2,880	2,880	2,592	
2. Diesel generator	5,387	623	6,010	5,948	5%
3. Fuel	0	65,613	65,613	59,052	0.23 \$/kWh
4. Distribution lines	0	700	700	350	
Adjsutment for Kampong Kor diesel pow	wer station				
1. Road powerhouse	24	0.50	km	12,000	

20

0.2

2,000

2,000

2. Embankment of station yard

3. Land acquisition

 $m^2$ 

 $m^2$ 

40,000

400

# **Table A6 Economic Benefits**

Appendix-H Evaluation Sheet for Biomass Pilot Projects

# Community Electrication Project, Kampong Kor, Phase 1, soft Ioan @ 3% - 15 yr including 3-yr grace **Table A7** Unit Costs of Electricity

# Table A8 Tariff Setting

Items	with tax (\$)	with tax exemption and subsidy (\$)	Items	\$	Riel
1. Capital Costs	689,099	485,234	Unit cost of electricity from 7th year (\$/kWh)	0.280	1,119
2. CEC facilitation costs	33,000	33,000	Rate of reserve for operational risks (12%)	0.034	134
3. Total construction costs excluding design, ter	sting, etc.	518,234	Average tariff (\$/kWh)	\$0.313	1,252
Interest rate	3.0%		Tariff adopted for nighttime demand	\$0.350	1,400
Repayment period	10 yr		Tariff adopted for street lights	\$0.350	1,400
CRF (3.0%, 10 yr) =	0.1172		Tariff adopted for industrial demand	\$0.300	1,200
4. Annual costs excluding design, etc.	80,783	60,753	Tariff adopted for irrigation demand	\$0.300	1,200
5. O&M costs in 10th year	28,242	28,242	Monthly revenue (US\$/mon)	\$7,178	
5.1 O&M	16,650	16,650	from nighttime users	\$4,652	
5.2 Fuel costs	8,558	8,558	for street lights	\$210	
5.3 EAC license fee	104	104	from industrial users	\$1,994	
5.4 Yearly monitoring fee by DIME	2,930	2,930	from irrigation pump users	\$323	
6. Annual total costs	109,025	88,995	Average monthly tariff @ 15 kWh per HH (\$)	\$5.25	21,000
7. Annual energy sales from 7th year (MWh)	259.3	259.3	Tariff for street lights	\$0.24	900
8. Unit cost of electricity from 7th year (\$/kWh	) 0.420	0.343	Total @ 15 kWh/hh including street lights	\$5.49	21,900
9. NPV of energy sold	MWh	4,661	Average monthly tariff @ 10 kWh per HH (\$) including street lights	\$3.74	14,900
10. NPV of finacial costs excluding tax	\$	1,303,981	Tariff of poor household (\$/mon/hh) @ 40 W x 4h x 30 days = 4.8 kWh/month + street lights	\$1.92	7,700
11. Average cost of electricity	\$/kWh	0.280	Tariff of poorest household (US\$/mon/hh) @ 7 W x 4h x 30 days = 0.84 kWh/mon + street	\$0.53	2,100
				Monthly	Costs
			ATP for monthly tariff	\$	Riel
			Diesel oil lamp (100%)	\$1.46	5,844

 Diesel oil lamp (100%)
 \$1.46
 5,844

 Battery lighting (70%, incl. Riel 4,000 per month for battery purchase)
 \$3.12
 12,470

 Total
 \$4.58
 18,314

Community Electrication Project, Kampong Kor, Phase 1, soft loan @ 3% - 15 yr including 3. **Table 1 Adopted Conditions for Economic and Finacial Analyses** 

- 1. Energy sold See attached Table A2
- 2. Tariff See attached Table A7
- 3. Long-term borrowing from GOC
  - 3% per year
  - 25 years repayment period including 5 years' grace
- 4. Short-term borrowing from commercial bank
  - 10% per year
  - revolving every year
- 5. Depreciation

- Ratio of depreciation	90%
- Ratio of residual value	10%

Generating equipment

- 5 years' grace and 5 years' depreciation for the first 10 years
- 10 years' depreciation from 11th year onward

Distribution lines, service wires, etc.

- 5 years' grace and 20 years' depreciation
- 6. Interest earning
  - Interest of saving deposit at 10% per year

Community Electrication Project, Kampong Kor, Phase 1, soft Ioan @ 3% - 15 yr including 3-yr grace <b>Table 2 Financial Analysis</b>																				
	0	1	2	3	4	5	6	7	8	9	10	11	12	19	20	21	22	29	30	(unit: \$) Total
(Expenditure)																				
Initital costs																				
Construction costs excluding tax	552,979											179,400				179,400				911,779
Supports to CEC	24,750	8,250																		
Operation and maintenance costs		14,269	20,474	22,694	24,215	25,888	27,728	28,753	28,942	28,942	28,942	28,942	28,942	28,942	28,942	28,942	28,942	28,942	28,942	829,681
Personnel costs		3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	97,200
O&M of biomass gasification power plant		4,495	8,266	9,614	10,538	11,555	12,673	13,295	13,410	13,410	13,410	13,410	13,410	13,410	13,410	13,410	13,410	13,410	13,410	378,866
Maintenance of distribution lines, etc.		700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	21,000
Biomass fuel cost		2,869	5,275	6,135	6,725	7,374	8,088	8,485	8,558	8,558	8,558	8,558	8,558	8,558	8,558	8,558	8,558	8,558	8,558	241,785
EAC license fee @ Riel 1.6/kWh		35	64	74	82	89	98	103	104	104	104	104	104	104	104	104	104	104	104	2,931
Payment for technical supports		2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	87,900
Total expenditure	577,729	22,519	20,474	22,694	24,215	25,888	27,728	28,753	28,942	28,942	28,942	208,342	28,942	28,942	28,942	208,342	28,942	28,942	28,942	1,774,460
(Revenue)																				
Operating revenue through electricity sales		30,429	53,631	61,985	67,932	74,473	81,668	85,471	86,136	86,136	86,136	86,136	86,136	86,136	86,136	86,136	86,136	86,136	86,136	2,436,724
Sales of CER		791	1,455	1,692	1,855	2,033	2,230	2,340	2,360	2,360	2,360	2,360	2,360	2,360	2,360	2,360	2,360	2,360	2,360	66,676
Residual value of equipment											17,940				17,940				59,510	
Total revenue		31,220	55,086	63,677	69,786	76,507	83,899	87,811	88,496	88,496	106,436	88,496	88,496	88,496	106,436	88,496	88,496	88,496	148,006	2,598,789
(Net operating income)	-577,729	8,701	34,611	40,984	45,572	50,619	56,170	59,058	59,555	59,555	77,495	-119,845	59,555	59,555	77,495	-119,845	59,555	59,555	119,064	824,329
FIRR	6.2%																			

Community Electrication Project, Kampong Kor, Phase 1, soft loan @ 3% - 15 yr including 3-yr grace Table 2 Financial Analysis																				
Including taxes, excluding CER sales	0	1	2	3	4	5	6	7	8	9	10	11	12	19	20	21	22	29	30	(unit: \$) Total
(Expenditure)				-																
Initital costs																				
Construction costs	595,099											179,400				179,400				953,899
Supports to CEC	24,750	8,250																		
Operation and maintenance costs		14,269	20,474	22,694	24,215	25,888	27,728	28,753	28,942	28,942	28,942	28,942	28,942	28,942	28,942	28,942	28,942	28,942	28,942	829,681
Personnel costs		3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	97,200
O&M of biomass gasification power plant		4,495	8,266	9,614	10,538	11,555	12,673	13,295	13,410	13,410	13,410	13,410	13,410	13,410	13,410	13,410	13,410	13,410	13,410	378,866
Maintenance of distribution lines, etc.		700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	21,000
Biomass fuel cost		2,869	5,275	6,135	6,725	7,374	8,088	8,485	8,558	8,558	8,558	8,558	8,558	8,558	8,558	8,558	8,558	8,558	8,558	241,785
EAC license fee @ Riel 1.6/kWh		35	64	74	82	89	98	103	104	104	104	104	104	104	104	104	104	104	104	2,931
Payment for technical supports		2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	87,900
Total expenditure	619,849	22,519	20,474	22,694	24,215	25,888	27,728	28,753	28,942	28,942	28,942	208,342	28,942	28,942	28,942	208,342	28,942	28,942	28,942	1,816,580
(Revenue)																				
Operating revenue through electricity sales Sales of CER		30,429	53,631	61,985	67,932	74,473	81,668	85,471	86,136	86,136	86,136	86,136	86,136	86,136	86,136	86,136	86,136	86,136	86,136	2,436,724
Residual value of equipment											17,940				17,940				59,510	Ū
Total revenue		30,429	53,631	61,985	67,932	74,473	81,668	85,471	86,136	86,136	104,076	86,136	86,136	86,136	104,076	86,136	86,136	86,136	145,646	2,532,113
(Net operating income)	-619,849	7,910	33,157	39,292	43,717	48,585	53,940	56,718	57,195	57,195	75,135	-122,205	57,195	57,195	75,135	-122,205	57,195	57,195	116,704	715,533
FIRR	5.2%																			

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Excluding taxes and subsidy from costs, and i 0 Expenditure) nitital costs Construction costs Supports to CEC 24,7 Operation and maintenance costs Dersonnel costs D&M of biomass gasification power plant Maintenance of distribution lines, etc. Biomass fuel cost EAC license fee @ Riel 1.6/kWh Payment for technical supports	including ) 1 234 750 8,25 14,26 3,24 4,49 70 2,86 3	CER sa 2 0 9 20,474 0 3,240 5 8,266 0 700 9 5,275	les 3 22,694 3,240 9,614 700	4 24,215 3,240 10,538	5 25,888 3,240	6 27,728 3 240	7 28,753	8 28,942	9	10	11 179,400	12	19	20	21 179,400	22	29	30	(unit: \$) Total 750,034
Expenditure) nitital costs Construction costs Supports to CEC 24,7 Operation and maintenance costs Personnel costs D&M of biomass gasification power plant Aaintenance of distribution lines, etc. Biomass fuel cost CAC license fee @ Riel 1.6/kWh Payment for technical supports	234 750 8,25 14,26 3,24 4,49 70 2,86 3	2 0 9 20,474 0 3,240 5 8,266 0 700 9 5,275	22,694 3,240 9,614 700	24,215 3,240 10,538	25,888 3,240	27,728	28,753	28,942	28 942	10	179,400	12		20	179,400		29	50	750,034
nitital costs       391,2         Construction costs       391,2         Supports to CEC       24,7         Operation and maintenance costs       24         Personnel costs       24         O&M of biomass gasification power plant       4         Maintenance of distribution lines, etc.       3         Biomass fuel cost       24         EAC license fee @ Riel 1.6/kWh       2         Payment for technical supports       3	234 750 8,25 14,26 3,24 4,49 70 2,86 3	0 9 20,474 0 3,240 5 8,266 0 700 9 5,275	22,694 3,240 9,614 700	24,215 3,240 10,538	25,888 3,240	27,728	28,753	28,942	28 942		179,400				179,400				750,034
Construction costs391,2Supports to CEC24,7Operation and maintenance costsPersonnel costsD&M of biomass gasification power plantMaintenance of distribution lines, etc.Biomass fuel costEAC license fee @ Riel 1.6/kWhPayment for technical supports	234 750 8,25 14,26 3,24 4,49 70 2,86 3	0 9 20,474 0 3,240 5 8,266 0 700 9 5,275	22,694 3,240 9,614 700	24,215 3,240 10,538	25,888 3,240	27,728	28,753	28,942	28 942		179,400				179,400				750,034
Supports to CEC 24,7 <b>Operation and maintenance costs</b> Personnel costs D&M of biomass gasification power plant Maintenance of distribution lines, etc. Biomass fuel cost EAC license fee @ Riel 1.6/kWh Payment for technical supports	750 8,25 14,26 3,24 4,49 70 2,86 3	0 20,474 0 3,240 5 8,266 0 700 9 5,275	22,694 3,240 9,614 700	24,215 3,240 10,538	25,888 3,240	27,728	28,753	28,942	28 942										
Deration and maintenance costs Personnel costs D&M of biomass gasification power plant Aaintenance of distribution lines, etc. Biomass fuel cost EAC license fee @ Riel 1.6/kWh Payment for technical supports	14,26 3,24 4,49 70 2,86 3	<ul> <li>9 20,474</li> <li>0 3,240</li> <li>5 8,266</li> <li>0 700</li> <li>9 5,275</li> </ul>	22,694 3,240 9,614 700	24,215 3,240 10,538	25,888 3,240	27,728	28,753	28,942	28.942							Ì			
Personnel costs D&M of biomass gasification power plant Aaintenance of distribution lines, etc. Biomass fuel cost EAC license fee @ Riel 1.6/kWh Payment for technical supports	3,24 4,49 70 2,86 3	0 3,240 5 8,266 0 700 9 5,275	3,240 9,614 700	3,240 10,538	3,240	3 240			,	28,942	28,942	28,942	28,942	28,942	28,942	28,942	28,942	28,942	829,681
D&M of biomass gasification power plant Maintenance of distribution lines, etc. Biomass fuel cost EAC license fee @ Riel 1.6/kWh Payment for technical supports	4,49 70 2,86 3	5 8,266 0 700 9 5,275	9,614 700	10,538		5,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	97,200
Maintenance of distribution lines, etc. Biomass fuel cost EAC license fee @ Riel 1.6/kWh Payment for technical supports	70 2,86 3	0 700 9 5,275	700		11,555	12,673	13,295	13,410	13,410	13,410	13,410	13,410	13,410	13,410	13,410	13,410	13,410	13,410	378,866
Biomass fuel cost EAC license fee @ Riel 1.6/kWh Payment for technical supports	2,86 3	9 5,275		700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	21,000
EAC license fee @ Riel 1.6/kWh Payment for technical supports	3		6,135	6,725	7,374	8,088	8,485	8,558	8,558	8,558	8,558	8,558	8,558	8,558	8,558	8,558	8,558	8,558	241,785
Payment for technical supports		5 64	74	82	89	98	103	104	104	104	104	104	104	104	104	104	104	104	2,931
	2,93	0 2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	2,930	87,900
Total expenditure415,9	,984 22,5	19 20,474	22,694	24,215	25,888	27,728	28,753	28,942	28,942	28,942	208,342	28,942	28,942	28,942	208,342	28,942	28,942	28,942	1,612,715
Revenue)																			
Dperating revenue through electricity sales	30,42	9 53,631	61,985	67,932	74,473	81,668	85,471	86,136	86,136	86,136	86,136	86,136	86,136	86,136	86,136	86,136	86,136	86,136	2,436,724
ales of CER	79	1 1,455	1,692	1,855	2,033	2,230	2,340	2,360	2,360	2,360	2,360	2,360	2,360	2,360	2,360	2,360	2,360	2,360	66,676
Residual value of equipment										17,940				17,940				59,510	
`otal revenue	31,22	0 55,086	63,677	69,786	76,507	83,899	87,811	88,496	88,496	106,436	88,496	88,496	88,496	106,436	88,496	88,496	88,496	148,006	2,598,789
Net operating income) -415,	,984 8,70	01 34,611	40,984	45,572	50,619	56,170	59,058	59,555	59,555	77,495	-119,845	59,555	59,555	77,495	-119,845	59,555	59,555	119,064	986,074
FIRR 9.3	3%																		

JICA N Renew	Community Electrication Project, Kampong Kor, Phase 1, soft Ioan @ 3% - 15 yr including 3-yr grace       Table 3 Economic Evaluation																					
4/P S able		0	1	2	3	4	5	6	7	8	9	10	11	12	19	20	21	22	29	30	(unit: \$) Total	epoi
Study on R Energy in	(Economic costs) Initital costs Economic costs Supports to CEC	490,062 22,275	7,425										178,308				178,308				846,678	1
ural Electrifica the Kingdom o	<b>Operation and maintenance costs</b> Personenel costs O&M of biomass gasification power plant Maintenance of distribution lines, etc. Biomass fuel cost	0	8,174 2,916 4,449 350 459	12,290 2,916 8,180 350 844	13,762 2,916 9,514 350 982	14,771 2,916 10,429 350 1,076	15,881 2,916 11,435 350 1,180	17,101 2,916 12,541 350 1,294	17,781 2,916 13,158 350 1,358	17,906 2,916 13,271 350 1,369	87,480 374,939 10,500 38,686											
tion by f Camb	EAC license fee @ Riel 1.6/kWh Monitoring of CEC by DIME		31 0	58 0	67 0	73 0	80 0	88 0	93 0	2,638 0												
odia	Residual value											-17,831				-17,831				-49,006	-84,668	
	Total expenditure	512,337	15,630	12,347	13,829	14,844	15,961	17,190	17,874	18,000	18,000	169	196,308	18,000	18,000	169	196,308	18,000	18,000	-31,007	1,305,952	
AH-	(Economic benefits as costs of alternative dies Initital costs Economic costs Supports to CEC	<b>el mini-grid</b> 367,820 22,275	<b>i)</b> 7,425										91,308				91,308				550,436	
13	<b>Operation and maintenance costs</b> Personenel costs O&M of diesel power plant Maintenance of distribution lines, etc. Fuel cost	0	24,732 2,592 1,994 350 19,796	43,006 2,592 3,666 350 36,398	49,541 2,592 4,264 350 42,335	54,021 2,592 4,674 350 46,405	58,948 2,592 5,125 350 50,881	64,368 2,592 5,621 350 55,806	67,386 2,592 5,897 350 58,547	67,942 2,592 5,948 350 59,052	77,760 168,037 10,500 1,668,362	Appendix-H										
	EAC license fee Payment for technical supports		31 2,637	58 2,637	67 2,637	73 2,637	80 2,637	88 2,637	93 2,637	2,638 79,110	H Eva											
	Residual value											-9,131				-9,131				-36,782	-55,044	luatio
	Benefits from CER sales		791	1,455	1,692	1,855	2,033	2,230	2,340	2,360	2,360	2,360	2,360	2,360	2,360	2,360	2,360	2,360	2,360	2,360	66,676	on Sh
	Total benefits	390,095	35,617	47,155	53,937	58,586	63,699	69,324	72,455	73,032	73,032	63,901	164,340	73,032	73,032	63,901	164,340	73,032	73,032	36,250	2,598,176	leet f
	(Net benefits)	-122,242	19,986	34,808	40,108	43,742	47,738	52,134	54,582	55,032	55,032	63,732	-31,968	55,032	55,032	63,732	-31,968	55,032	55,032	67,257	1,292,224	or Bi
	EIRR	30.9%																				oma

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# Community Electrication Project, Kampong Kor, Phase 1, soft Ioan @ 3% - 15 yr including 3-yr grace Table 4 Financing Plan

				(unit: \$)
Financial Resources			Financial Application	
Equity - CEC			Power Plant before tax	404,106
Cash (@ \$50/hh)	44,300	6.8%	Biomass gasification power equipment	240,400
In kind ( @ \$40/MM)	52,747	8.2%	Road improvement works	60,000
1319 MM			Powerhouse, etc.	15,600
Grant			Switching equip. & transformer	61,000
REF	161,745	25.0%	Growing fuel trees	15,106
(25% of capital costs)			Misecellaneous equipment	12,000
Borrowing for capitals			Distribution facilities, service wires, etc.	181,535
Long-term	388,187	60.0%		
(15 yr including 3-year grace, 3%/yr)			Contingecy	28,338
			Capital costs before tax	613,979
Total fund for capital costs and CEC supports	646,979	100.0%	CEC support	33,000
Borrowing for operation	5,000		Operation fund in hand	5,000
Short-term (Revolving, 15%/yr)				
Tax exemption	42,120		Customs and tax	42,120
Total Financial Resources	694,099		Total Financial Resources	694,099

Community Electrication Project, Kampong Kor, Phase 1, soft loan @ 3% - 15 yr including 3-yr grace <b>Table 5 Profit and Loss Statement with Cash Flow, 15-yr repayment period</b>											Final												
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	20	21	22	30	(unit: \$) Total	Rep
Operating revenue incl. CER & resi	idual va	lue	30,429	53,631	61,985	67,932	74,473	81,668	85,471	86,136	86,136	86,136	86,136	86,136	86,136	86,136	86,136	86,136	86,136	86,136	86,136	2,436,724	ort
Operating costs			14,269	20,474	22,694	24,215	25,888	27,728	28,753	28,942	28,942	28,942	28,942	28,942	28,942	28,942	28,942	28,942	28,942	28,942	28,942	829,681	
new land required for tree plantation	l				3.9	2.7	2.9	3.2	1.8	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.9	
tree plantation costs for increasing de	emand			2,464	1,689	1,858	2,044	1,138	210	0	0	0	0	0	0	0	0	0	0	0	9,402	18,804	
Gross profit			16,160	30,693	37,599	41,857	46,539	52,799	56,507	57,194	57,195	57,195	57,195	57,195	57,195	57,195	57,195	57,195	57,195	57,195	47,793	1,588,224	
Interests payment																							
Short-term commercial loan (15%/yr)			750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	22,500	
Long-term soft loan	3.0%		11,646	11,646	11,646	10,675	9,705	8,734	7,764	6,793	5,823	4,852	3,882	2,911	1,941	970						98,988	
Deprecitation																							
10 yr)	216,360							43,272	43,272	43,272	43,272	43,272	21,636	21,636	21,636	21,636	21,636	21,636	21,636	21,636	21,636	649,080	
Others (20 yr from 6th year)	365,921							18,296	18,296	18,296	18,296	18,296	18,296	18,296	18,296	18,296	18,296	18,296	18,296	18,296		365,921	
Operating profit before depreciation	n		3,764	18,297	25,203	30,432	36,084	43,315	47,993	49,651	50,622	51,592	52,563	53,533	54,504	55,474	56,445	56,445	56,445	56,445	47,043	1,466,736	Appen
Interests received (10%)			0	0	2,431	2,128	2,335	3,145	4,779	7,056	9,727	12,764	17,994	22,051	26,610	31,723	37,444	96,204	113,499	130,730	347,479	2,690,565	dix-
Residual value upon completion of depreciation	10%											17,940						17,940			59,510	95,390	I
CER received			791	1,455	1,692	1,855	2,033	2,230	2,340	2,360	2,360	2,360	2,360	2,360	2,360	2,360	2,360	2,360	2,360	2,360	2,360	66,676	Eval
Net profit after depreciation			4,555	19,752	29,326	34,414	40,452	-12,878	-6,456	-2,501	1,141	23,088	32,985	38,012	43,542	49,625	56,316	133,017	132,372	149,602	434,755	3,304,366	uatio
Cash in hand			4,555	19,752	29,326	34,414	40,452	48,690	55,112	59,067	62,709	84,656	72,917	77,944	83,474	89,557	96,248	172,949	172,304	189,534	456,391	4,319,367	n Sł
Accumulated cash in hand after principal repayment		0	4,555	24,307	21,284	23,349	31,453	47,794	70,557	97,275	127,635	179,942	220,510	266,105	317,230	374,438	470,687	1,134,993	1,307,297	1,496,831	3,931,179		neet for
Principal repayment	388,187	0	0	0	32,349	32,349	32,349	32,349	32,349	32,349	32,349	32,349	32,349	32,349	32,349	32,349						388,187	Bio
Long-term debt balance	388,187	388,187	388,187	388,187	355,838	323,490	291,141	258,792	226,443	194,094	161,745	129,396	97,047	64,698	32,349	-0							mass

Appendix-H Evaluation Sheet for Biomass Pilot Projects

Community Electrication Project, Samlout, Phase 1, soft Ioan @ 3% - 15 yr including 3-yr grace

## Table A1 Principal Features of Electrification Plan

# (1) Generating Equipment Planning

Items	Unit	Q'ty	Remarks
Nos. of households	h.h.	774	11% of the total 7,284 households
Unit nighttime domestic demand	W/hh	100	
Nighttime domestic demand	kW	77.4	
Street light demand	kW	3.1	1 light per 40 m of LV lir 155 street lights
Reserve capacity	kW	23.2	30% of nighttime domestic demand, allocated for station use + reserved power + distribution losses
Required capacity	kW	103.7	
Adopted capacity	kW	120.0	

# (2) Energy Generation Planning for 8th Year Onward

Items	Monthly Unit Energy Sold	Monthly Energy Sold	Annual Energy Sold	Station Use, Losses, etc. (10%)	Annual Energy Generated	Annual Plant Factor	Annual Operation Hours	Remarks (refer to Table A2 for demand growth rates)
	kWh/hh	MWh	MWh	MWh	MWh	%	hr	
Nighttime domestic demand $\underline{1}$ /, $\underline{2}$	15.0	11.6	139.3	13.9	153.3	14.6%	1,277	100% from 8th year onward
Street light demand	0.6	0.5	5.6	0.6	6.1	0.6%	51	100% from the 1st year
Industrial demand <u>3/</u>	7.5	5.8	69.7	7.0	76.6	7.3%	639	100% from 8th year onward
Irrigation pump demand 4/	6.1	14.1	56.4	5.6	62.1	5.9%	517	in 4 dry months, 100% from 8th year onward
Total energy	29.2	32.0	271.0	27.1	298.1	28.4%	2,484	100% from 8th year onward

### Note:

1/ Typical consumption level of existing mini-grids in rural villages as of 2005 was 10 kWh (= 100W / 1,000 \* 5hrs \* 30 days \* 67%) and assumed to be realized from 2nd year.

2/ Average consumption of existing REE mini-grids supplying to rural towns as of 2005 was 15 kWh (= 100 W / 1,000 \* 7.5hrs \* 30days \* 67%) and was assumed to be realized in 7th year.

 $\underline{3}$ / Power demand of BCS, rice-mills, water supply stations, ice factory, workshop of boat engines, etc. Assumed to be 50% of the nighttime demand based on the actual demand of existing Anlong Ta Mey mini-grid (700 kWh at nighttime, 300 kWh for BCS at daytime) and potential daytime users in the villages shown in Table A3.

 $\underline{4}$  see Table A3 for irrigation power demand.

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	C	ommun	ity Elect	trication	Project	t, Samlo	ut, Phas	se I, sof	t loan (	<i>v</i> ) 3% - 1 Sala	15 yr inc	luding	3-yr gra	ce					
					Iab	ole A2	Energ	gy and	CER	<b>S01</b> a									
	1	2	3	4	5	6	7	8	9	10	11	12	19	20	21	22	29	30	Total
(Annual energy sold)			-		-	-		-						-			-		
Demand growth Growth rate																			
Domestic 1.10	50%	67%	73%	81%	89%	98%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Street lights 0.00	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Industrial 1.10	0%	50%	67%	73%	81%	89%	98%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Irrigation 1.10	0%	50%	67%	73%	81%	89%	98%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Energy sold (MWh/yr) Demand																			
Domestic 139.3	69.7	92.9	102.2	112.4	123.6	136.0	139.3	139.3	139.3	139.3	139.3	139.3	139.3	139.3	139.3	139.3	139.3	139.3	3,980
Street lights 5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	167
Industrial 69.7	0.0	34.8	46.4	51.1	56.2	61.8	68.0	69.7	69.7	69.7	69.7	69.7	69.7	69.7	69.7	69.7	69.7	69.7	1,921
Irrigation 56.4	0.0	28.2	37.6	41.4	45.5	50.1	55.1	56.4	56.4	56.4	56.4	56.4	56.4	56.4	56.4	56.4	56.4	56.4	1,556
Total 271.0	75.2	161.5	191.8	210.4	230.9	253.5	268.0	271.0	271.0	271.0	271.0	271.0	271.0	271.0	271.0	271.0	271.0	271.0	7,624
Unit energy sold (kWh per household per more	nth)																		
Domestic 15.0	7.5	10.0	11.0	12.1	13.3	14.6	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	
Street lights 0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
Industrial 7.5	0.0	3.8	5.0	5.5	6.1	6.7	7.3	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	
Irrigation 6.1	0.0	3.0	4.1	4.5	4.9	5.4	5.9	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	
Total 29.2	8.1	17.4	20.7	22.7	24.9	27.3	28.9	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	
(Operating revenue from electricity sales, \$)																			
Tariff																			
Domestic \$0.34	23,336	31,115	34,226	37,649	41,414	45,555	46,672	46,672	46,672	46,672	46,672	46,672	46,672	46,672	46,672	46,672	46,672	46,672	1,333,428
Street lights \$0.34	1,869	1,869	1,869	1,869	1,869	1,869	1,869	1,869	1,869	1,869	1,869	1,869	1,869	1,869	1,869	1,869	1,869	1,869	56,079
Industrial \$0.28	0	9,578	12,771	14,048	15,453	16,998	18,698	19,157	19,157	19,157	19,157	19,157	19,157	19,157	19,157	19,157	19,157	19,157	528,146
Irrigation \$0.28	0	7,760	10,347	11,382	12,520	13,772	15,149	15,520	15,520	15,520	15,520	15,520	15,520	15,520	15,520	15,520	15,520	15,520	427,896
Total	25,205	50,323	59,213	64,948	71,256	78,194	82,388	83,218	83,218	83,218	83,218	83,218	83,218	83,218	83,218	83,218	83,218	83,218	2,345,549
(Monthly tariff, \$ per household)																			
Domestic	2.51	3.35	3.69	4.05	4.46	4.90	5.03	5.03	5.03	5.03	5.03	5.03	5.03	5.03	5.03	5.03	5.03	5.03	
Street lights	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	
Industrial	0.00	1.03	1.38	1.51	1.66	1.83	2.01	2.06	2.06	2.06	2.06	2.06	2.06	2.06	2.06	2.06	2.06	2.06	
Irrigation	0.00	0.84	1.11	1.23	1.35	1.48	1.63	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	
Total	2.71	5.42	6.38	6.99	7.67	8.42	8.87	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96	
(Tariff receivable, \$/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
kg-CO <sub>2</sub> /kWh																			
(CER saleable) (to-CO <sub>2</sub> ) 1.3	98	210	249	274	300	329	348	352	352	352	352	352	352	352	352	352	352	352	9,912
(\$/yr) <u>1</u> / <b>\$7</b>	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
Fuel tree consumed (ton per month)	94	20.2	24.0	26.3	28.9	31.7	33 5	33.9	33.9	33.9	33.9	33.9	33.9	33.9	33.9	33.9	33.9	33.9	953
Land required to supply fuel trees (ha)	11.3	24.2	28.8	31.6	34.6	38.0	40.2	40.6	40.6	40.6	40.6	40.6	40.6	40.6	40.6	40.6	40.6	40.6	,
Nos. of fuel tree farmers (0.2 ha per farmer)	56	121	144	158	173	190	201	203	203	203	203	203	203	203	203	203	203	203	
Payment to fuel tree farmers (\$/farmer/month	3.4	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	
Total payment to fuel tree farmers (\$/yr)	2,257	4,845	5,754	6,313	6,928	7,604	8,039	8,130	8,130	8,130	8,130	8,130	8,130	8,130	8,130	8,130	8,130	8,130	228,729
	· · ·	, -	,	, -	, -	,	, -	, -	, -	/ -	/	/ -	· · ·	, -	/			, -	,

Note: 1/ Assumed at %4/ton-CO2/yr deducting costs required for prepration of PDD, application and monitoring. CER: Certified Emission Reduction

Final Report

# Appendix-H Evaluation Sheet for Biomass Pilot Projects

# Community Electrication Project, Samlout, Phase 1, soft loan @ 3% - 15 yr including 3-yr grace Table A3 Potential Daytime Users and Demand

No.	Demand	Diesel Consumption	Electricity Demand	Operation Hour	Unit Power Demand	Nos. of Customers		Total Demar	nd
		liter/month	kWh/month	hr/month	kW		kW	kWh/month	Load Factor
1	BCS	200	600	50	12.00	5	60.00	3,000	6.9%
2	Water supply	60	180	15	12.00	10	120.00	1,800	2.1%
3	Rice-mill	30	90	30	3.00	30	90.00	2,700	4.2%
4	Ice factory	30	90	30	3.00	1	3.00	90	4.2%
5	Workshop	25	75	60	1.25	1	1.25	75	8.3%
6	Café	115	345	296	1.17	1	1.17	345	41.1%
Ν	/onthly total	460	1,380	481	-	48	120.00	8,010	9.3%
1	Annual total	5520	16,560	5,772	-	-	120.00	96,120	9.3%

Source: The potential daytime users above are candidates in Kampong Kor for reference purpose.

# Potential irrigation demand in the dry season

Unit land to irrigate	0.5	ha/hh
Ratio of irrigation hh	50.0%	
Total land area to irrigate	193.5	ha
Depth of irrigation	500	mm
Total irrigation water	0.968	mcm/yr
Irrigation period	4	month
Daily operation hour	8	hr/day
Total pump discharge	0.280	m <sup>3</sup> /s
Pumping head	15.0	m
Combined efficiency	0.70	
Total power required	59	kW
Total energy required	56	MWh

### Project Samlout Pha Electric e 1 soft loan @ 3% - 15 cludin , 3. ....

Community Electrication Project	, Samout, Fliase 1, s	on ioan @ 576 - 15 yi	including 5-yr grace
	Table A4 Cost H	Estimate	

	Unit Price (\$)	Q'ty	Unit	Amount(\$)	Total (\$)
Power Station				1.5 - 0.0 -	
Biomass gasification power generating equipment (FOB)	1,300	120	kW	156,000	
Ocean freight & insurance (FOBx8%)	104	120	kW	12,480	
Inland transportation & installation (FOB x (2%+5%))	91	120	kW	10,920	
Switching equipment, main transformer		150	kVA	61,000	
					240,400
Civil and substation works					
to be further improved to all weather read in Phase 2	24	0.20	km	4,800	
L and nowerhouse water tank etc. (10%FOB)	130	120	kW	15 600	
Eand, powernouse, water tank, etc. (10761 OD)	150	120	K U	15,000	20,400
Fuel tree preparation for 2nd year demand					.,
Scarified seeds of Leucaena of 0.4-0.5 kg/ha and \$15/kg	8	24	ha	182	
Nursery	1	240	m <sup>2</sup>	240	
Watering of nursery for the first 3 months	100	3	month	300	
Bush clearing	40	24	ha	969	
Land preparation	80	24	ha	1 938	
Transplanting	80	24	ha	1,038	
Maintenance for initial 6 months @ \$60/ha/mon	360	24	ha	8 721	
Manifestatice for minital o months @ \$00/namon	500	24	nu	0,721	14 288
Sub-total of power station and fuel preparation					275.088
Miscellaneous of power station (5%, consumables, gas detector,					,
fire distinguisher, water content meter, computer set, etc.)				12,000	
Power station sub-total (before tax)					287,088
Customs & VAT (CIF x 25%)	351	120	kW	42.120	
Power station sub-total (including tax)				,	329,208
					,
Distribution Facilities					
MV lines	6,000	6.3	km	37,800	
MV-LV lines	10,700	3.7	km	39,590	
LV lines	7,100	2.5	km	17,750	
Pole-mounted distribution transformers					
15 kVA-1P	6,200		set	0	
25 kVA-3P	7,300	1	set	7,300	
50 kVA-3P	8,100	3	set	24,300	
Distribution line - transformer sub-total (including tax)	.,			,	126,740
Miscellaneous (5%, street lights, etc.)				6.337	.,
Distribution line - transformer sub-total (including tax)				0,000	133 077
Service wire, etc.				38 700	
Domestic cutomers	50	774	hh	38 700	
Davtime customers (to be fixed individually)	0	,,,	customers	0	
Distribution line - transformer - service wires, etc. sub-total	Ŭ		edistolliers	Ŭ	
Sub-total					500,985
Sontingety (370)					23,047
Construction costs total					526,034
			11.3	۸	
Contraction OFC	Unit Datas (C)	04		Amount(N)	
Costs for CEC supports	Unit Price (\$)	Q'ty	Unit	22.000	
Costs for CEC supports Costs for CEC supports and training Costs for CEC supports and training	Unit Price (\$)	Q'ty	Unit	33,000	
Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management	Unit Price (\$)	Q'ty 12.00	MM	<b>33,000</b> 6,000	
Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports	Unit Price (\$) 500 500	Q'ty 12.00 18.00	MM MM	<b>33,000</b> 6,000 9,000	
Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging	Unit Price (\$) 500 500 1,000	Q'ty 12.00 18.00 18.00	MM MM month	<b>33,000</b> 6,000 9,000 18,000	
Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Deperation and maintenance costs	Unit Price (\$) 500 500 1,000	Q'ty 12.00 18.00 18.00	MM MM month	<b>33,000</b> 6,000 9,000 18,000	
Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff	Unit Price (\$) 500 500 1,000	Q'ty 12.00 18.00 18.00 Nos. of	MM MM month	<b>33,000</b> 6,000 9,000 18,000	Total (\$)
Costs for CEC supports Costs for CEC supports and training L1 Facilitation for CEC setting up and management L2 Technical supports L3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Countries Chiefe	Unit Price (\$) 500 500 1,000 Salary (\$/mon)	Q'ty 12.00 18.00 18.00 Nos. of person	MM MM month MM	<b>33,000</b> 6,000 9,000 18,000 Amount(\$)	Total (\$)
Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 3.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operation Chief Operation Chief	Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80	Q'ty 12.00 18.00 18.00 Nos. of person 1	MM MM month 12.00	33,000         6,000         9,000         18,000           Amount(\$)         960	Total (\$)
Costs for CEC supports Costs for CEC supports and training Costs for CEC supports and training 1.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operator D characteristic period	Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40	Q'ty 12.00 18.00 18.00 Nos. of person 1 2	MM MM month 12.00 12.00	33,000         6,000         9,000         18,000           Amount(\$)         960	Total (\$)
Costs for CEC supports Costs for CEC supports and training 1 Facilitation for CEC setting up and management 2. Technical supports 3. Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operator Fuel preparation workers December 2012	Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30	Q'ty 12.00 18.00 18.00 Nos. of person 1 2 1	MM MM month 12.00 12.00 12.00 12.00	33,000         6,000         9,000         18,000           Amount(\$)         960         960         360	Total (\$)
Costs for CEC supports Costs for CEC supports and training 1 Facilitation for CEC setting up and management 2. Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operator Fuel preparation workers Director and accountant Demond Lower Low	Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40	Q'ty 12.00 18.00 18.00 <u>Person</u> 1 2 1 2 1 2	MM MM month 12.00 12.00 12.00 12.00	33,000         6,000         9,000         18,000           Amount(\$)         960         960         360         960	Total (\$)
Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operator Fuel preparation workers Director and accountant Personnel costs sub-total	Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40	Q'ty 12.00 18.00 18.00 Nos. of person 1 2 1 2	MM MM month 12.00 12.00 12.00 12.00 12.00	<b>33,000</b> 6,000 9,000 18,000 18,000 960 960 960 360 960	Total (\$) \$3,240
Costs for CEC supports Costs for CEC supports and training Costs for CEC supports and training Cost for CEC setting up and management Cost supports Cost and lodging Coperation and maintenance costs Personnel costs of CEC staff Operation Chief Operation Chief Fuel preparation workers Director and accountant Personnel costs sub-total Maintenance costs of gasifier and engine-generator	Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 CIF (\$)	Qty 12.00 18.00 18.00 Nos. of person 1 2 1 2	MM MM month 12.00 12.00 12.00 12.00 Ratio of O&M Costs	33,000         6,000         9,000         18,000           Amount(\$)         960         960         360         960	Total (\$) \$3,240 Total (\$)
Costs for CEC supports Costs for CEC supports and training Costs for CEC setting up and management Cost costs of CEC setting up and management Cost costs of cec staff Operation and maintenance costs Personnel costs of CEC staff Operator Fuel preparation workers Director and accountant Personnel costs ub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF)	Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 CIF (\$) 240,400	Qty 12.00 18.00 18.00 Nos. of person 1 2 1 2	MM MM month 12.00 12.00 12.00 12.00 12.00 Ratio of O&M Costs	33,000         6,000         9,000         18,000           Amount(\$)         960         960         360         960           Amount (\$)         Amount (\$)         960         360         960         960         960         960         96	Total (\$) <b>\$3,240</b> Total (\$)
Costs for CEC supports Costs for CEC supports and training Costs for CEC supports and training Cost for CEC setting up and management Cost of CEC setting up and management Cost of CEC staff Operation and maintenance costs Personnel costs of CEC staff Operator Fuel preparation workers Director and accountant Personnel costs sub-total Maintenance costs gasifier and engine-generator Gasifier and engine-generator costs (CIF) S% of engine-generator set	Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 \$20 \$40 \$240,400 80.133	Qty 12.00 18.00 18.00 Nos. of person 1 2 1 2	MM MM month 12.00 12.00 12.00 12.00 12.00 Ratio of O&M Costs 5.0%	33,000         6,000         9,000         18,000           Amount(\$)         960         960         360         960	Total (\$) <b>\$3,240</b> Total (\$)
Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 3.3 Vehicles and lodging Deration and maintenance costs Personnel costs of CEC staff Operation Chief Operator Fuel preparation workers Director and accountant Personnel costs sub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator costs (CIF) 5% of engine-generator costs (CIF) 5% of engine-generator set ever 3.000 hr	Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$80 \$30 \$40 CIF (\$) 240,400 80,133 1/0 5 5 5	Q'ty 12.00 18.00 18.00 Nos. of person 1 2 1 2	MM MM month 12.00 12.00 12.00 12.00 12.00 8 atio of 0&M Costs	33,000         6,000         9,000         18,000           Amount(\$)         960         960         360         960           Amount (\$)         4,010         6,016         5616	Total (\$) \$3,240 Total (\$)
Costs for CEC supports Costs for CEC supports and training Costs for CEC supports and training 1.1 Facilitation for CEC setting up and management 2.2 Technical supports 3.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operator Fuel preparation workers Director and accountant Personnel costs sub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr operation very one year, 4-6%)	Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 \$40 \$30 \$40 \$30 \$40 \$30 \$40 \$30 \$40 \$30 \$40 \$30 \$40 \$30 \$30 \$40 \$30 \$30 \$40 \$30 \$30 \$40 \$30 \$30 \$40 \$30 \$30 \$40 \$30 \$30 \$40 \$30 \$30 \$40 \$30 \$30 \$40 \$30 \$30 \$40 \$30 \$30 \$40 \$30 \$30 \$40 \$30 \$30 \$30 \$40 \$30 \$30 \$40 \$30 \$30 \$40 \$30 \$40 \$30 \$40 \$30 \$40 \$30 \$40 \$30 \$40 \$30 \$40 \$30 \$40 \$30 \$40 \$30 \$40 \$30 \$40 \$30 \$40 \$30 \$40 \$30 \$40 \$40 \$30 \$40 \$40 \$30 \$40 \$40 \$30 \$40 \$40 \$30 \$40 \$40 \$30 \$40 \$40 \$30 \$40 \$40 \$30 \$40 \$40 \$40 \$30 \$40 \$40 \$40 \$40 \$40 \$40 \$40 \$40 \$40 \$4	Qty 12.00 18.00 18.00 Nos. of person 1 2 1 2	MM MM month 12.00 12.00 12.00 12.00 12.00 12.00 5.0% 5.0%	33,000         6,000         9,000         18,000           Amount(\$)         960	Total (\$) <b>\$3,240</b> Total (\$)
Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Deration and maintenance costs Personnel costs of CEC staff Operation Chief Operation Chief Operation and accountant Personnel costs sub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/every one year, 4-6%) Replacement of lamp of street lights, office stationery and	Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 CIF (\$) 240,400 80,133 160,267	Qty 12.00 18.00 18.00 Nos. of person 1 2 1 2	MM MM month 12.00 12.00 12.00 12.00 12.00 Ratio of O&M Costs 5.0% 5.0%	33,000         6,000         9,000         18,000           Amount(\$)         960         960         360         960	Total (\$) <b>\$3,240</b> Total (\$)
Costs for CEC supports Costs for CEC supports and training 1.1 Facilitation for CEC setting up and management 2.2 Technical supports 3.3 Vehicles and lodging Deration and maintenance costs Personnel costs of CEC staff Operation Chief Operator Fuel preparation workers Director and accountant Personnel costs ub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/every one year, 4-6%) Replacement of lamp of street lights, office stationery and consumables	Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 CIF (\$) 240,400 80,133 160,267	Q'ty 12.00 18.00 18.00 Nos. of person 1 2 1 2	MM MM month 12.00 12.00 12.00 12.00 12.00 12.00 8 atio of <u>O&amp;M Costs</u> 5.0%	33,000         6,000         9,000         18,000           Amount(\$)         960         960         360         960	Total (\$) <b>\$3,240</b> Total (\$)
Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 3.3 Vehicles and lodging Deration and maintenance costs Personnel costs of CEC staff Operation Chief Operation Operation Chief Operator Fuel preparation workers Director and accountant Personnel costs sub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator costs (CIF) 5% of engine-generator sets Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/very one year, 4-6%) Replacement of lamp of street lights, office stationery and consumables Maintenance costs of powerhouse (% of powerhouse)	Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 \$30 \$40 CIF (\$) CIF (\$) 240,400 80,133 160,267	Q'ty 12.00 18.00 18.00 Nos. of person 1 2 1 2	MM MM month 12.00 12.00 12.00 12.00 12.00 8 atio of 0&M Costs 5.0% 5.0% 2.0%	33,000         6,000         9,000         18,000           Amount(\$)         960         960         360         960         360         960         360         960         360         960         360         960         360         960         310         1,080         310	Total (\$) <b>\$3,240</b> Total (\$)
Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 3.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operator Fuel preparation workers Director and accountant Personnel costs sub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/every one year, 4-6%) Replacement of lamp of street lights, office stationery and consumables Maintenance costs of powerhouse (% of powerhouse) Maintenance costs sub-total	Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$40 \$40 \$40 \$13 \$40,267 15,600	Q'ty 12.00 18.00 18.00 Nos. of person 1 2 1 2	MM MM month 12.00 12.00 12.00 12.00 12.00 5.0% 5.0% 5.0% 2.0%	33,000           6,000           9,000           18,000           Amount(\$)           960           960           960           360           960           360           960           360           960           310	Total (\$) \$3,240 Total (\$) 13,410
Costs for CEC supports Costs for CEC supports and training Costs for CEC supports and training 1.1 Facilitation for CEC setting up and management 2.2 Technical supports 3.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operator Fuel preparation workers Director and accountant Personnel costs sub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr operatio/every one year, 4-6%) Replacement of lamp of street lights, office stationery and consumables Maintenance costs of powerhouse (% of powerhouse) Maintenance costs sub-total Devention and provide the cost of th	Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 \$40 \$30 \$40 \$10 \$240,400 80,133 160,267 15,600	Q'ty 12.00 18.00 18.00 Nos. of person 1 2 1 2	MM MM month 12.00 12.00 12.00 12.00 12.00 12.00 5.0% 5.0% 5.0% 5.0%	33,000         6,000         9,000         18,000           Amount(\$)         960         960         960         960         960         960         960         960         960         960         960         960         960         960         960         960         360         960         360         960         360         960         360         960         360         960         360         960         360         310	Total (\$) \$3,240 Total (\$) 13,410
Costs for CEC supports         Costs for CEC supports and training         1.1 Facilitation for CEC setting up and management         2.2 Technical supports         .3 Vehicles and lodging         Operation and maintenance costs         'ersonnel costs of CEC staff         Operation Chief         Operator         Fuel preparation workers         Director and accountant         'ersonnel costs of gasifier and engine-generator         Gasifier and engine-generator costs (CIF)         5% of engine-generator set         Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/every one year, 4-6%)         Replacement of lamp of street lights, office stationery and consumables         Maintenance costs sub-total         Waintenance costs sub-total	Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 CIF (\$) 240,400 80,133 160,267 15,600	Qty 12.00 18.00 18.00 Nos. of person 1 2 1 2	MM MM month 12.00 12.00 12.00 12.00 12.00 12.00 5.0% 5.0% 5.0%	33,000         6,000         9,000         18,000           Amount(\$)         960         960         360         960         360         960         360         960         360         960         360         960         360         960         310	Total (\$) \$3,240 Total (\$) 13,410 16,650
Costs for CEC supports Costs for CEC supports and training 1.1 Facilitation for CEC setting up and management 2.2 Technical supports 3.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operation Chief Operation and accountant Personnel costs sub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/every one year, 4-6%) Replacement of lamp of street lights, office stationery and consumables Maintenance costs sub-total Operation and maintenance costs sub-total Deperation and maintenance costs sub-total	Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 CIF (\$) 240,400 80,133 160,267 15,600	Qty 12.00 18.00 18.00 Nos. of person 1 2 1 2	MM MM month 12.00 12.00 12.00 12.00 12.00 12.00 5.0% 5.0% 5.0%	33,000         6,000         9,000         18,000           Amount(\$)         960         960         360         960         360         960         360         960         360         960         360         960         360         960         360         960         360         960         360         960         360         960         360         960         360         960         310         1,080         310	Total (\$) \$3,240 Total (\$) 13,410 16,650 2,560
Costs for CEC supports         Costs for CEC supports and training         1.1 Facilitation for CEC setting up and management         2.2 Technical supports         2.3 Vehicles and lodging         Operation and maintenance costs         Personnel costs of CEC staff         Operation Chief         Operation Chief         Operator         Fuel preparation workers         Director and accountant         Personnel costs of gasifier and engine-generator         Gasifier and engine-generator costs (CIF)         5% of engine-generator set         Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/very one year, 4-6%)         Replacement of lamp of street lights, office stationery and commandels         Maintenance costs sub-total         Operation and maintenance costs sub-total         Parention and maintenance costs sub-total	Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 CIF (\$) 240,400 80,133 160,267 15,600	Qty 12.00 18.00 18.00 Nos. of person 1 2 1 2	MM MM month 12.00 12.00 12.00 12.00 12.00 12.00 5.0% 5.0% 5.0%	33,000         6,000         9,000         18,000           Amount(\$)         960         960         360         960         360         960         360         960         360         960         360         960         360         960         360         960         360         960         360         960         360         960         360         960         310	Total (\$) \$3,240 Total (\$) 13,410 16,650 2,560
Costs for CEC supports         Costs for CEC supports and training         1.1 Facilitation for CEC setting up and management         2.2 Technical supports         :3 Vehicles and lodging         Deration and maintenance costs         'sronnel costs of CEC staff         Operation Chief         Operator         Fuel preparation workers         Director and accountant         'ersonnel costs of gasifier and engine-generator         Gasifier and engine-generator costs (CIF)         5% of engine-generator set         Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/every one year, 4-6%)         Replacement of lamp of street lights, office stationery and consumables         Maintenance costs sub-total         Operation and maintenance costs sub-total         Paration and maintenance costs sub-total         Payment for technical supports (\$/yr for 15 years from 1st year)         Items	Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 CIF (\$) 240,400 80,133 160,267 15,600 Unit fuel cost (\$4,23,25)	Q'ty 12.00 18.00 18.00 Nos. of person 1 2 1 2 Energy	MM MM month 12.00 12.00 12.00 12.00 12.00 2.00% 5.0% 5.0% 2.0%	33,000         6,000         9,000         18,000           Amount(\$)         960         960         360         960         360         960         360         960         360         960         360         960         360         960         360         960         360         960         360         960         360         960         360         960         310	Total (\$) \$3,240 Total (\$) 13,410 16,650 2,560 Fuel costs (\$)
Costs for CEC supports Costs for CEC supports and training 1.1 Facilitation for CEC setting up and management 2.2 Technical supports 3.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operation Chief Operation and accountant Personnel costs sub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/every one year, 4-6%) Replacement of lamp of street lights, office stationery and consumables Maintenance costs sub-total Operation and maintenance costs sub-total Nament for technical supports (\$/yr for 15 years from 1st year) Items Vinual fuel costs	Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 CIF (\$) 240,400 80,133 160,267 15,600 Unit fuel cost (\$/kWh) 0,03	Q'ty 12.00 18.00 18.00 Nos. of person 1 2 1 2 Energy generation 298	Unit MM MM month 12.00 12.00 12.00 12.00 12.00 12.00 5.0% 5.0% 2.0% 2.0%	33,000 6,000 9,000 18,000 Amount(\$) 960 960 360 960 Amount (\$) 4,010 8,010 1,080 310	Total (\$) \$3,240 Total (\$) 13,410 16,650 2,560 Fuel costs (\$) 8.943
Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 3.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operation Operation Chief Operation Operation Chief Operation Chief Operation Operation Costs sub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator costs (CIF) 5% of engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/very one year, 4-6%) Replacement of lamp of street lights, office stationery and consumables Maintenance costs sub-total Operation and maintenance costs sub-total Parention and maintenance costs sub-total Parention and maintenance costs sub-total Parention and maintenance (% of powerhouse) Maintenance costs sub-total Parention and maintenance costs sub-total Parention and maintenance (% of powerhouse) Items	Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 CIF (\$) 240,400 80,133 160,267 15,600 Unit fuel cost (\$/kWh) 0,03	Q'ty 12.00 18.00 18.00 Nos. of person 1 2 1 2 1 2 Energy generation 298	MM MM month 12.00 12.00 12.00 12.00 12.00 5.0% 5.0% 2.0% 2.0%	33,000 6,000 9,000 18,000 Amount(\$) 960 960 360 960 360 960 300 1,080 310	Total (\$) \$3,240 Total (\$) 13,410 16,650 2,560 Fuel costs (\$) 8,943
JICA M/P Study on Rural Electrification by Renewable Energy in the Kingdom of Cambodia					
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Community Electrication Project,	Samlout, Phase 1,	soft loan @ 3% - 15	yr including 3-yr grace

**Table A5 Economic Costs** 

#### **Table A6 Economic Benefits**

Local Financial Economic

Foreign

	Foreign	Local	Financial	Economi	
Items	Currency	Currency	Costs	c Costs	Remarks
	\$	\$	\$	\$	
1. Hard costs	279,507	246,527	526,034	449,671	SCF
1.1 Generating equip. excl. tax	168,480	10,920	179,400	178,308	0.90
1.2 Customs & VAT	0	42,120	42,120	0	LCF
1.3 Road and powerhouse		20,400	20,400	10,200	0.50 <u>1</u> /
1.4 Growing fuel trees	182	14,106	14,288	7,235	
1.5 Swichyard equip.		61,000	61,000	54,900	
1.6 Powerhouse miscellaneous		12,000	12,000	10,800	
1.7 Distribution lines	84,916	41,824	126,740	122,558	
1.8 Service wires, etc.	25,929	12,771	38,700	37,423	
1.9 Distri. Lines miscellaneous		6,337	6,337	5,703	
1.10 Contingency (5%)		25,049	25,049	22,544	
2. CEC facilitation costs	0	33,000	33,000	29,700	
<b>Project Costs Total</b>	279,507	279,527	559,034	479,371	
O&M	12,020	14,273	26,293	17,806	
1. Personnel costs	0	3,240	3,240	2,754	
2. Biomass gasifier generator	12,020	1,390	13,410	13,271	
3. Fuel		8,943	8,943	1,431	0.16 <u>2</u> /
4. Distribution lines	0	700	700	350	

Note: 1/ Economic conversion factor for seasonal jobless labors

Items	Currency	Currency	Costs	Costs	Remarks
	\$	\$	\$	\$	
1. Hard costs	141,070	209,676	350,746	307,069	
1.1 Diesel generator excl. tax	81,480	10,920	92,400	91,308	770 \$/kW
1.2 Customs & VAT		23,100	23,100		
1.3 Road & land preparation		4,800	4,800	2,400	
1.4 Powerhouse & fuel tank (10%)		9,240	9,240	8,316	
1.5 Swichyard equip.		61,000	61,000	54,900	
1.6 Powerhouse miscellaneous (5%)		9,527	9,527	8,574	
1.7 Distribution lines	59,590	29,350	88,940	86,005	
1.8 Service wires, etc.		38,700	38,700	34,830	
1.9 Distri. Lines miscellaneous		6,337	6,337	5,703	
1.10 Contingency (5%)		16,702	16,702	15,032	
2. CEC facilitation costs	0	33,000	33,000	29,700	
Project Costs Total	141,070	242,676	383,746	336,769	
O&M	5,387	72,765	78,152	70,596	
1. Personnel costs	0	2,880	2,880	2,592	
2. Diesel generator	5,387	623	6,010	5,948	5%
3. Fuel	0	68,562	68,562	61,706	0.23 \$/kWh
4. Distribution lines	0	700	700	350	

#### 1. Road powerhouse upong 24 0.20 4,800 km 2. Embankment of station yard $m^2$ 2,000 0 3. Land acquisition 2,000 $m^2$ 0

0

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## С 1. Capital Costs

JICA M/P Study on Rural Electrification by Renewable Energy in the Kingdom of Cambodia

ommunity El	lectrication	Project, S	amlout, F	Phase 1, s	soft loan	@ 3% -	15 yr	including 3	-yr grace
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 Table A7
 Unit Costs of Electricity

Table A8 Tariff Setting

Items	with tax (\$)	with tax exemption and subsidy (\$)	Items	\$	Riel
1. Capital Costs	620,034	433,436	Unit cost of electricity from 7th year (\$/kWh)	0.255	1,020
2. CEC facilitation costs	33,000	33,000	Rate of reserve for operational risks (12%)	0.031	122
3. Total construction costs excluding design, test	ing, etc.	466,436	Average tariff (\$/kWh)	\$0.286	1,144
Interest rate	3.0%		Tariff adopted for nighttime demand	\$0.335	1,340
Repayment period	10 yr		Tariff adopted for street lights	\$0.335	1,340
CRF (3.0%, 10 yr) =	0.1172		Tariff adopted for industrial demand	\$0.275	1,100
4. Annual costs excluding design, etc.	72,687	54,680	Tariff adopted for irrigation demand	\$0.275	1,100
5. O&M costs in 10th year	28,261	28,261	Monthly revenue (US\$/mon)	\$6,935	
5.1 O&M	16,650	16,650	from nighttime users	\$3,889	
5.2 Fuel costs	8,943	8,943	for street lights	\$156	
5.3 EAC license fee	108	108	from industrial users	\$1,596	
5.4 Yearly monitoring fee by DIME	2,560	2,560	from irrigation pump users	\$1,293	
6. Annual total costs	100,948	82,942	Average monthly tariff @ 15 kWh per HH (\$)	\$5.03	20,100
7. Annual energy sales from 7th year (MWh)	271.0	271.0	Tariff for street lights	\$0.20	800
8. Unit cost of electricity from 7th year (\$/kWh)	0.373	0.306	Total @ 15 kWh/hh including street lights	\$5.23	20,900
9. NPV of energy sold	MWh	4,840	Average monthly tariff @ 10 kWh per HH (\$) including street lights	\$3.55	14,200
10. NPV of finacial costs excluding tax	\$	1,234,281	(a) 40  W x  4h  x  30  days = 4.8  kWh/month + street lights	\$1.81	7,200
11. Average cost of electricity	\$/kWh	0.255	Tariff of poorest household (US\$/mon/hh) ( $a$ ) 7 W x 4h x 30 days = 0.84 kWh/mon + street	\$0.48	1,900
				Monthly	Costs
			ATP for monthly tariff	\$	Riel
			Diesel oil lamp (100%)	\$1.46	5,844
			Battery lighting (70%, incl. Riel 4,000 per month for battery purchase)	\$3.12	12,470
			Total	\$4.58	18,314

#### Community Electrication Project, Samlout, Phase 1, soft Ioan @ 3% - 15 yr incluc Table 1 Adopted Conditions for Economic and Finacial Analyses

1. Energy sola See attached Tuble 112
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2. Tariff See attached Table A7

- 3. Long-term borrowing from GOC
  - 3% per year
  - 25 years repayment period including 5 years' grace
- 4. Short-term borrowing from commercial bank
  - 10% per year
  - revolving every year
- 5. Depreciation

Ratio of depreciation	90%
Ratio of residual value	10%

Generating equipment

- 5 years' grace and 5 years' depreciation for the first 10 years
- 10 years' depreciation from 11th year onward

Distribution lines, service wires, etc.

- 5 years' grace and 20 years' depreciation
- 6. Interest earning
  - Interest of saving deposit at 10% per year

		Comm	unity E	lectricat	ion Pro	ject, Sai Tabl	mlout, I	Phase 1,	soft loa	n @ 3%	6 - 15 yr	r includir	ng 3-yr g	grace							Final
	0	1	2	3	4	5	6	7	u Ana. 8	y 515 Q	10	11	12	19	20	21	22	29	30	(unit: \$) Total	l Rep
(Expenditure)		1	2	5		5	0	/	0	,	10	11	12	17	20	21	22	27	50	Total	ort
Initital costs																					
Construction costs excluding tax	483,914											179,400				179,400				842,714	
Supports to CEC	24,750	8,250																			
Operation and maintenance costs		12,736	19,887	22,398	23,942	25,640	27,507	28,711	28,961	28,961	28,961	28,961	28,961	28,961	28,961	28,961	28,961	28,961	28,961	826,934	
Personnel costs		3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	97,200	
O&M of biomass gasification power plant		3,723	7,992	9,492	10,413	11,427	12,542	13,261	13,410	13,410	13,410	13,410	13,410	13,410	13,410	13,410	13,410	13,410	13,410	377,280	
Maintenance of distribution lines, etc.		700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	21,000	
Biomass fuel cost		2,483	5,330	6,330	6,944	7,620	8,364	8,843	8,943	8,943	8,943	8,943	8,943	8,943	8,943	8,943	8,943	8,943	8,943	251,604	
EAC license fee @ Riel 1.6/kWh		30	65	77	84	92	101	107	108	108	108	108	108	108	108	108	108	108	108	3,050	
Payment for technical supports		2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	76,800	
Total expenditure	508,664	20,986	19,887	22,398	23,942	25,640	27,507	28,711	28,961	28,961	28,961	208,361	28,961	28,961	28,961	208,361	28,961	28,961	28,961	1,702,648	
(Revenue)																					Ap
Operating revenue through electricity sales	5	25,205	50,323	59,213	64,948	71,256	78,194	82,388	83,218	83,218	83,218	83,218	83,218	83,218	83,218	83,218	83,218	83,218	83,218	2,345,549	pe
Sales of CER		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	'nd
Residual value of equipment											17,940				17,940				52,603		іх-Н
Total revenue		25,890	51,792	60,959	66,863	73,357	80,501	84,827	85,684	85,684	103,624	85,684	85,684	85,684	103,624	85,684	85,684	85,684	138,288	2,503,413	Evalu
(Net operating income)	-508,664	4,904	31,906	38,561	42,921	47,717	52,993	56,116	56,723	56,723	74,663	-122,677	56,723	56,723	74,663	-122,677	56,723	56,723	109,326	800,766	lation S
FIRR	6.7%																				heet fo
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JICA			Com	munity I	Electrica	ation Pro	oject, Sa <b>Tab</b>	amlout, le 2 F	Phase 1 <b>inanci</b>	, soft lo <b>al An</b> a	an @ 39 Ilysis	% - 15 yr	includir	ng 3-yr g	grace							Final
M/P	Including taxes, excluding CER sales	0	1	2	3	4	5	6	7	8	9	10	11	12	19	20	21	22	29	30	(unit: \$) Total	Repo
Stuc	(Expenditure)																					цц.
ły o	Initital costs																					
n R	Construction costs	526,034											179,400				179,400				884,834	
ura	Supports to CEC	24,750	8,250																			
ΕI																						
ectri	Operation and maintenance costs		12,736	19,887	22,398	23,942	25,640	27,507	28,711	28,961	28,961	28,961	28,961	28,961	28,961	28,961	28,961	28,961	28,961	28,961	826,934	
ifica	Personnel costs		3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	97,200	
atio	O&M of biomass gasification power plant		3,723	7,992	9,492	10,413	11,427	12,542	13,261	13,410	13,410	13,410	13,410	13,410	13,410	13,410	13,410	13,410	13,410	13,410	377,280	
n þy	Maintenance of distribution lines, etc.		700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	21,000	
1	Biomass fuel cost		2,483	5,330	6,330	6,944	7,620	8,364	8,843	8,943	8,943	8,943	8,943	8,943	8,943	8,943	8,943	8,943	8,943	8,943	251,604	
	EAC license fee @ Riel 1.6/kWh		30	65	77	84	92	101	107	108	108	108	108	108	108	108	108	108	108	108	3,050	
	Payment for technical supports		2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	76,800	
Α	Total expenditure	550,784	20,986	19,887	22,398	23,942	25,640	27,507	28,711	28,961	28,961	28,961	208,361	28,961	28,961	28,961	208,361	28,961	28,961	28,961	1,744,768	
C-H																						
24	(Revenue)																					Ap
	Operating revenue through electricity sales		25,205	50,323	59,213	64,948	71,256	78,194	82,388	83,218	83,218	83,218	83,218	83,218	83,218	83,218	83,218	83,218	83,218	83,218	2,345,549	pe
	Sales of CER																				0	nd
	Residual value of equipment											17,940				17,940				52,603		×
	1 1																					I
	Total revenue		25,205	50,323	59,213	64,948	71,256	78,194	82,388	83,218	83,218	101,158	83,218	83,218	83,218	101,158	83,218	83,218	83,218	135,822	2,434,032	Eva
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	(Net operating income)	-550,784	4,219	30,436	36,815	41,006	45,616	50,687	53,677	54,257	54,257	72,197	-125,143	54,257	54,257	72,197	-125,143	54,257	54,257	106,860	689,265	ion
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Community Electrication Project, Samlout, Phase 1, soft loan @ 3% - 15 yr including 3-yr grace																				
Table 2 Financial Analysis																				
Excluding taxes and subsidy from costs,	and inclu	ding CE	R sales					_					(a. 1	10	•			1		(unit: \$)
(Expanditure)	0	I	2	3	4	5	6	1	8	9	10	11	12	19	20	21	22	29	30	Iotal
Initital costs																				(00 <b>83</b> (
Construction costs	339,436											179,400				179,400				698,236
Supports to CEC	24,750	8,250																		
Operation and maintenance costs		12,736	19,887	22,398	23,942	25,640	27,507	28,711	28,961	28,961	28,961	28,961	28,961	28,961	28,961	28,961	28,961	28,961	28,961	826,934
Personnel costs		3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	97,200
O&M of biomass gasification power plant		3,723	7,992	9,492	10,413	11,427	12,542	13,261	13,410	13,410	13,410	13,410	13,410	13,410	13,410	13,410	13,410	13,410	13,410	377,280
Maintenance of distribution lines, etc.		700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	21,000
Biomass fuel cost		2,483	5,330	6,330	6,944	7,620	8,364	8,843	8,943	8,943	8,943	8,943	8,943	8,943	8,943	8,943	8,943	8,943	8,943	251,604
EAC license fee @ Riel 1.6/kWh		30	65	77	84	92	101	107	108	108	108	108	108	108	108	108	108	108	108	3,050
Payment for technical supports		2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	76,800
Total expenditure	364,186	20,986	19,887	22,398	23,942	25,640	27,507	28,711	28,961	28,961	28,961	208,361	28,961	28,961	28,961	208,361	28,961	28,961	28,961	1,558,169
(Revenue)																				
Operating revenue through electricity sales		25,205	50,323	59,213	64,948	71,256	78,194	82,388	83,218	83,218	83,218	83,218	83,218	83,218	83,218	83,218	83,218	83,218	83,218	2,345,549
Sales of CER		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
Residual value of equipment											17,940				17,940				52,603	
Total revenue		25,890	51,792	60,959	66,863	73,357	80,501	84,827	85,684	85,684	103,624	85,684	85,684	85,684	103,624	85,684	85,684	85,684	138,288	2,503,413
(Net operating income)	-364,186	4,904	31,906	38,561	42,921	47,717	52,993	56,116	56,723	56,723	74,663	-122,677	56,723	56,723	74,663	-122,677	56,723	56,723	109,326	945,244
FIRR	9.9%																			

	Community Electrication Project, Samlout, Phase 1, soft Ioan @ 3% - 15 yr including 3-yr grace <b>Table 3 Economic Evaluation</b>												Final F								
	0	1	2	3	4	5	6	7	8	9	10	11	12	19	20	21	22	29	30	(unit: \$) Total	lepo
(Economic costs) Initital costs Economic costs Supports to CEC	449,671 22,275	7,425			·	U		,			10	178,308			20	178,308				806,287	rt
<b>Operation and maintenance costs</b> Personenel costs O&M of biomass gasification power plant Maintenance of distribution lines, etc. Biomass fuel cost	0	7,348 2,916 3,685 350 397	12,028 2,916 7,909 350 853	13,672 2,916 9,393 350 1,013	14,682 2,916 10,305 350 1,111	15,794 2,916 11,308 350 1,219	17,016 2,916 12,412 350 1,338	17,804 2,916 13,123 350 1,415	17,968 2,916 13,271 350 1,431	87,480 373,369 10,500 40,257											
EAC license fee @ Riel 1.6/kWh Monitoring of CEC by DIME		27 0	58 0	69 0	76 0	83 0	91 0	96 0	98 0	2,745 0											
Residual value											-17,831				-17,831				-44,967	-80,629	
Total expenditure	471,946	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	-26,902	1,269,709	
(Economic benefits as costs of alternative dies Initital costs	sel mini-gri	1)																			
Economic costs Supports to CEC	307,069 22,275	7,425										91,308				91,308				489,685	
<b>Operation and maintenance costs</b> Personenel costs O&M of diesel power plant Maintenance of distribution lines, etc. Fuel cost	0	21,725 2,592 1,651 350 17,132	43,262 2,592 3,545 350 36,776	50,828 2,592 4,210 350 43,676	55,477 2,592 4,619 350 47,916	60,591 2,592 5,068 350 52,581	66,217 2,592 5,563 350 57,712	69,842 2,592 5,881 350 61,019	70,596 2,592 5,948 350 61,706	77,760 167,334 10,500 1,736,053	Appendix										
EAC license fee Payment for technical supports		27 2,304	58 2,304	69 2,304	76 2,304	83 2,304	91 2,304	96 2,304	98 2,304	2,745 69,120	н Н										
Residual value											-9,131				-9,131				-30,707	-48,968	valua
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	tion
Total benefits	329,344	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	44,757	2,603,309	Shee
(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	t for
EIRR	27.4%																				Bior
																					nass Pilo
																					t Project

JICA M/P Study on Rural Electrification by Renewable Energy in the Kingdom of Cambodia

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#### Community Electrication Project, Samlout, Phase 1, soft loan @ 3% - 15 yr including 3-yr grace Table 4 Financing Plan

				(unit: \$)
Financial Resources			<b>Financial Application</b>	
Equity - CEC			Power Plant before tax	348,088
Cash (@ \$50/hh)	38,700	6.7%	Biomass gasification power equipment	240,400
In kind ( @ \$40/MM)	47,987	8.3%	Road improvement works	4,800
1200 MM			Powerhouse, etc.	15,600
Grant			Switching equip. & transformer	61,000
REF	144,479	25.0%	Growing fuel trees	14,288
(25% of capital costs)			Misecellaneous equipment	12,000
Borrowing for capitals			Distribution facilities, service wires, etc.	171,777
Long-term	346,748	60.0%		
(15 yr including 3-year grace, 3%/yr)			Contingecy	25,049
			Capital costs before tax	544,914
Total fund for capital costs and CEC supports	577,914	100.0%	CEC support	33,000
Borrowing for operation	5,000		Operation fund in hand	5,000
Short-term (Revolving, 15%/yr)				
Tax exemption	42,120		Customs and tax	42,120
Total Financial Resources	625,034		<b>Total Financial Resources</b>	625,034

Community Electrication Project, Samlout, Phase 1, soft loan @ 3% - 15 yr including 3-yr grace																						
Table 5 Profit and Loss Statement with Cash Flow, 15-yr repayment period																						
		0		2	2		,		-	0	0	10		12	12		1.5	20	21		20	(unit: \$)
One pating never us incl. CED & new	idual va	<u></u>	25 205	50 323	50 212	64 048	71 256	78 104	/ 87.288	8	9	10	82 218	82 218	82 218	14 82.218	15	20	21	22 83 218	30	2 245 540
Operating revenue mei. CEK & res	iuuai va	nue	25,205	50,525	39,213	04,940	/1,250	78,194	82,388	85,218	65,216	85,218	85,218	85,218	65,218	85,218	65,216	05,210	85,218	65,216	85,218	2,343,349
Operating costs			12,736	19,887	22,398	23,942	25,640	27,507	28,711	28,961	28,961	28,961	28,961	28,961	28,961	28,961	28,961	28,961	28,961	28,961	28,961	826,934
new land required for tree plantation	1				4.5	2.8	3.1	3.4	2.2	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.4
tree plantation costs for increasing d	lemand			2,681	1,648	1,812	1,994	1,285	267	0	0	0	0	) 0	0	0	0	0	0	0	9,686	19,372
Gross profit			12,469	27,755	35,163	39,191	43,619	49,399	53,408	54,256	54,257	54,257	54,257	54,257	54,257	54,257	54,257	54,257	54,257	54,257	44,571	1,499,227
Interests payment																						
Short-term commercial loan (15%/yr)			750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	22,500
Long-term soft loan	3.0%		10 402	10 402	10 402	9 536	8 669	7 802	6 935	6.068	5 201	4 3 3 4	3 467	2 601	1 734	867						88 421
Long-term soft loan	5.070		10,402	10,402	10,402	7,550	8,007	7,002	0,755	0,000	5,201	4,554	5,407	2,001	1,754	007						00,421
Deprecitation																						
Generating equipment (5 yr - 10 yr -	216 360							43 272	43 272	43 272	43 272	43 272	21.636	21.636	21.636	21.636	21.636	21.636	21.636	21.636	21.636	649 080
10 yr)								10,272	10,272	10,272	13,272	10,272	21,050	21,000	21,050	21,050	21,000	21,050	21,000	21,000	21,050	010,000
Others (20 yr from 6th year)	303,763							15,188	15,188	15,188	15,188	15,188	15,188	15,188	15,188	15,188	15,188	15,188	15,188	15,188		303,763
Operating profit before depreciation	n		1,317	16,603	24,011	28,905	34,201	40,847	45,723	47,438	48,306	49,173	50,039	50,906	51,773	52,640	53,507	53,507	53,507	53,507	43,821	1,388,306
Interests received (10%)			0	0	2,007	1,894	2,276	3,244	4,994	7,421	10,263	13,477	18,893	23,144	27,906	33,231	39,175	97,264	114,381	131,417	345,713	2,702,314
Residual value upon completion of	100/											17.040						17.040			52 (02	00 402
depreciation	10%											17,940						17,940			52,605	88,483
CER received			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	2,466	69,381
Net profit after depreciation			2,001	18,072	27,764	32,715	38,578	-12,063	-5,304	-1,135	2,575	24,596	34,575	39,692	45,321	51,513	58,324	134,352	133,530	150,565	422,968	3,295,642
Cash in hand			2,001	18,072	27,764	32,715	38,578	46,398	53,156	57,325	61,035	83,056	71,399	76,516	82,145	88,337	95,148	171,177	170,354	187,390	444,604	4,248,484
Accumulated cash in hand after		0	2,001	20,074	18,942	22,760	32,443	49,945	74,205	102,634	134,774	188,934	231,437	279,058	332,307	391,748	486,896	1,143,812	1,314,166	1,501,556	3,901,736	
principal repayment																						
Principal repayment	346,748	0	0	0	28,896	28,896	28,896	28,896	28,896	28,896	28,896	28,896	28,896	28,896	28,896	28,896						346,748
Long-term debt balance	346,748	346,748	346,748	346,748	317,853	288,957	260,061	231,166	202,270	173,374	144,479	115,583	86,687	57,791	28,896	-0		l				

Community Electrication Project, Pramaoy, Phase 1, soft loan @ 3% - 15 yr including 3-yr grace

#### Table A1 Principal Features of Electrification Plan

#### (1) Generating Equipment Planning

Items	Unit	Q'ty	Remarks	
Nos. of households	h.h.	146	80% of the total 182 households	
Unit nighttime domestic demand	W/hh	100		
Nighttime domestic demand	kW	14.6		
Street light demand	kW	1.5	1 light per 40 m of LV lir	75 street lights
Reserve capacity	kW	4.4	30% of nighttime domestic deman	d, allocated for station use + reserved power + distribution losses
Required capacity	kW	20.5		
Adopted capacity	kW	20.0		

#### (2) Energy Generation Planning for 8th Year Onward

Items	Monthly Unit Energy Sold	Monthly Energy Sold	Annual Energy Sold	Station Use, Losses, etc. (10%)	Annual Energy Generated	Annual Plant Factor	Annual Operation Hours	Remarks (refer to Table A2 for demand growth rates)
	kWh/hh	MWh	MWh	MWh	MWh	%	hr	- ( )
Nighttime domestic demand $\underline{1}$ /, $\underline{2}$ /	15.0	2.2	26.3	2.6	28.9	16.5%	1,445	100% from 8th year onward
Street light demand	1.5	0.2	2.7	0.3	3.0	1.7%	149	100% from the 1st year
Industrial demand <u>3/</u>	5.0	0.7	8.8	0.9	9.6	5.5%	482	100% from 8th year onward
Irrigation pump demand 4/	0.7	0.3	1.3	0.1	1.4	0.8%	70	in 4 dry months, 100% from 8th year onward
Total energy	22.3	3.5	39.0	3.9	42.9	24.5%	2,146	100% from 8th year onward

#### Note:

1/ Typical consumption level of existing mini-grids in rural villages as of 2005 was 10 kWh (= 100W / 1,000 \* 5hrs \* 30 days \* 67%) and assumed to be realized from 2nd year.

2/ Average consumption of existing REE mini-grids supplying to rural towns as of 2005 was 15 kWh (= 100 W / 1,000 \* 7.5hrs \* 30days \* 67%) and was assumed to be realized in 7th year.

 $\underline{3}$ / Power demand of BCS, rice-mills, water supply stations, ice factory, workshop of boat engines, etc. Assumed to be 50% of the nighttime demand based on the actual demand of existing Anlong Ta Mey mini-grid (700 kWh at nighttime, 300 kWh for BCS at daytime) and potential daytime users in the villages shown in Table A3.

 $\underline{4}$  see Table A3 for irrigation power demand.

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	Community Electrication Project, Pramaoy, Phase 1, soft loan @ 3% - 15 yr including 3-yr grace																			
	Table 112 Energy and CERCOUR																			
	1 2 3 4 5 6 7 8 9 10 11 12 19 20 21 22 29 30 Total																			
(Annual energy sold)																				
Demand growth	Growth rate																			
Domestic	1.10	50%	67%	73%	81%	89%	98%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Street lights	0.00	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Industrial	1.10	0%	50%	67%	73%	81%	89%	98%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Irrigation	1.10	0%	50%	67%	73%	81%	89%	98%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Energy sold (MWh/yr)	Demand																			
Domestic	26.3	13.1	17.5	19.3	21.2	23.3	25.7	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	751
Street lights	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	81
Industrial	8.8	0.0	4.4	5.8	6.4	7.1	7.8	8.6	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	242
Irrigation	1.3	0.0	0.6	0.9	0.9	1.0	1.1	1.2	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	35
Total	39.0	15.8	25.2	28.7	31.3	34.1	37.3	38.8	39.0	39.0	39.0	39.0	39.0	39.0	39.0	39.0	39.0	39.0	39.0	1,109
Unit energy sold (kWh	per household per mor	nth)																		,
Domestic	15.0	7.5	10.0	11.0	12.1	13.3	14.6	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	
Street lights	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	
Industrial	5.0	0.0	2.5	3.3	3.7	4.0	4.4	4.9	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	
Irrigation	0.7	0.0	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	
Total	22.3	9.0	14.4	16.4	17.8	19.5	21.3	22.1	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	
(O						- / 10														
(Operating revenue from	relectricity sales, 5)																			
Domostia	1 aritt \$0,40	5 256	7 008	7 700	0 100	0 2 2 8	10 260	10 512	10 5 1 2	10 512	10 512	10 512	10 5 1 2	10 512	10 512	10 512	10 512	10 512	10 512	200 220
Street lighte	\$0.40 \$0.40	1,020	1,000	1,709	0,400	9,520	1 0 2 0 0	1 0 9 0	1 0 2 0	1 0 9 0	1 080	1 0 9 0	1 0 9 0	1 080	1 0 2 0	1 0 9 0	1 0 9 0	1 0 2 0	1 0 9 0	300,329
Succe lights	\$0.40 \$0.24	1,080	1,000	1,000	2,194	2,402	1,080	2,007	2,070	1,080	2,079	1,000	2,079	1,080	1,080	1,080	1,080	1,080	2,079	52,400 82,115
Industrial	\$0.54	0	1,409	1,980	2,104	2,405	2,045	2,907	2,970	2,970	2,970	2,970	2,970	2,978	2,970	2,970	2,970	2,970	2,978	02,115
Total	\$0.54	6 2 2 6	0 704	11.064	12 062	12 161	14 360	14 023	15 005	15 005	15 005	15 005	15 005	15 005	15 005	15 005	15 005	15 005	15 005	11,975
Total		0,550	9,794	11,004	12,002	15,101	14,509	14,923	15,005	15,005	15,005	15,005	15,005	15,005	15,005	15,005	15,005	15,005	15,005	420,818
(Monthly tariff, \$ per ho	usehold)																			
Domestic		3.00	4.00	4.40	4.84	5.32	5.86	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	
Street lights		0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	
Industrial		0.00	0.85	1.13	1.25	1.37	1.51	1.66	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	
Irrigation		0.00	0.12	0.17	0.18	0.20	0.22	0.24	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	
Total		3.62	5.59	6.32	6.88	7.51	8.20	8.52	8.56	8.56	8.56	8.56	8.56	8.56	8.56	8.56	8.56	8.56	8.56	
(Tariff receivable, \$/vr)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
· · · · · · · · · · · · · · · · · · ·	kg-CO <sub>2</sub> /kWh			-	-		-	-	-	-			-	Ť	-		-		· ·	-
(CER saleable)	$(to-CO_2)$ 1.3	21	33	37	41	44	48	50	51	51	51	51	51	51	51	51	51	51	51	1,441
· · · ·	(\$/yr) <u>1</u> / <b>\$7</b>	144	230	261	284	310	339	353	355	355	355	355	355	355	355	355	355	355	355	10,088
<b>P</b> 1/																				
Fuel tree consumed (ton	per month)	2.0	3.2	3.6	3.9	4.3	4.7	4.8	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	139
Land required to supply	tuel trees (ha)	2.4	3.8	4.3	4.7	5.1	5.6	5.8	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	
Nos. of fuel tree farmers	(0.2 ha per farmer)	12	19	21	23	26	28	29	29	29	29	29	29	29	29	29	29	29	29	
Payment to fuel tree farmers (\$/farmer/month 3.3 3.3 3.4 3.4 3.4 3.3 3.3 3.3 3.4 3.4																				
I otal payment to fuel tre	e tarmers (\$/yr)	475	757	860	938	1,023	1,118	1,163	1,171	1,171	1,171	1,171	1,171	1,171	1,171	1,171	1,171	1,171	1,171	33,257
Ratio of tariff collected	and billed= 100%		Note: <u>1</u> /	Assume	ed at %4/	ton-CO <sub>2</sub> /	yr deduct	ing costs	required	for prepi	ation of I	PDD, app	ication a	nd monite	oring.	CER: Cer	tified En	nission Re	duction	

Note: 1/ Assumed at %4/ton-CO2/yr deducting costs required for prepration of PDD, application and monitoring. CER: Certified Emission Reduction

Final Report

Appendix-H Evaluation Sheet for Biomass Pilot Projects

No Domond		Diesel	Electricity	Operation	Unit Power	Nos. of		Total Dema	nd
NO.	Demand	liter/month	kWh/month	hr/month	kW	Customers	kW	kWh/month	Load Factor
1	BCS	200	600	50	12.00	5	60.00	3,000	6.9%
2	Water supply	60	180	15	12.00	10	120.00	1,800	2.1%
3	Rice-mill	30	90	30	3.00	30	90.00	2,700	4.2%
4	Ice factory	30	90	30	3.00	1	3.00	90	4.2%
5	Workshop	25	75	60	1.25	1	1.25	75	8.3%
6	Café	115	345	296	1.17	1	1.17	345	41.1%
Ν	Aonthly total	460	1,380	481	-	48	20.00	8,010	55.6%
	Annual total	5520	16,560	5,772	-	-	20.00	96,120	55.6%

#### Community Electrication Project, Pramaoy, Phase 1, soft loan @ 3% - 15 yr including 3-yr grace Table A3 Potential Daytime Users and Demand

Source: The potential daytime users above are candidates in Kampong Kor for reference purpose.

#### Potential irrigation demand in the dry season

Unit land to irrigate	0.1	ha/hh
Ratio of irrigation hh	30.0%	
Total land area to irrigate	4.38	ha
Depth of irrigation	500	mm
Total irrigation water	0.022	mcm/yr
Irrigation period	4	month
Daily operation hour	8	hr/day
Total pump discharge	0.006	m <sup>3</sup> /s
Pumping head	15.0	m
Combined efficiency	0.70	
Total power required	1	kW
Total energy required	1	MWh

#### Community Electrication Project, Pramaoy, Phase 1, soft Ioan @ 3% - 15 yr including 3-yr grace Table A4 Cost Estimate

(1)	Construction Costs	Unit Price (\$)	Q'ty	Unit	Amount(\$)	Total (\$)	%
	Power Station	1 200	20	1.337	26.000		
	Ocean freight & insurance (FOBx8%)	1,300	20	k W	20,000		
	Inland transportation & installation (FOB x (2%+5%))	91	20	kW	1 820		
	Switching equipment, main transformer		25	kVA	0		
						29,900	38.3%
	Civil and substation works						
	to be further improved to all weather road in Phase 2	24	0.05	km	1,200		
	Land, powerhouse, water tank, etc. (10%FOB)	130	20	kW	2,600		
						3,800	
	Fuel tree preparation for 2nd year demand	0	4	ha	20		
	Scatthed seeds of Leucaena of 0.4-0.5 kg/na and \$15/kg	0	4	m <sup>2</sup>	28		
	Watering of nursery for the first 3 months	100	40	month	300		
	Bush clearing	40	4	ha	151		
	Land preparation	80	4	ha	303		
	Transplanting	80	4	ha	303		
	Maintenance for initital 6 months @ \$60/ha/mon	360	4	ha	1,363		
	Sub total of non-one station and fuel monomotion					2,488	46 20/
	Miscellaneous of power station (5%, consumables, gas detector.					50,100	40.376
	fire distinguisher, water content meter, computer set, etc.)				1,500		
	Power station sub-total (before tax)					37,688	48.3%
	Customs & VAT (CIF x 25%)	351	20	kW	7,020	44 500	57.20/
	Power station sub-total (including tax)					44,708	57.3%
	Distribution Facilities						
	MV lines	6,000		km	0		
	MV-LV lines	10,700		km	0		
	LV lines	7,100	3.0	km	21,300		
	Pole-mounted distribution transformers						
	15 kVA-1P	6,200		set	0		
	25 KVA-3P 50 EVA-3P	7,300		set	0		
	Distribution line - transformer sub-total (including tax)	0,100		301	0	21.300	27.3%
	Miscellaneous (5%, street lights, etc.)				1,065	,	
	Distribution line - transformer sub-total (including tax)					22,365	28.6%
	Service wire, etc.				7,300		9.3%
	Domestic cutomers	50	146	hh	7,300		
	Daytime customers (to be fixed individually)	0		customers	0	)	
	(including tax)					29,665	38.0%
	(						
	Sub-total					74,373	
	Contingecy (5%)					3,719	
	Construction costs total					78.092	100.0%
							100.070
(2)	Costs for CEC supports	Unit Price (\$)	Q'ty	Unit	Amount(\$)	_	
	Costs for CEC supports and training				8,000		
	2.1 Facilitation for CEC setting up and management	500	4.00	MM	2,000		
	2.2 Technical supports 2.3 Vehicles and lodging	1 000	4.00	month	2,000		
	2.5 Veneres and longing	1,000	4.00	monui	4,000		
(3)	Operation and maintenance costs						
	Personnel costs of CEC staff	Salary (\$/mon)	Nos. of	MM	Amount(\$)	Total (\$)	
	Operation Chief	\$60	person 1	12.00	720	(1)	
	Operator	\$40	1	12.00	480		
	Fuel preparation workers	\$30	1	12.00	360		
	Director and accountant	\$40	2	12.00	960		
	Personnel costs sub-total			Define		\$2,520	
	Maintenance costs of gasifier and engine-generator	CIF (\$)		O&M Costs	Amount (\$)	Total (\$)	
	Gasifier and engine-generator costs (CIF)	29,900		oun cosis			
	5% of engine-generator set	9,967		5.0%	500		
	Heat resistant cone of gasifier (replacement at ever 3,000 hr	19,933		5.0%	1,000		
	Replacement of lamp of street lights, office stationery and				0.40		
	consumables				840		
	Maintenance costs of powerhouse (% of powerhouse)	2,600		2.0%	50		
	Maintenance costs sub-total					2,390	
	Operation and maintenance costs sub-total					4,910	
	<b>•</b>					,	
	Payment for technical supports (\$/yr for 15 years from 1st year)					480	
		Unit fuel cost	Energy				
	Items	(\$/kWh)	generation	unit		Fuel costs (\$)	
	Annual fuel costs	0.03	43	MWh/yr		1,288	
	Operation, maintenance and fuel costs sub-total					6,198	
(4)	Maintenance costs of distribution facilities						
(*)	Maintenance costs (0.5% of construction costs)					100	

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Community Electrication Project, Pramaoy, Phase 1, soft loan @ 3% - 15 yr including 3-yr grace
Table A5         Economic Costs

#### **Table A6 Economic Benefits** Local

\$

27,541

1,820

3,850

1,200

1,540

1,100

7,029

7,300

1,065

2,638

8,000

35,541

12,750

2,160

9,871

618

100

0.05

2,000

2,000

0

Financial Economic

Costs

\$

48,693

15,218

600

0

990

20,597

6,570

2,374

7,200

55,893

12,476

1,944

1,598

8,884

1,200

0

0

50

5%

0.23 \$/kWh

959

1,386

Remarks

770 \$/kW

Costs

\$

55,392

15,400

3,850

1,200

1,540

1,100

21,300

7,300

1,065

2,638

8,000

63,392

13,791

2,160

1,660

9,871

km

m<sup>2</sup>

 $m^2$ 

100

0

1. Road powerhouse

3. Land acquisition

2. Embankment of station yard

27,851

13,580

14,271

0

27,851

1,042

1,042

0

0

0

24

0

0

Currency Currency

	Foreign	Local	Financial	Economi			Foreign
Items	Currency	Currency	Costs	c Costs	Remarks	Items	Currency
	\$	\$	\$	\$			\$
1. Hard costs	47,270	30,822	78,092	66,188	SCF	1. Hard costs	27,85
1.1 Generating equip. excl. tax	28,080	1,820	29,900	29,718	0.90	1.1 Diesel generator excl. tax	13,58
1.2 Customs & VAT	0	7,020	7,020	0	LCF	1.2 Customs & VAT	
1.3 Road and powerhouse		3,800	3,800	1,900	0.50 <u>1</u> /	1.3 Road & land preparation	
1.4 Growing fuel trees	28	2,460	2,488	1,258		1.4 Powerhouse & fuel tank (10%)	
1.5 Swichyard equip.		0	0	0		1.5 Swichyard equip.	
1.6 Powerhouse miscellaneous		1,500	1,500	1,350		1.6 Powerhouse miscellaneous (5%)	
1.7 Distribution lines	14,271	7,029	21,300	20,597		1.7 Distribution lines	14,27
1.8 Service wires, etc.	4,891	2,409	7,300	7,059		1.8 Service wires, etc.	
1.9 Distri. Lines miscellaneous		1,065	1,065	959		1.9 Distri. Lines miscellaneous	
1.10 Contingency (5%)		3,719	3,719	3,347		1.10 Contingency (5%)	
2. CEC facilitation costs	0	8,000	8,000	7,200		2. CEC facilitation costs	
Project Costs Total	47,270	38,822	86,092	73,388		Project Costs Total	27,85
O&M	1,500	4,798	6,298	4,663		O&M	1,04
1. Personnel costs	0	2,520	2,520	2,106		1. Personnel costs	
2. Biomass gasifier generator	1,500	890	2,390	2,301		2. Diesel generator	1,04
3. Fuel		1,288	1,288	206	0.16 <u>2</u> /	3. Fuel	
4. Distribution lines	0	100	100	50		4. Distribution lines	
Note: 1/ Economic conversion factor	or for seasonal	jobless labors				Adjsutment for Kampong Kor diesel por	wer station

Appendix-H	
Evaluation Sheet for	
or Biomass Pilo	
t Projects	

### Co 1. Capital Costs 2. CEC facilitat 3. Total constru

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JICA M/P Study on Rural Electrification by Renewable Energy in the Kingdom of Cambodia

ommunity Electrication Project	t, Pramaoy, Phase 1, soft loan	@ 3% - 15 yr including 3-yr grace
Table A7	<b>Unit Costs of Electricity</b>	r

Table A8 Tariff Setting

Items	with tax (\$)	with tax exemption and subsidy (\$)	Items	\$	Riel
1. Capital Costs	86,092	59,304	Unit cost of electricity from 7th year (\$/kWh)	0.336	1,342
2. CEC facilitation costs	8,000	8,000	Rate of reserve for operational risks (12%)	0.040	161
3. Total construction costs excluding design, test	ting, etc.	67,304	Average tariff (\$/kWh)	\$0.376	1,504
Interest rate	3.0%		Tariff adopted for nighttime demand	\$0.400	1,600
Repayment period	10 yr		Tariff adopted for street lights	\$0.400	1,600
CRF (3.0%, 10 yr) =	0.1172		Tariff adopted for industrial demand	\$0.340	1,360
4. Annual costs excluding design, etc.	10,093	7,890	Tariff adopted for irrigation demand	\$0.340	1,360
5. O&M costs in 10th year	6,694	6,694	Monthly revenue (US\$/mon)	\$1,250	
5.1 O&M	4,910	4,910	from nighttime users	\$876	
5.2 Fuel costs	1,288	1,288	for street lights	\$90	
5.3 EAC license fee	16	16	from industrial users	\$248	
5.4 Yearly monitoring fee by DIME	480	480	from irrigation pump users	\$36	
6. Annual total costs	16,786	14,584	Average monthly tariff @ 15 kWh per HH (\$)	\$6.00	24,000
7. Annual energy sales from 7th year (MWh)	39.0	39.0	Tariff for street lights	\$0.62	2,500
8. Unit cost of electricity from 7th year (\$/kWh)	0.430	0.374	Total @ 15 kWh/hh including street lights	\$6.62	26,500
9. NPV of energy sold	MWh	707	Average monthly tariff @ 10 kWh per HH (\$) including street lights	\$4.62	18,500
10. NPV of finacial costs excluding tax	\$	237,259	Tariff of poor household (\$/mon/hh) @ 40 W x 4h x 30 days = 4.8 kWh/month + street lights	\$2.54	10,100
11. Average cost of electricity	\$/kWh	0.336	Tariff of poorest household (US\$/mon/hh) (a) 7 W x 4h x 30 days = $0.84$ kWh/mon + street	\$0.95	3,800
				Monthly	Costs
			ATP for monthly tariff	\$	Riel
			Diesel oil lamp (100%)	\$1.46	5,844
			Battery lighting (70%, incl. Riel 4,000 per month for battery purchase)	\$3.12	12,470

Total

18,314

\$4.58

#### Community Electrication Project, Pramaoy, Phase 1, soft Ioan @ 3% - 15 yr including 3-yr gra Table 1 Adopted Conditions for Economic and Finacial Analyses

1. Energy solu see attached Fable A	1.	Energy sold	See attached Table A	42
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- 2. Tariff See attached Table A7
- 3. Long-term borrowing from GOC
  - 3% per year
  - 25 years repayment period including 5 years' grace
- 4. Short-term borrowing from commercial bank
  - 10% per year
  - revolving every year
- 5. Depreciation
  - Ratio of depreciation
    90%
    Ratio of residual value
    10%
  - Generating equipment
  - 5 years' grace and 5 years' depreciation for the first 10 years
  - 10 years' depreciation from 11th year onward

Distribution lines, service wires, etc.

- 5 years' grace and 20 years' depreciation
- 6. Interest earning
  - Interest of saving deposit at 10% per year

Model         Model <th< th=""><th>IICA</th><th></th><th></th><th>Comm</th><th>unity El</th><th>ectricat</th><th>ion Proj</th><th>ect, Pra <b>Tabl</b></th><th>maoy, F e 2 Fi</th><th>Phase 1, <b>nancia</b></th><th>soft loa I <b>Anal</b></th><th>n @ 3% ysis</th><th>5 - 15 yr</th><th>includin</th><th>ng 3-yr g</th><th>grace</th><th></th><th></th><th></th><th></th><th></th><th></th><th>Final ]</th></th<>	IICA			Comm	unity El	ectricat	ion Proj	ect, Pra <b>Tabl</b>	maoy, F e 2 Fi	Phase 1, <b>nancia</b>	soft loa I <b>Anal</b>	n @ 3% ysis	5 - 15 yr	includin	ng 3-yr g	grace							Final ]
Competitive?)         D <thd< th="">         D         <thd< th=""> <th< th=""><th>M/P</th><th></th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th><b>,</b></th><th>10</th><th>11</th><th>12</th><th>19</th><th>20</th><th>21</th><th>22</th><th>29</th><th>30</th><th>(unit: \$) Total</th><th>Repo</th></th<></thd<></thd<>	M/P		0	1	2	3	4	5	6	7	8	<b>,</b>	10	11	12	19	20	21	22	29	30	(unit: \$) Total	Repo
National costs         Status         71.072 <th< th=""><th>Stu</th><th>(Expenditure)</th><th>0</th><th>1</th><th>2</th><th>5</th><th></th><th>5</th><th>0</th><th>/</th><th>0</th><th>,</th><th>10</th><th></th><th>12</th><th>17</th><th>20</th><th>21</th><th>22</th><th>2)</th><th>50</th><th>Total</th><th>ĨŤ</th></th<>	Stu	(Expenditure)	0	1	2	5		5	0	/	0	,	10		12	17	20	21	22	2)	50	Total	ĨŤ
Construction costs excluding tax         71.07         2000	dv o	Initial costs																					
Supports to CEC         6,000         2,000	n R	Construction costs excluding tax	71,072											29,900				29,900				130,872	
Total expenditure         7.7072         6.396         5.813         6.09         6.330         6.627         6.794	IIFa	Supports to CEC	6,000	2,000																			
Operation and maintenance costs       4.599       5,813       6,890       6,320       6,721       6,734       6,794	E F																						
Personnel costs       2,50	etri	Operation and maintenance costs		4,599	5,489	5,813	6,059	6,330	6,627	6,771	6,794	6,794	6,794	6,794	6,794	6,794	6,794	6,794	6,794	6,794	6,794	197,942	
Control         Control         Loss	fica	Personnel costs		2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	75,600	
Total expenditure       100 <th>tion</th> <th>O&amp;M of biomass gasification power plant</th> <th></th> <th>970</th> <th>1,546</th> <th>1,756</th> <th>1,915</th> <th>2,090</th> <th>2,282</th> <th>2,375</th> <th>2,390</th> <th>67,904</th> <th></th>	tion	O&M of biomass gasification power plant		970	1,546	1,756	1,915	2,090	2,282	2,375	2,390	2,390	2,390	2,390	2,390	2,390	2,390	2,390	2,390	2,390	2,390	67,904	
Biomass fuel cost         523         833         946         1,032         1,126         1,230         1,288         1,280         1,400         1,400         1,205         1,505	ı hv	Maintenance of distribution lines, etc.		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	3,000	
EAC license fee @ Ridel 1.6/kWh       6       10       11       13       14       15       16 <th></th> <th>Biomass fuel cost</th> <th></th> <th>523</th> <th>833</th> <th>946</th> <th>1,032</th> <th>1,126</th> <th>1,230</th> <th>1,280</th> <th>1,288</th> <th>36,594</th> <th></th>		Biomass fuel cost		523	833	946	1,032	1,126	1,230	1,280	1,288	1,288	1,288	1,288	1,288	1,288	1,288	1,288	1,288	1,288	1,288	36,594	
Payment for technical supports         480         4		EAC license fee @ Riel 1.6/kWh		6	10	11	13	14	15	16	16	16	16	16	16	16	16	16	16	16	16	443	
A         Total expenditure         77,072         6,599         5,489         5,813         6,059         6,30         6,794		Payment for technical supports		480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	14,400	
Total expenditure         77,072         6,399         5,819         5,813         6,059         6,330         6,627         6,771         6,794 <th></th>																							
CRevenue)       Operating revenue through electricity sales       6,336       9,794       11,064       12,062       13,161       14,369       14,923       15,005       <	ΑH	Total expenditure	77,072	6,599	5,489	5,813	6,059	6,330	6,627	6,771	6,794	6,794	6,794	36,694	6,794	6,794	6,794	36,694	6,794	6,794	6,794	336,814	
(Revenue)	-36																						7
Operating revenue through electricity sales         6,336         9,794         11,064         12,062         13,161         14,369         14,923         15,005	5	(Revenue)																					pp
Sales of CER       144       230       261       284       310       339       355       356		Operating revenue through electricity sales		6,336	9,794	11,064	12,062	13,161	14,369	14,923	15,005	15,005	15,005	15,005	15,005	15,005	15,005	15,005	15,005	15,005	15,005	426,818	ben
Residual value of equipment       2,990       7,809       1		Sales of CER		144	230	261	284	310	339	353	355	355	355	355	355	355	355	355	355	355	355	10,088	d X
Total revenue       6,480       10,024       11,325       12,347       13,471       14,708       15,276       15,360       16,375       113,881		Residual value of equipment											2,990				2,990				7,809		Ξ
Total revenue       6,480       10,024       11,325       12,347       13,471       14,708       15,276       15,360<																							Ā
(Net operating income)       -77,072       -119       4,535       5,511       6,288       7,141       8,081       8,505       8,566       11,556       -21,334       8,566       8,566       16,375       113,881         FIRR       6.3%       -77,072       -119       4,535       5,511       6,288       7,141       8,081       8,505       8,566       11,556       -21,334       8,566       8,566       16,375       113,881       Step to the provide the providet the providet the provide the provide the providet the		Total revenue		6,480	10,024	11,325	12,347	13,471	14,708	15,276	15,360	15,360	18,350	15,360	15,360	15,360	18,350	15,360	15,360	15,360	23,169	450,695	/alu
(Net operating income) -77,072 -119 4,535 5,511 6,288 7,141 8,081 8,505 8,566 8,566 11,556 -21,334 8,566 8,566 11,556 -21,334 8,566 8,566 16,375 113,881 FIRR 6.3%																							atio
FIRR 6.3%		(Net operating income)	-77,072	-119	4,535	5,511	6,288	7,141	8,081	8,505	8,566	8,566	11,556	-21,334	8,566	8,566	11,556	-21,334	8,566	8,566	16,375	113,881	n S
FIRR 6.3%																							neet
Biomass Pilot Projec		FIRR	6.3%																				for
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	ne (																						Pro
	2006																						jects

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JIC/ Ren			Comm	unity El	ectricati	ion Proj	ect, Pra	maoy, F	hase 1,	soft loa	in @ 3%	6 - 15 yr	includin	g 3-yr g	grace							ГШа
A M/P	Including taxes, excluding CER sales	0	1	2	3	4	1 abi	e 2 F1	nancia		9	10	11	12	19	20	21	22	29	30	(unit: \$) Total	- deve
Stuc	(Expenditure)		1	2	5		5	0	/	0	,	10	11	12	17	20	21	22	2)	50	1011	
ly oj	Initial costs																					
R	Construction costs	78,092											29,900				29,900				137,892	
ıral El	Supports to CEC	6,000	2,000																			
ectrifi	Operation and maintenance costs		4,599	5,489	5,813	6,059	6,330	6,627	6,771	6,794	6,794	6,794	6,794	6,794	6,794	6,794	6,794	6,794	6,794	6,794	197,942	
icati	Personnel costs		2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	75,600	
onl	O&M of biomass gasification power plant		970	1,546	1,756	1,915	2,090	2,282	2,375	2,390	2,390	2,390	2,390	2,390	2,390	2,390	2,390	2,390	2,390	2,390	67,904	
by	Maintenance of distribution lines, etc.		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	3,000	
	Biomass fuel cost		523	833	946	1,032	1,126	1,230	1,280	1,288	1,288	1,288	1,288	1,288	1,288	1,288	1,288	1,288	1,288	1,288	36,594	
	EAC license fee @ Riel 1.6/kWh		6	10	11	13	14	15	16	16	16	16	16	16	16	16	16	16	16	16	443	
	Payment for technical supports		480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	14,400	
AH-3	Total expenditure	84,092	6,599	5,489	5,813	6,059	6,330	6,627	6,771	6,794	6,794	6,794	36,694	6,794	6,794	6,794	36,694	6,794	6,794	6,794	343,834	
7	(Revenue)																					T
	Operating revenue through electricity sales Sales of CER		6,336	9,794	11,064	12,062	13,161	14,369	14,923	15,005	15,005	15,005	15,005	15,005	15,005	15,005	15,005	15,005	15,005	15,005	426,818 0	
	Residual value of equipment											2,990				2,990				7,809		
	Total revenue		6,336	9,794	11,064	12,062	13,161	14,369	14,923	15,005	15,005	17,995	15,005	15,005	15,005	17,995	15,005	15,005	15,005	22,814	440,607	
	(Net operating income)	-84,092	-263	4,305	5,251	6,003	6,831	7,742	8,152	8,211	8,211	11,201	-21,689	8,211	8,211	11,201	-21,689	8,211	8,211	16,020	96,774	~
	FIRR	5.1%																				01 101 2101

ass Pilot Projects

		Comm	unity El	ectricati	ion Proj	iect, Pra <b>Tabl</b>	maoy, I <b>e 2 Fi</b>	Phase 1, <b>nancia</b>	soft loa I Anal	an @ 3% Iysis	6 - 15 yr	includir	ng 3-yr	grace						
Excluding taxes and subsidy from costs,	and inclu	iding (	CER sal	es																(unit: \$)
(Expanditure)	0	1	2	3	4	5	6	7	8	9	10	11	12	19	20	21	22	29	30	Total
Initital costs	51.204											20.000				20.000				111 104
Construction costs	51,304											29,900				29,900				111,104
Supports to CEC	6,000	2,000																		
Operation and maintenance costs		4,599	5,489	5,813	6,059	6,330	6,627	6,771	6,794	6,794	6,794	6,794	6,794	6,794	6,794	6,794	6,794	6,794	6,794	197,942
Personnel costs		2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	75,600
O&M of biomass gasification power plant		970	1,546	1,756	1,915	2,090	2,282	2,375	2,390	2,390	2,390	2,390	2,390	2,390	2,390	2,390	2,390	2,390	2,390	67,904
Maintenance of distribution lines, etc.		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	3,000
Biomass fuel cost		523	833	946	1,032	1,126	1,230	1,280	1,288	1,288	1,288	1,288	1,288	1,288	1,288	1,288	1,288	1,288	1,288	36,594
EAC license fee @ Riel 1.6/kWh		6	10	11	13	14	15	16	16	16	16	16	16	16	16	16	16	16	16	443
Payment for technical supports		480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	14,400
Total expenditure	57,304	6,599	5,489	5,813	6,059	6,330	6,627	6,771	6,794	6,794	6,794	36,694	6,794	6,794	6,794	36,694	6,794	6,794	6,794	317,046
(Revenue)																				
Operating revenue through electricity sales		6,336	9,794	11,064	12,062	13,161	14,369	14,923	15,005	15,005	15,005	15,005	15,005	15,005	15,005	15,005	15,005	15,005	15,005	426,818
Sales of CER		144	230	261	284	310	339	353	355	355	355	355	355	355	355	355	355	355	355	10,088
Residual value of equipment											2,990				2,990				7,809	,
Total revenue		6,480	10,024	11,325	12,347	13,471	14,708	15,276	15,360	15,360	18,350	15,360	15,360	15,360	18,350	15,360	15,360	15,360	23,169	450,695
(Net operating income)	-57,304	-119	4,535	5,511	6,288	7,141	8,081	8,505	8,566	8,566	11,556	-21,334	8,566	8,566	11,556	-21,334	8,566	8,566	16,375	133,649
FIRR	9.0%																			

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Appendix-H Evaluation Sheet for Biomass Pilot Projects

		Comn	nunity E	lectrica	tion Pro	ject, Pr	amaoy,	Phase 1	, soft lo	an @ 39	% - 15 уі	r includi	ng 3-yr	grace						
						Table	e 3 Ec	onomi	c Eval	uation										
	0	1	2	3	4	5	6	7	8	0	10	11	12	10	20	21	22	20	30	(unit: \$) Total
(Economic costs)	0	1	2	3	4	5	0	/	0	,	10	11	12	19	20	21	22	29	30	Total
Initial costs	(( 100											20.719				20.719				125 (24
Supports to CEC	5,400	1,800										29,/18				29,718				125,624
	ŕ																			
Operation and maintenance costs Personenel costs	0	3,336	3,940	4,160	4,327	4,510	4,712	4,810	4,825	4,825	4,825	4,825	4,825 2,268	4,825 2,268	4,825	4,825	4,825	4,825 2.268	4,825	68.040
O&M of biomass gasification power plant		934	1,488	1,690	1,844	2,012	2,197	2,287	2,301	2,301	2,301	2,301	2,301	2,301	2,301	2,301	2,301	2,301	2,301	65,375
Maintenance of distribution lines, etc.		50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	1,500
Biomass luer cost		84	155	151	165	180	197	205	206	206	206	206	206	206	206	206	206	206	206	3,833
EAC license fee @ Riel 1.6/kWh		6	9	10	11	12	13	14	14	14	14	14	14	14	14	14	14	14	14	399
Monitoring of CEC by DIME       0 <th0< th="">       0<!--</th--><th>0</th></th0<>															0					
Residual value											-2,972				-2,972				-6,619	-12,562
Total expenditure	71,588	5,142	3,949	4,170	4,338	4,522	4,725	4,824	4,839	4,839	1,867	34,557	4,839	4,839	1,867	34,557	4,839	4,839	-1,780	261,431
(Economic benefits as costs of alternative di	iesel mini-gri	d)																		
Total expenditure       71,588       5,142       3,949       4,170       4,338       4,522       4,725       4,839       4,839       1,867       34,557       4,839       1,867       34,557       4,839       1,867       34,557       4,839       1,867       34,557       4,839       1,867       34,557       4,839       1,867       34,557       4,839       1,867       34,557       4,839       1,867       34,557       4,839       1,867       34,557       4,839       1,867       34,557       4,839       1,867       34,557       4,839       1,867       34,557       4,839       1,867       34,557       4,839       1,867       34,557       4,839       4,839       -1,780       261,431         Initial costs       48,693       5,400       1,800       5,400       1,5218       5,218       5,218       5,218       5,218       5,218       5,218       5,218       5,218																				
Supports to CEC	5,400	1,800										10,210				10,210				,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
Operation and maintenance costs	0	6,250	8,775	9,695	10,392	11,160	12,004	12,412	12,476	12,476	12,476	12,476	12,476	12,476	12,476	12,476	12,476	12,476	12,476	
Personenel costs		1,944	1,944	1,944	1,944	1,944	1,944	1,944	1,944	1,944	1,944	1,944	1,944	1,944	1,944	1,944	1,944	1,944	1,944	58,320
O&M of diesel power plant		649	1,034	1,174	1,280	1,397	1,526	1,588	1,598	1,598	1,598	1,598	1,598	1,598	1,598	1,598	1,598	1,598	1,598	45,407
Fuel cost		3,607	5,747	6,527	7,118	7,768	8,484	8,830	8,884	8,884	8,884	8,884	8,884	8,884	8,884	8,884	8,884	8,884	8,884	252,418
EAC ligance for		6	0	10	11	12	12	14	14	1.4	14	14	14	14	14	14	14	14	14	200
Payment for technical supports		432	432	432	432	432	432	432	432	432	432	432	432	432	432	432	432	432	432	12,960
Residual value											-1,522				-1,522				-4,869	-7,913
Benefits from CER sales		144	230	261	284	310	339	353	355	355	355	355	355	355	355	355	355	355	355	10,088
Total benefits	54,093	8,631	9,445	10,398	11,120	11,914	12,788	13,211	13,278	13,278	11,756	28,496	13,278	13,278	11,756	28,496	13,278	13,278	8,408	459,509
(Net benefits)	-17,495	3,490	5,497	6,228	6,782	7,392	8,063	8,387	8,438	8,438	9,888	-6,062	8,438	8,438	9,888	-6,062	8,438	8,438	10,188	198,077
EIRR	33.5%																			

JICA M/P Study on Rural Electrification by Renewable Energy in the Kingdom of Cambodia

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Final Report

#### Community Electrication Project, Pramaoy, Phase 1, soft loan @ 3% - 15 yr including 3-yr grace Table 4 Financing Plan

				(unit: \$)
Financial Resources			Financial Application	
Equity - CEC			Power Plant before tax	37,688
Cash (@ \$50/hh)	7,300	9.2%	Biomass gasification power equipment	29,900
In kind ( @ \$40/MM)	4,561	5.8%	Road improvement works	1,200
114 MM			Powerhouse, etc.	2,600
Grant			Switching equip. & transformer	0
REF	19,768	25.0%	Growing fuel trees	2,488
(25% of capital costs)			Misecellaneous equipment	1,500
Borrowing for capitals			Distribution facilities, service wires, etc.	29,665
Long-term	47,443	60.0%		
(15 yr including 3-year grace, 3%/yr)			Contingecy	3,719
			Capital costs before tax	71,072
Total fund for capital costs and CEC supports	79,072	100.0%	CEC support	8,000
Borrowing for operation	2,000		Operation fund in hand	2,000
Short-term				
(Revolving, 15%/yr)				
Tax exemption	7,020		Customs and tax	7,020
Total Financial Resources	88,092		Total Financial Resources	88,092

			Та	Comm able 5	unity Ele <b>Profi</b>	etrication technologies the sector of the se	on Projec Loss S	et, Prama <b>tatem</b>	aoy, Pha <b>ent wi</b>	se 1, sof	t loan @ sh Flo	) 3% - 1 w, 15-	5 yr inch <b>yr rep</b>	uding 3-y aymer	/r grace <b>it peri</b>	iod						
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	20	21	22	30	(unit: \$) Total
Operating revenue incl. CER & resi	dual va	lue	6,336	9,794	11,064	12,062	13,161	14,369	14,923	15,005	15,005	15,005	15,005	15,005	15,005	15,005	15,005	15,005	15,005	15,005	15,005	426,818
Operating costs			4,599	5,489	5,813	6,059	6,330	6,627	6,771	6,794	6,794	6,794	6,794	6,794	6,794	6,794	6,794	6,794	6,794	6,794	6,794	197,942
new land required for tree plantation					0.5	0.4	0.4	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1
tree plantation costs for increasing de	emand			338	256	282	310	150	24	0	0	0	0	0	0	0	0	0	0	0	1,358	2,717
Gross profit			1,737	3,968	4,994	5,721	6,521	7,591	8,128	8,211	8,211	8,211	8,211	8,211	8,211	8,211	8,211	8,211	8,211	8,211	6,853	226,158
Interests payment																						
Short-term commercial loan (15%/yr)			300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	9,000
Long-term soft loan	3.0%		1,423	1,423	1,423	1,305	1,186	1,067	949	830	712	593	474	356	237	119						12,098
Deprecitation																						
Generating equipment (5 yr - 10 yr - 10 yr)	26,910							5,382	5,382	5,382	5,382	5,382	2,691	2,691	2,691	2,691	2,691	2,691	2,691	2,691	2,691	80,730
Others (20 yr from 6th year)	44,255							2,213	2,213	2,213	2,213	2,213	2,213	2,213	2,213	2,213	2,213	2,213	2,213	2,213		44,255
Operating profit before depreciation	1		13	2,244	3,271	4,117	5,035	6,224	6,879	7,081	7,199	7,318	7,437	7,555	7,674	7,793	7,911	7,911	7,911	7,911	6,553	205,060
Interests received (10%)			0	0	263	247	317	488	797	1,205	1,674	2,201	3,092	3,785	4,559	5,423	6,384	15,329	17,987	20,612	53,638	423,240
Residual value upon completion of depreciation	10%											2,990						2,990			7,809	13,789
CER received			144	230	261	284	310	339	353	355	355	355	355	355	355	355	355	355	355	355	355	10,088
Net profit after depreciation			157	2,474	3,795	4,648	5,662	-544	435	1,046	1,633	5,269	5,980	6,792	7,684	8,667	9,747	21,681	21,350	23,975	65,664	527,192
Cash in hand			157	2,474	3,795	4,648	5,662	7,050	8,030	8,641	9,228	12,864	10,884	11,695	12,588	13,570	14,651	26,585	26,253	28,879	68,355	652,176
Accumulated cash in hand after principal repayment		0	157	2,631	2,472	3,167	4,875	7,972	12,048	16,735	22,010	30,920	37,850	45,592	54,227	63,844	78,494	179,872	206,125	235,004	604,733	
Principal repayment	47,443	0	0	0	3,954	3,954	3,954	3,954	3,954	3,954	3,954	3,954	3,954	3,954	3,954	3,954						47,443
Long-term debt balance	47,443	47,443	47,443	47,443	43,490	39,536	35,582	31,629	27,675	23,722	19,768	15,814	11,861	7,907	3,954	0						

Community Electrication Project, Samraong, Phase 1, soft loan @ 3% - 15 yr including 3-yr grace

#### Table A1 Principal Features of Electrification Plan

#### (1) Generating Equipment Planning

Items	Unit	Q'ty	Remarks
Nos. of households	h.h.	470	31% of the total 1,536 households
Unit nighttime domestic demand	W/hh	100	
Nighttime domestic demand	kW	47.0	
Street light demand	kW	1.3	1 light per 40 m of LV lir 63 street lights
Reserve capacity	kW	14.1	30% of nighttime domestic demand, allocated for station use + reserved power + distribution losses
Required capacity	kW	62.4	
Adopted capacity	kW	64.0	

#### (2) Energy Generation Planning for 8th Year Onward

Items	Monthly Unit Energy Sold	Monthly Energy Sold	Annual Energy Sold	Station Use, Losses, etc. (10%)	Annual Energy Generated	Annual Plant Factor	Annual Operation Hours	Remarks (refer to Table A2 for demand growth rates)
	kWh/hh	MWh	MWh	MWh	MWh	%	hr	
Nighttime domestic demand 1/, 2/	15.0	7.1	84.6	8.5	93.1	16.6%	1,454	100% from 8th year onward
Street light demand	0.4	0.2	2.3	0.2	2.5	0.4%	39	100% from the 1st year
Industrial demand 3/	7.5	3.5	42.3	4.2	46.5	8.3%	727	100% from 8th year onward
Irrigation pump demand 4/	2.4	3.4	13.7	1.4	15.1	2.7%	236	in 4 dry months, 100% from 8th year onward
Total energy	25.3	14.2	142.9	14.3	157.2	28.0%	2,456	100% from 8th year onward

#### Note:

1/ Typical consumption level of existing mini-grids in rural villages as of 2005 was 10 kWh (= 100W / 1,000 \* 5hrs \* 30 days \* 67%) and assumed to be realized from 2nd year.

2/ Average consumption of existing REE mini-grids supplying to rural towns as of 2005 was 15 kWh (= 100 W / 1,000 \* 7.5hrs \* 30days \* 67%) and was assumed to be realized in 7th year.

 $\underline{3}$ / Power demand of BCS, rice-mills, water supply stations, ice factory, workshop of boat engines, etc. Assumed to be 50% of the nighttime demand based on the actual demand of existing Anlong Ta Mey mini-grid (700 kWh at nighttime, 300 kWh for BCS at daytime) and potential daytime users in the villages shown in Table A3.

 $\underline{4}$ / see Table A3 for irrigation power demand.

H4

		Co	mmunit	y Electi	rication	Project	, Samra	ong, Pha	ase 1, so	off loan	@ 3% -	15 yr in	cluding	3-yr gra	ace					
						Iar	Die A2	Energ	gy and	CER	5010									
		1	2	3	4	5	6	7	8	9	10	11	12	19	20	21	22	29	30	Total
(Annual energy sold)	-																			
Demand growth	Growth rate																			
Domestic	1.10	50%	67%	73%	81%	89%	98%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Street lights	0.00	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Industrial	1.10	0%	50%	67%	73%	81%	89%	98%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Irrigation	1.10	0%	50%	67%	73%	81%	89%	98%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Energy sold (MWh/yr)	Demand																			
Domestic	84.6	42.3	56.4	62.0	68.2	75.1	82.6	84.6	84.6	84.6	84.6	84.6	84.6	84.6	84.6	84.6	84.6	84.6	84.6	2,417
Street lights	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	68
Industrial	42.3	0.0	21.2	28.2	31.0	34.1	37.5	41.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	1,166
Irrigation	13.7	0.0	6.9	9.1	10.1	11.1	12.2	13.4	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	378
Total	142.9	44.6	86.7	101.6	111.6	122.5	134.5	141.5	142.9	142.9	142.9	142.9	142.9	142.9	142.9	142.9	142.9	142.9	142.9	4,029
Unit energy sold (kWh per hou	isehold per mo	nth)																		
Domestic	15.0	7.5	10.0	11.0	12.1	13.3	14.6	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	
Street lights	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	
Industrial	7.5	0.0	3.8	5.0	5.5	6.1	6.7	7.3	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	
Irrigation	2.4	0.0	1.2	1.6	1.8	2.0	2.2	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	
Total	25.3	7.9	15.4	18.0	19.8	21.7	23.9	25.1	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	
$\begin{array}{c} \text{Potential} \\ \hline \\ \text{Operating revenue from electricity sales, $) \\ \hline \\ \text{Tariff} \\ \hline \\ \text{Solution} \\ \hline \\ \text{Tariff} \\ \hline \\ \text{Tariff} \\ \hline \\ \text{Solution} \\ \hline \\ \text{Tariff} \\ \hline \\ \hline \\ \text{Solution} \\ \hline \\ \text{Tariff} \\ \hline \\ \hline \\ \text{Solution} \\ \hline \\ \text{Tariff} \\ \hline \\ \hline \\ \text{Solution} \\ \hline \\ \ \\ \text{Tariff} \\ \hline \\ \hline \\ \text{Solution} \\ \hline \\ \hline \\ \text{Tariff} \\ \hline \\ \hline \\ \ \\ \ \\ \ \\ \ \\ \ \\ \ \\ \ \\ \$																				
(Operating revenue from electricity sales, \$) Tariff Domestic \$0.27 11,421 15,228 16,751 18,426 20,268 22,295 22,842 22																				
Domestic	\$0.27	11,421	15,228	16,/51	18,426	20,268	22,295	22,842	22,842	22,842	22,842	22,842	22,842	22,842	22,842	22,842	22,842	22,842	22,842	652,597
Street lights	\$0.27	612	612	612	612	612	612	612	612	612	612	612	612	612	612	612	612	612	612	18,371
Industrial	\$0.25	0	5,288	7,050	7,755	8,531	9,384	10,322	10,575	10,575	10,575	10,575	10,575	10,575	10,575	10,575	10,575	10,575	10,575	291,553
Irrigation	\$0.25	0	1,714	2,285	2,513	2,765	3,041	3,345	3,427	3,427	3,427	3,427	3,427	3,427	3,427	3,427	3,427	3,427	3,427	94,485
lotal		12,033	22,841	26,698	29,306	32,176	35,332	37,121	37,456	37,456	37,456	37,456	37,456	37,456	37,456	37,456	37,456	37,456	37,456	1,057,007
(Monthly tariff, \$ per household	)																			
Domestic		2.03	2.70	2.97	3.27	3.59	3.95	4.05	4.05	4.05	4.05	4.05	4.05	4.05	4.05	4.05	4.05	4.05	4.05	
Street lights		0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	
Industrial		0.00	0.94	1.25	1.38	1.51	1.66	1.83	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88	
Irrigation		0.00	0.30	0.41	0.45	0.49	0.54	0.59	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	
Total		2.13	4.05	4.73	5.20	5.70	6.26	6.58	6.64	6.64	6.64	6.64	6.64	6.64	6.64	6.64	6.64	6.64	6.64	
(Tariff receivable, \$/yr)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	kg-CO <sub>2</sub> /kWh																			
(CER saleable) (to-C	CO <sub>2</sub> ) 1.3	58	113	132	145	159	175	184	186	186	186	186	186	186	186	186	186	186	186	5,238
(\$/yr	) <u>1</u> / <b>\$7</b>	406	789	925	1,015	1,115	1,224	1,288	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	36,666
Fuel tree consumed (ton per mor	nth)	5.6	10.8	12.7	13.9	15.3	16.8	17.7	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	504
Land required to supply fuel tre	es (ha)	6.7	13.0	15.2	16.7	18.4	20.2	21.2	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	
Nos. of fuel tree farmers (0.2 ha	per farmer)	33	65	76	84	92	101	106	107	107	107	107	107	107	107	107	107	107	107	
Payment to fuel tree farmers (\$/	farmer/month	3.4	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	
Total payment to fuel tree farme	ers (\$/yr)	1,337	2,600	3,049	3,348	3,675	4,036	4,246	4,286	4,286	4,286	4,286	4,286	4,286	4,286	4,286	4,286	4,286	4,286	120,877
Ratio of tariff collected and bill	ed= 100%		Note: 1/	Assume	ed at %4/	ton-CO <sub>2</sub> /	vr deduct	ing costs	required	for prepi	ation of I	DD, appl	ication a	nd monit	oring.					

Final Report

Appendix-H Evaluation Sheet for Biomass Pilot Projects

No	Demand	Diesel Consumption	Electricity Demand	Operation Hour	Unit Power Demand	Nos. of Customers		Total Demar	nd
110.	Demand	liter/month	kWh/month	hr/month	kW	Customers	kW	kWh/month	Load Factor
1	BCS	200	600	50	12.00	5	60.00	3,000	6.9%
2	Water supply	60	180	15	12.00	10	120.00	1,800	2.1%
3	Rice-mill	30	90	30	3.00	30	90.00	2,700	4.2%
4	Ice factory	30	90	30	3.00	1	3.00	90	4.2%
5	Workshop	25	75	60	1.25	1	1.25	75	8.3%
6	Café	115	345	296	1.17	1	1.17	345	41.1%
Ν	Aonthly total	460	1,380	481	-	48	64.00	8,010	17.4%
Annual total		5520	16,560	5,772	-	-	64.00	96,120	17.4%

#### Community Electrication Project, Samraong, Phase 1, soft loan @ 3% - 15 yr including 3-yr grace Table A3 Potential Daytime Users and Demand

Source: The potential daytime users above are candidates in Kampong Kor for reference purpose.

#### Potential irrigation demand in the dry season

0.2	ha/hh
50.0%	
47	ha
500	mm
0.235	mcm/yr
4	month
8	hr/day
0.068	m <sup>3</sup> /s
15.0	m
0.70	
14	kW
14	MWh
	$\begin{array}{c} 0.2\\ 50.0\%\\ 47\\ 500\\ 0.235\\ 4\\ 8\\ 0.068\\ 15.0\\ 0.70\\ 14\\ 14\\ 14\end{array}$

#### Community Electrication Project, Samraong, Phase 1, soft loan @ 3% - 15 yr including 3-yr grace Table A4 Cost Estimate

Construction Costs	Unit Price (\$)	Q'ty	Unit	Amount(\$)	Total (\$)	%
Power Station	1 200		1 337	02 200		
Discuss gasification power generating equipment (FOB)	1,300	64	KW	83,200		
Ocean freight & insurance (FOBx8%)	104	64	kW	6,656		
Initiand transportation & installation (FOB x (2%+5%))	91	64 80	KW LAVA	5,824		
Switching equipment, main transformer		80	KVA		95,680	49
Civil and substation works					,	
Road improvement works for dry season use	24	0.20	km	4 800		
to be further improved to all weather road in Phase 2		6120	1.117	0,000		
Land, powernouse, water tank, etc. (10%FOB)	130	64	ĸw	8,320	13 120	
Fuel tree preparation for 2nd year demand					15,120	
Scarified seeds of Leucaena of 0.4-0.5 kg/ha and \$15/kg	8	13	ha	98		
Nursery	1	130	m <sup>2</sup>	130		
Watering of nursery for the first 3 months	100	3	month	300		
Bush clearing	40	13	ha	520		
Land preparation	80	13	ha	1,040		
Transplanting	80	13	ha	1,040		
Maintenance for initital 6 months @ \$60/ha/mon	360	13	ha	4,680		
					7,808	
Sub-total of power station and fuel preparation					116,608	59
Miscellaneous of power station (5%, consumables, gas detector,				4,800		
Power station sub-total (before tax)					121 408	62
Customs & VAT (CIF x 25%)	351	64	kW	22 464	121,400	52
Power station sub-total (including tax)	551	04		22,.04	143.872	73
· · · · · · · · · · · · · · · · · · ·					,	
Distribution Facilities						
MV lines	6,000		km	0		
MV-LV lines	10,700		km	0		
LV lines	7,100	2.5	km	17,750		
Pole-mounted distribution transformers						
15 kVA-1P	6,200		set	0		
25 kVA-3P	7,300		set	0		
50 kVA-3P	8,100		set	0	17.750	0
Miscellancous (5% street lights ata)				000	17,750	9.
Distribution line transformer sub total (including tax)				888	19 629	0
Service wire atc				23 500	18,038	12
Domestic cutomers	50	470	hh	23,500		12
Domestic cutomers Davtime customers (to be fixed individually)	50	470	customers	23,500		
Distribution line - transformer - service wires, etc. sub-total	Ū		customers	0	12 1 20	
(including tax)					42,138	21
Sub-total					186.010	
Contingecy (5%)					9,301	
Construction and data					105 211	100
Construction costs total					195,311	100
Costs for CEC supports	Unit Price (\$)	Q'ty	Unit	Amount(\$)		
Costs for CEC supports and training				24,000		
2.1 Facilitation for CEC setting up and management	500	12.00	MM	6,000		
61 6		12.00	MM	6,000		
2.2 Technical supports	500	12.00				
2.2 Technical supports 2.3 Vehicles and lodging	500 1,000	12.00	month	12,000		
2.2 Technical supports 2.3 Vehicles and lodging	500 1,000	12.00	month	12,000		
2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs	500 1,000	12.00 12.00	month	12,000		
2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff	500 1,000 Salary (\$/mon)	Nos. of person	month	12,000 Amount(\$)	Total (\$)	
2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief	500 1,000 Salary (\$/mon) \$80	Nos. of 12.00	month MM 12.00	12,000 Amount(\$) 960	Total (\$)	
2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operator	500 1,000 Salary (\$/mon) \$80 \$40	Nos. of 12.00 Nos. of 2	MM 12.00 12.00	12,000 Amount(\$) 960 960	Total (\$)	
2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operator Fuel preparation workers	500 1,000 Salary (\$/mon) \$80 \$40 \$30	12.00 12.00 Nos. of person 1 2 1	month MM 12.00 12.00 12.00	12,000 Amount(\$) 960 960 360	Total (\$)	
2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operator Fuel preparation workers Director and accountant	500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40	12.00 12.00 Nos. of person 1 2 1 2	MM 12.00 12.00 12.00 12.00	12,000 Amount(\$) 960 960 360 960	Total (\$)	
2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operator Fuel preparation workers Director and accountant Personnel costs sub-total	500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40	12.00 12.00 Nos. of person 1 2 1 2	MM 12.00 12.00 12.00 12.00	12,000 Amount(\$) 960 960 360 960	Total (\$) \$3,240	
2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operator Fuel preparation workers Director and accountant Personnel costs sub-total Maintenance costs of gasifier and engine-generator	500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 CIF (\$)	12.00 12.00 Nos. of person 1 2 1 2	MM MM 12.00 12.00 12.00 12.00 Ratio of O&M Costs	12,000 Amount(\$) 960 960 360 960 Amount (\$)	Total (\$) \$3,240 Total (\$)	
2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operator Fuel preparation workers Director and accountant Personnel costs sub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF)	500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 CIF (\$) 95,680	12.00 12.00 Nos. of person 1 2 1 2	MM MM 12.00 12.00 12.00 12.00 Ratio of O&M Costs	12,000 Amount(\$) 960 960 360 960 Amount (\$)	Total (\$) <b>\$3,240</b> Total (\$)	
2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operation Chief Director and accountant Personnel costs sub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator set	500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 CIF (\$) 95,680 31,893	12:00 12:00 Nos. of person 1 2 1 2	MM MM 12.00 12.00 12.00 12.00 Ratio of O&M Costs 5.0%	12,000 Amount(\$) 960 960 960 960 Amount (\$) 1,590	Total (\$) <b>\$3,240</b> Total (\$)	
2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operator Fuel preparation workers Director and accountant Personnel costs sub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr	500 1,000 Salary (S/mon) \$80 \$40 \$30 \$40 CIF (\$) 95,680 31,893 63,787	12.00 12.00 Nos. of person 1 2 1 2	MM MM 12.00 12.00 12.00 12.00 Ratio of O&M Costs 5.0% 5.0%	12,000 Amount(\$) 960 960 960 960 Amount (\$) 1,590 3 190	Total (\$) <b>\$3,240</b> Total (\$)	
2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operator Fuel preparation workers Director and accountant Personnel costs sub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/every one year, 4-6%) Pendogement of lemp of texter lights gotter at the gas of the set of text lights gotter at the set of text lights gotter t	500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 CIF (\$) 95,680 31,893 63,787	12.00 12.00 Nos. of person 1 2 1 2	MM MM 12.00 12.00 12.00 12.00 12.00 8 atio of <u>O&amp;M Costs</u> 5.0% 5.0%	12,000 Amount(\$) 960 960 360 960 Amount (\$) 1,590 3,190	Total (\$) <b>\$3,240</b> Total (\$)	
2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operator Fuel preparation workers Director and accountant Personnel costs sub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator costs (CIF) 5% of engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/every one year, 4-6%) Replacement of lamp of street lights, office stationery and consumables	500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 CIF (\$) 95,680 31,893 63,787	12.00 12.00 Nos. of person 1 2 1 2	MM MM 12.00 12.00 12.00 12.00 Colored Colored S.0% 5.0%	12,000 Amount(\$) 960 360 960 Amount (\$) 1,590 3,190 1,080	Total (\$) <b>\$3,240</b> Total (\$)	
2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operator Fuel preparation workers Director and accountant Personnel costs sub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/every one year, 4-6%) Replacement of lamp of street lights, office stationery and consumables Maintenance costs of powerhouse (% of powerhouse)	500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 CIF (\$) 95,680 31,893 63,787 8,320	12.00 12.00 Nos. of person 1 2 1 2	MM MM 12.00 12.00 12.00 12.00 Ratio of <u>O&amp;M Costs</u> 5.0% 5.0% 2.0%	12,000 Amount(\$) 960 960 960 4mount (\$) 1,590 3,190 1,080 170	Total (\$) <b>\$3,240</b> Total (\$)	
2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operator Fuel preparation workers Director and accountant Personnel costs sub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/every one year, 4-6%) Replacement of lamp of street lights, office stationery and consumables Maintenance costs of powerhouse (% of powerhouse) Maintenance costs sub-total	500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 CIF (\$) 95,680 31,893 63,787 8,320	12.00 12.00 Nos. of person 1 2 1 2	MM MM 12.00 12.00 12.00 12.00 Ratio of <u>O&amp;M Costs</u> 5.0% 5.0% 2.0%	12,000 Amount(\$) 960 960 960 960 4mount (\$) 1,590 3,190 1,080 170	Total (\$) \$3,240 Total (\$) 6,030	
2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operator Fuel preparation workers Director and accountant Personnel costs sub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator costs (CIF) 5% of engine-generator costs (CIF) 5% of engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/every one year, 4-6%) Replacement of lamp of street lights, office stationery and consumables Maintenance costs of powerhouse (% of powerhouse) Maintenance costs sub-total Operation and maintenance costs sub-total	500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 CIF (\$) 95,680 31,893 63,787 8,320	12.00 12.00 Nos. of person 1 2 1 2	MM 12.00 12.00 12.00 12.00 0&M Costs 5.0% 5.0% 2.0%	12,000 Amount(\$) 960 360 960 Amount (\$) 1,590 3,190 1,080 170	Total (\$) \$3,240 Total (\$) 6,030 9,270	
2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operation Chief Operator Fuel preparation workers Director and accountant Personnel costs sub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/every one vear, 4-6%) Replacement of lamp of street lights, office stationery and consumables Maintenance costs of powerhouse (% of powerhouse) Maintenance costs sub-total Operation and maintenance costs sub-total	500 1,000 Salary (S/mon) \$80 \$40 \$30 \$40 CIF (\$) 95,680 31,893 63,787 8,320	12.00 12.00 Nos. of person 1 2 1 2	MM MM 12.00 12.00 12.00 12.00 Ratio of <u>0&amp;M Costs</u> 5.0% 5.0% 2.0%	12,000 Amount(\$) 960 360 960 Amount (\$) 1,590 3,190 1,080 170	Total (\$) \$3,240 Total (\$) 6,030 9,270	
2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operator Fuel preparation workers Director and accountant Personnel costs sub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/every one year, 4-6%) Replacement of lamp of street lights, office stationery and consumables Maintenance costs of powerhouse (% of powerhouse) Maintenance costs sub-total Operation and maintenance costs sub-total Payment for technical supports (\$/yr for 15 years from 1st year)	500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 CIF (\$) 95,680 31,893 63,787 8,320	12.00 12.00 Nos. of person 1 2 1 2	MM 12.00 12.00 12.00 12.00 12.00 Ratio of <u>O&amp;M Costs</u> 5.0% 5.0% 2.0%	12,000 Amount(\$) 960 960 360 4mount (\$) 1,590 3,190 1,080 170	Total (\$) <b>\$3,240</b> Total (\$) 6,030 9,270 1,550	
2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operation Chief Operation Chief Operation and accountant Personnel costs sub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/every one year, 4-6%) Replacement of lamp of street lights, office stationery and consumables Maintenance costs of powerhouse (% of powerhouse) Maintenance costs sub-total Operation and maintenance costs sub-total Payment for technical supports (\$/yr for 15 years from 1st year) Items	500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 CIF (\$) 95,680 31,893 63,787 8,320 Unit fuel cost (\$/tWb)	Energy	month MM 12.00 12.00 12.00 12.00 Ratio of <u>O&amp;M Costs</u> 5.0% 5.0% 2.0%	12,000 Amount(\$) 960 960 960 Amount (\$) 1,590 3,190 1,080 170	Total (\$) \$3,240 Total (\$) 6,030 9,270 1,550 Fuel costs (\$)	

Maintenance costs of distribution facilities Maintenance costs (0.5% of construction costs)

(4)

100

Renewable Energy in the Kingdom of Cambodia	JICA M/P Study on Rural Electrification by
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O&M

3. Fuel

Community Electrication Project, Samraong, Phase 1, soft loan @ 3% - 15 yr including 3-yr grace
Table A5    Economic Costs

Local

Currency

\$

77,720

5,824

22,464

13,120

7,710 0

4,800

5,858

7,755

9,301

24,000

101,720

9,305

3,240

1,250

4,715

100

888

Foreign

Currency

\$

117,592

89,856

0

98

11,893

15,745

0

117,592

4,780

0

Items

1.1 Generating equip. excl. tax

1.2 Customs & VAT

1.3 Road and powerhouse

1.4 Growing fuel trees

1.5 Swichyard equip. 1.6 Powerhouse miscellaneous

1.7 Distribution lines

1.8 Service wires, etc.

2. CEC facilitation costs

1. Personnel costs

4. Distribution lines

1.10 Contingency (5%)

1.9 Distri. Lines miscellaneous

**Project Costs Total** 

2. Biomass gasifier generator

1. Hard costs

#### **Table A6 Economic Benefits**

2,000

0

m<sup>2</sup>

0

Financial	Economi			Foreign	Local	Financial	Economic	
Costs	c Costs	Remarks	Items	Currency	Currency	Costs	Costs	Remarks
\$	\$			\$	\$	\$	\$	
195,311	158,989	SCF	1. Hard costs	55,349	67,536	122,884	103,122	
95,680	95,098	0.90	1.1 Diesel generator excl. tax	43,456	5,824	49,280	48,698	770 \$/kW
22,464	0	LCF	1.2 Customs & VAT		12,320	12,320		
13,120	6,560	0.50 <u>1</u> /	1.3 Road & land preparation		4,800	4,800	2,400	
7,808	3,953		1.4 Powerhouse & fuel tank (10%)		4,928	4,928	4,435	
0	0		1.5 Swichyard equip.		0	0	0	
4,800	4,320		1.6 Powerhouse miscellaneous (5%)		3,566	3,566	3,210	
17,750	17,164		1.7 Distribution lines	11,893	5,858	17,750	17,164	
23,500	22,725		1.8 Service wires, etc.		23,500	23,500	21,150	
888	799		1.9 Distri. Lines miscellaneous		888	888	799	
9,301	8,371		1.10 Contingency (5%)		5,852	5,852	5,266	
24,000	21,600		2. CEC facilitation costs	0	24,000	24,000	21,600	
219,311	180,589		Project Costs Total	55,349	91,536	146,884	124,722	
14,085	9,463		O&M	2,944	39,898	42,842	38,812	
3,240	2,754		1. Personnel costs	0	2,880	2,880	2,592	
6,030	5,905		2. Diesel generator	2,944	770	3,714	3,637	5%
4,715	754	0.16 <u>2</u> /	3. Fuel	0	36,148	36,148	32,533	0.23 \$/kWh
100	50		4. Distribution lines	0	100	100	50	
			Adjsutment for Kampong Kor diesel pov	ver station				
			1. Road powerhouse	24	0.20	km	4,800	
			2. Embankment of station vard	0	2,000	$m^2$	0	

3. Land acquisition

4,780 0 Note: 1/ Economic conversion factor for seasonal jobless labors

Appendix-H Evaluation Sheet for Biomass Pilot Projects

#### Community Electrication Project, Samraong, Phase 1, soft loan @ 3% - 15 yr including 3-yr grace **Table A7** Unit Costs of Electricity

#### Table A8 Tariff Setting

Items	with tax (\$)	with tax exemption and subsidy (\$)
1. Capital Costs	219,311	147,635
2. CEC facilitation costs	24,000	24,000
3. Total construction costs excluding design, tes	sting, etc.	171,635
Interest rate	3.0%	
Repayment period	10 yr	
CRF (3.0%, 10 yr) =	0.1172	
4. Annual costs excluding design, etc.	25,710	20,121
5. O&M costs in 10th year	15,592	15,592
5.1 O&M	9,270	9,270
5.2 Fuel costs	4,715	4,715
5.3 EAC license fee	57	57
5.4 Yearly monitoring fee by DIME	1,550	1,550
6. Annual total costs	41,302	35,713
7. Annual energy sales from 7th year (MWh)	142.9	142.9
8. Unit cost of electricity from 7th year (\$/kWh	) 0.289	0.250
9. NPV of energy sold	MWh	2,561
10. NPV of finacial costs excluding tax	\$	589,015
11. Average cost of electricity	\$/kWh	0.230

Items	\$	Riel
Unit cost of electricity from 7th year (\$/kWh)	0.230	920
Rate of reserve for operational risks (12%)	0.028	110
Average tariff (\$/kWh)	\$0.258	1,032
Tariff adopted for nighttime demand	\$0.270	1,080
Tariff adopted for street lights	\$0.270	1,080
Tariff adopted for industrial demand	\$0.250	1,000
Tariff adopted for irrigation demand	\$0.250	1,000
Monthly revenue (US\$/mon)	\$3,121	
from nighttime users	\$1,904	
for street lights	\$51	
from industrial users	\$881	
from irrigation pump users	\$286	
Average monthly tariff @ 15 kWh per HH (\$)	\$4.05	16,200
Tariff for street lights	\$0.11	400
Total @ 15 kWh/hh including street lights	\$4.16	16,600
Average monthly tariff @ 10 kWh per HH (\$) including street lights	\$2.81	11,200
Tariff of poor household (\$/mon/hh)         (@. 40 W x 4h x 30 days = 4.8 kWh/month +         street lights	\$1.40	5,600
Tariff of poorest household (US\$/mon/hh) @ 7 W x 4h x 30 days = 0.84 kWh/mon + street	\$0.34	1,300
	Monthly	Costs
ATP for monthly tariff	\$	Riel
Diesel oil lamp (100%)	\$1.46	5,844
Battery lighting (70%, incl. Riel 4,000 per month for battery purchase)	\$3.12	12,470
Total	\$4.58	18,314

# JICA M/P Study on Rural Electrification by Renewable Energy in the Kingdom of Cambodia

# Appendix-H Evaluation Sheet for Biomass Pilot Projects

#### Community Electrication Project, Samraong, Phase 1, soft loan @ 3% - 15 yr including 3-yr g Table 1 Adopted Conditions for Economic and Finacial Analyses

1.	Energy sold	See attached Table A2	
2.	Tariff	See attached Table A7	
3.	Long-term borr - 3% per year - 25 years repa	rowing from GOC syment period including 5 years' grace	
4.	Short-term born - 10% per year - revolving eve	rowing from commercial bank ery year	
5.	Depreciation		
	- Ratio of depr	eciation	90%
	- Ratio of resid	lual value	10%
	Generating equ	ipment	
	- 5 years' grace	e and 5 years' depreciation for the first 10 years	
	- 10 years' dep	reciation from 11th year onward	
	Distribution lin - 5 years' grace	es, service wires, etc. e and 20 years' depreciation	

- 6. Interest earning
  - Interest of saving deposit at 10% per year

(Expenditure)         0         1         2         3         4         5         6         7         8         9         10         11         12         19         20         21         21         20         21	Community Electrication Project, Samraong, Phase 1, soft loan @ 3% - 15 yr including 3-yr grace <b>Table 2 Financial Analysis</b>																				
(Expenditure)         Difficuosis       Construction costs excluding tax       17.847       77.847       81.000       67.97       81.000       67.97       81.000       67.97       81.000       67.97       81.000		0	1	2	3	4	5	6	7	8	9	10	11	12	19	20	21	22	29	30	(unit: \$) Total
Initiati cosis       Image: Private Pr	(Expenditure)																				
Construction costs excluding tax       172,847 $172,847$ $172,847$ $172,847$ $172,847$ $18,00$ $6,00$ $1121111111111111111111111111111111111$	Initital costs																				
Supports to CEC         18,00         6,00	Construction costs excluding tax	172,847											95,680				95,680				364,207
Operation and maintenance costs       8,60       11,443       12,575       13,326       14,153       15,02	Supports to CEC	18,000	6,000																		
Personnel costs       3,240	Operation and maintenance costs		8,260	11,443	12,575	13,326	14,153	15,062	15,591	15,692	15,692	15,692	15,692	15,692	15,692	15,692	15,692	15,692	15,692	15,692	451,329
O&M of biomass gasification power plant       1,881       3,658       4,290       4,709       5,171       5,678       5,973       6,030 </td <td>Personnel costs</td> <td></td> <td>3,240</td> <td>97,200</td>	Personnel costs		3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	97,200
Maintenance of distribution lines, etc.       100	O&M of biomass gasification power plant		1,881	3,658	4,290	4,709	5,171	5,678	5,973	6,030	6,030	6,030	6,030	6,030	6,030	6,030	6,030	6,030	6,030	6,030	170,051
Biomass fuel cost       1,471       2,860       3,368       3,682       4,043       4,400       4,715 <td>Maintenance of distribution lines, etc.</td> <td></td> <td>100</td> <td>3,000</td>	Maintenance of distribution lines, etc.		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	3,000
EAC license fee @ Riel 1.6/kWh       18       35       41       45       49       54       57	Biomass fuel cost		1,471	2,860	3,354	3,682	4,043	4,440	4,671	4,715	4,715	4,715	4,715	4,715	4,715	4,715	4,715	4,715	4,715	4,715	132,967
Payment for technical supports       1,550	EAC license fee @ Riel 1.6/kWh		18	35	41	45	49	54	57	57	57	57	57	57	57	57	57	57	57	57	1,612
Total expenditure       190,87       14,20       11,443       12,575       13,320       14,153       15,692       15,692       15,692       15,692       15,692       11,372       15,692       11,372       15,692       11,372       15,692       11,375       15,692       15,	Payment for technical supports		1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	46,500
(Revenue)       12,033       22,841       26,698       29,306       32,176       35,332       37,121       37,456       1,000       1,300	Total expenditure	190,847	14,260	11,443	12,575	13,326	14,153	15,062	15,591	15,692	15,692	15,692	111,372	15,692	15,692	15,692	111,372	15,692	15,692	15,692	839,536
Operating revenue through electricity sales       12,033       22,841       26,698       29,306       32,176       35,332       37,121       37,456 <t< td=""><td>(Revenue)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>	(Revenue)																				
Sales of CER       406       789       925       1,015       1,115       1,224       1,288       1,300 <t< td=""><td>Operating revenue through electricity sales</td><td></td><td>12,033</td><td>22,841</td><td>26,698</td><td>29,306</td><td>32,176</td><td>35,332</td><td>37,121</td><td>37,456</td><td>37,456</td><td>37,456</td><td>37,456</td><td>37,456</td><td>37,456</td><td>37,456</td><td>37,456</td><td>37,456</td><td>37,456</td><td>37,456</td><td>1,057,007</td></t<>	Operating revenue through electricity sales		12,033	22,841	26,698	29,306	32,176	35,332	37,121	37,456	37,456	37,456	37,456	37,456	37,456	37,456	37,456	37,456	37,456	37,456	1,057,007
Residual value of equipment       9,568       9,568       19,531         Total revenue       12,439       23,630       27,623       30,322       33,291       36,557       38,757       48,325       38,757       48,325       38,757       48,325       38,757       48,325       38,757       38,757       38,757       58,288       1,132,34         (Net operating income)       -190,847       -1,821       12,187       15,048       16,996       19,138       21,495       22,818       23,064       32,632       -72,616       23,064       32,632       -72,616       23,064       42,596       292,800         FIRR       6.5%<	Sales of CER		406	789	925	1,015	1,115	1,224	1,288	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	36,666
Total revenue       12,439       23,630       27,623       30,322       33,291       36,557       38,757       48,325       38,757       38,757       48,325       38,757       48,325       38,757       48,325       38,757       48,325       38,757       48,325       38,757       38,757       58,288       1,132,34         (Net operating income)       -190,847       -1,821       12,187       15,048       16,996       19,138       21,495       22,818       23,064       32,632       -72,616       23,064       32,632       -72,616       23,064       42,596       292,800         FIRR       6.5%       6.5	Residual value of equipment											9,568				9,568				19,531	
(Net operating income) -190,847 -1,821 12,187 15,048 16,996 19,138 21,495 22,818 23,064 32,632 -72,616 23,064 32,632 -72,616 23,064 23,064 42,596 292,80 FIRR 6.5%	Total revenue		12,439	23,630	27,623	30,322	33,291	36,557	38,409	38,757	38,757	48,325	38,757	38,757	38,757	48,325	38,757	38,757	38,757	58,288	1,132,340
FIRR 6.5%	(Net operating income)	-190,847	-1,821	12,187	15,048	16,996	19,138	21,495	22,818	23,064	23,064	32,632	-72,616	23,064	23,064	32,632	-72,616	23,064	23,064	42,596	292,804
	FIRR	6.5%																			

Community Electrication Project, Samraong, Phase 1, soft Ioan @ 3% - 15 yr including 3-yr grace <b>Table 2 Financial Analysis</b>																					
Including taxes, excluding CER sales	0	1	2	3	4	5	6	7	8	9	10	11	12	19	20	21	22	29	30	(unit: \$) Total	Repo
(Expenditure)		-		-		-															п
Initital costs																					
Construction costs	195,311											95,680				95,680				386,671	
Supports to CEC	18,000	6,000																			
Operation and maintenance costs		8,260	11,443	12,575	13,326	14,153	15,062	15,591	15,692	15,692	15,692	15,692	15,692	15,692	15,692	15,692	15,692	15,692	15,692	451,329	
Personnel costs		3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	97,200	
O&M of biomass gasification power plant		1,881	3,658	4,290	4,709	5,171	5,678	5,973	6,030	6,030	6,030	6,030	6,030	6,030	6,030	6,030	6,030	6,030	6,030	170,051	
Maintenance of distribution lines, etc.		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	3,000	
Biomass fuel cost		1,471	2,860	3,354	3,682	4,043	4,440	4,671	4,715	4,715	4,715	4,715	4,715	4,715	4,715	4,715	4,715	4,715	4,715	132,967	
EAC license fee @ Riel 1.6/kWh		18	35	41	45	49	54	57	57	57	57	57	57	57	57	57	57	57	57	1,612	
Payment for technical supports		1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	46,500	
Total expenditure	213,311	14,260	11,443	12,575	13,326	14,153	15,062	15,591	15,692	15,692	15,692	111,372	15,692	15,692	15,692	111,372	15,692	15,692	15,692	862,000	
(Revenue)																					Ap
Operating revenue through electricity sales		12,033	22,841	26,698	29,306	32,176	35,332	37,121	37,456	37,456	37,456	37,456	37,456	37,456	37,456	37,456	37,456	37,456	37,456	1,057,007	pend
Residual value of equipment											9,568				9,568				19,531	0	dix-F
																					⊥ E
Total revenue		12,033	22,841	26,698	29,306	32,176	35,332	37,121	37,456	37,456	47,024	37,456	37,456	37,456	47,024	37,456	37,456	37,456	56,988	1,095,674	valua
(Net operating income)	-213,311	-2,226	11,399	14,123	15,980	18,023	20,270	21,531	21,764	21,764	31,332	-73,916	21,764	21,764	31,332	-73,916	21,764	21,764	41,295	233,674	tion Sh
FIRR	4.9%																				leet fo
																					r Bio
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																					ects

		Comm	unity Ele	ectricati	on Proje	ect, Sam	iraong,	Phase 1	, soft lo	an @ 3%	⁄ю - 15 у	r includi	ng 3-yr	grace							rına
Excluding taxes and subsidy from costs	and incl	uding (	TER sal	65		1 201	ez fi	папсіа	ai Ana	lysis										(unit: \$)	IKe
Excluding taxes and subsidy from costs,		1	2	3	4	5	6	7	8	9	10	11	12	19	20	21	22	29	30	Total	por
(Expenditure)																					-
Initital costs																					
Construction costs	123,635											95,680				95,680				314,995	
Supports to CEC	18,000	6,000																			
Operation and maintenance costs		8,260	11,443	12,575	13,326	14,153	15,062	15,591	15,692	15,692	15,692	15,692	15,692	15,692	15,692	15,692	15,692	15,692	15,692	451,329	
Personnel costs		3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	3,240	97,200	
O&M of biomass gasification power plant		1,881	3,658	4,290	4,709	5,171	5,678	5,973	6,030	6,030	6,030	6,030	6,030	6,030	6,030	6,030	6,030	6,030	6,030	170,051	
Maintenance of distribution lines, etc.		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	3,000	
Biomass fuel cost		1,471	2,860	3,354	3,682	4,043	4,440	4,671	4,715	4,715	4,715	4,715	4,715	4,715	4,715	4,715	4,715	4,715	4,715	132,967	
EAC license fee @ Riel 1.6/kWh		18	35	41	45	49	54	57	57	57	57	57	57	57	57	57	57	57	57	1,612	
Payment for technical supports		1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	46,500	
Total expenditure	141,635	14,260	11,443	12,575	13,326	14,153	15,062	15,591	15,692	15,692	15,692	111,372	15,692	15,692	15,692	111,372	15,692	15,692	15,692	790,324	
(Revenue)																					Ap
Operating revenue through electricity sales		12,033	22,841	26,698	29,306	32,176	35,332	37,121	37,456	37,456	37,456	37,456	37,456	37,456	37,456	37,456	37,456	37,456	37,456	1,057,007	pe
Sales of CER		406	789	925	1,015	1,115	1,224	1,288	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	36,666	ndi
Residual value of equipment											9,568				9,568				19,531		X-H
Total revenue		12,439	23,630	27,623	30,322	33,291	36,557	38,409	38,757	38,757	48,325	38,757	38,757	38,757	48,325	38,757	38,757	38,757	58,288	1,132,340	Evalu
(Net operating income)	-141,635	-1,821	12,187	15,048	16,996	19,138	21,495	22,818	23,064	23,064	32,632	-72,616	23,064	23,064	32,632	-72,616	23,064	23,064	42,596	342,016	ation S
FIRR	9.3%																				heet t
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Community Electrication Project, Samraong, Phase 1, soft loan @ 3% - 15 yr including 3-yr grace																				
	Table 3   Economic Evaluation																			
	0	1	2	3	4	5	6	7	8	0	10	11	12	10	20	21	22	20	30	(unit: \$) Total
(Economic costs)	0	1	2	5	4	5	0	/	0	7	10	11	12	19	20	21	22	29	30	Total
Initial costs	158 080											05.008				95 098				3/10 185
Supports to CEC	16,200	5,400										95,098				95,098				549,105
<b>Operation and maintenance costs</b> Personenel costs O&M of biomass gasification power plant Maintenance of distribution lines, etc. Biomass fuel cost	0	5,043 2,916 1,842 50 235	7,006 2,916 3,582 50 458	7,704 2,916 4,201 50 537	8,167 2,916 4,612 50 589	8,676 2,916 5,064 50 647	9,237 2,916 5,561 50 710	9,563 2,916 5,850 50 747	9,625 2,916 5,905 50 754	87,480 166,525 1,500 21,275										
EAC license fee @ Riel 1.6/kWh Monitoring of CEC by DIME		16 0	31 0	37 0	40 0	44 0	48 0	51 0	1,451 0											
Residual value											-9,510				-9,510				-15,899	-34,918
Total expenditure	175,189	10,459	7,037	7,740	8,207	8,721	9,285	9,614	9,677	9,677	167	104,774	9,677	9,677	167	104,774	9,677	9,677	-6,222	614,097
(Economic benefits as costs of alternative die	sel mini-grio	l)																		
Economic costs	103,122											48,698				48,698				200,518
Supports to CEC	16,200	5,400										,								
<b>Operation and maintenance costs</b> Personenel costs O&M of diesel power plant Maintenance of distribution lines, etc. Fuel cost	0	13,925 2,592 1,135 50 10,148	24,584 2,592 2,206 50 19,735	28,374 2,592 2,587 50 23,145	30,890 2,592 2,840 50 25,408	33,658 2,592 3,119 50 27,897	36,702 2,592 3,425 50 30,635	38,473 2,592 3,603 50 32,228	38,812 2,592 3,637 50 32,533	77,760 102,566 1,500 917,454										
EAC license fee Payment for technical supports		16 1,395	31 1,395	37 1,395	40 1,395	44 1,395	48 1,395	51 1,395	1,451 41,850											
Residual value											-4,870				-4,870				-10,312	-20,052
Benefits from CER sales		406	789	925	1,015	1,115	1,224	1,288	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	36,666
Total benefits	119,322	21,141	26,798	30,731	33,341	36,212	39,370	41,207	41,559	41,559	36,689	90,256	41,559	41,559	36,689	90,256	41,559	41,559	31,246	1,381,312
(Net benefits)	-55,867	10,682	19,762	22,991	25,134	27,491	30,084	31,593	31,882	31,882	36,522	-14,518	31,882	31,882	36,522	-14,518	31,882	31,882	37,468	767,216
EIRR	37.3%																			

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#### Community Electrication Project, Samraong, Phase 1, soft Ioan @ 3% - 15 yr including 3-yr grace **Table 4 Financing Plan**

				(unit: \$)
Financial Resources			Financial Application	
Equity - CEC			Power Plant before tax	121,408
Cash (@ \$50/hh)	23,500	11.9%	Biomass gasification power equipment	95,680
In kind ( @ \$40/MM)	6,027	3.1%	Road improvement works	4,800
151 MM			Powerhouse, etc.	8,320
Grant			Switching equip. & transformer	0
REF	49,212	25.0%	Growing fuel trees	7,808
(25% of capital costs)			Misecellaneous equipment	4,800
Borrowing for capitals			Distribution facilities, service wires, etc.	42,138
Long-term	118,108	60.0%		
(15 yr including 3-year grace, 3%/yr)			Contingecy	9,301
			Capital costs before tax	172,847
Total fund for capital costs and CEC supports	196,847	100.0%	CEC support	24,000
Borrowing for operation Short-term	3,000		Operation fund in hand	3,000
(Revolving, 15%/yr)				
Tax exemption	22,464		Customs and tax	22,464
Total Financial Resources	222,311		Total Financial Resources	222,311

#### **Table A1 Principal Features of Electrification Plan**

#### (1) Generating Equipment Planning

Items	Unit	Q'ty	Remarks
Nos. of households	h.h.	600	
Unit nighttime domestic demand	W/hh	100	
Nighttime domestic demand	kW	60.0	
Street light demand	kW	4.5	1 light per 40 m of LV lin 225 street lights
Reserve capacity	kW	18.0	30% of nighttime domestic demand, allocated for station use + reserved power + distribution losses
Required capacity	kW	82.5	
Adopted capacity	kW	82.5	

#### (2) Energy Generation Planning for 8th Year Onward

Items	Monthly Unit Energy Sold	Monthly Energy Sold	Annual Energy Sold	Station Use, Losses, etc. (10%)	Annual Energy Generated	Annual Plant Factor	Annual Operation Hours	Remarks (refer to Table A2 for demand growth rates)			
	kWh/hh	MWh	MWh	MWh	MWh	%	hr				
Nighttime domestic demand 1/, 2/	15.0	9.0	108.0	10.8	118.8	16.4%	1,440	100% from 8th year onward			
Street light demand	1.1	0.7	8.1	0.8	8.9	1.2%	108	100% from the 1st year			
Industrial demand <u>3</u> /	7.5	4.5	54.0	5.4	59.4	8.2%	720	100% from 8th year onward			
Irrigation pump demand 4/	1.2	2.2	8.8	0.9	9.6	1.3%	117	in 4 dry months, 100% from 8th year onward			
Total energy	24.8	16.4	178.9	17.9	196.7	27.2%	2,385	100% from 8th year onward			

#### Note:

1/ Typical consumption level of existing mini-grids in rural villages as of 2005 was 10 kWh (= 100W / 1,000 \* 5hrs \* 30 days \* 67%) and assumed to be realized from 2nd year.

2/ Average consumption of existing REE mini-grids supplying to rural towns as of 2005 was 15 kWh (= 100 W / 1,000 \* 7.5hrs \* 30days \* 67%) and was assumed to be realized in 7th year.

 $\underline{3}$ / Power demand of BCS, rice-mills, water supply stations, ice factory, workshop of boat engines, etc. Assumed to be 50% of the nighttime demand based on the actual demand of existing Anlong Ta Mey mini-grid (700 kWh at nighttime, 300 kWh for BCS at daytime) and potential daytime users in the villages shown in Table A3.

 $\underline{4}$ / see Table A3 for irrigation power demand.

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Community Electrication Project, Cambodia, soft loan @ 3% - 15 yr including 3-yr grace																				
Table A2   Energy and CER Sold																				
						-		_			10				•			• •	•	
(Annual onergy sold)		1	2	3	4	5	6	7	8	9	10	11	12	19	20	21	22	29	30	Total
Demand growth	Growth rate																			
Domestic	1 10	50%	67%	73%	81%	80%	08%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Street lights	0.00	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Industrial	1 10	0%	50%	67%	73%	81%	80%	08%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Irrigation	1.10	0%	50%	67%	73%	81%	80%	98%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Energy sold (MWh/yr)	Demond	070	5070	0770	/3/0	0170	07/0	10/0	10070	10070	10070	10070	10070	10070	10070	10070	10070	10070	10070	
Domestic	108.0	54.0	72.0	79.2	871	95.8	105.4	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	3 086
Street lights	8 1	8 1	8 1	81	8 1	81	8 1	8 1	8 1	8 1	8 1	8 1	8 1	8 1	8 1	8 1	8 1	8 1	8 1	2/3
Industrial	54.0	0.1	27.0	36.0	30.6	/3.6	17.0	52.7	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	1 /89
Irrigation	88	0.0	27.0	5.8	6.4	7 1	7.8	85	8.8	8.8	88	8.8	8.8	24.0 8.8	88	8.8	8.8	88	8.8	241
Total	178.0	62.1	111.5	120.1	141.2	154.6	160.2	177.2	178.0	178.0	178.0	178.0	178.0	178.0	178.0	178.0	178.0	178.0	178.0	5 050
Unit energy sold (kWh per hou	1/0.7 usehold per ma	(02.1)	111.5	129.1	141.2	134.0	109.2	177.5	1/0.9	1/0.9	1/0.9	1/0.9	1/0.9	1/0.9	1/0.9	1/0.9	1/0.9	170.9	1/0.9	5,059
Domestic	15 0	75	10.0	11.0	12.1	13.3	14.6	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	
Street lights	11	1.5	1 1	11.0	12.1	11	14.0	1 1	13.0	13.0	11	13.0	13.0	13.0	13.0	13.0	13.0	13.0	10.0	
Industrial	7.5	0.0	3.8	5.0	5.5	6.1	6.7	73	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	
Irrigation	1.5	0.0	0.6	0.8	0.0	1.0	1.1	1.5	1.2	1.5	1.2	1.5	1.2	1.2	1.2	1.5	1.2	1.2	1.2	
Total	24.8	8.6	15.5	17.0	10.5	21.5	23.5	24.6	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	
Total	24.0	0.0	15.5	17.7	17.0	21.5	25.5	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	
(Operating revenue from electricity sales, \$)																				
	Tariff																			
Domestic	\$0.35	18,900	25,200	27,720	30,492	33,541	36,895	37,800	37,800	37,800	37,800	37,800	37,800	37,800	37,800	37,800	37,800	37,800	37,800	1,079,949
Street lights	\$0.35	2,835	2,835	2,835	2,835	2,835	2,835	2,835	2,835	2,835	2,835	2,835	2,835	2,835	2,835	2,835	2,835	2,835	2,835	85,050
Industrial	\$0.30	0	8,100	10,800	11,880	13,068	14,375	15,812	16,200	16,200	16,200	16,200	16,200	16,200	16,200	16,200	16,200	16,200	16,200	446,635
Irrigation	\$0.30	0	1,313	1,750	1,925	2,118	2,329	2,562	2,625	2,625	2,625	2,625	2,625	2,625	2,625	2,625	2,625	2,625	2,625	72,371
Total		21,735	37,448	43,105	47,132	51,562	56,434	59,009	59,460	59,460	59,460	59,460	59,460	59,460	59,460	59,460	59,460	59,460	59,460	1,684,005
Monthly towiff & non household	n																			
(Monthly tariii, 5 per nousehold	l)	262	2 50	2 05	4.24	1 66	5 1 2	5 25	5 25	5 25	5 25	5 25	5 25	5 25	5 25	5 25	5 25	5 25	5 25	
Street lights		2.05	0.20	0.30	4.24	4.00	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	
Inductrial		0.39	1.12	1.50	1.65	1.02	2.00	2 20	2.39	0.59	0.39	2.39	2.25	0.39	2.39	0.39	2.39	2.25	2.35	
Industrial		0.00	1.13	1.50	1.03	1.82	2.00	2.20	2.23	2.23	2.23	2.23	2.23	2.23	2.23	2.23	2.23	2.23	2.23	
Total		2.02	5.20	5.00	6.55	0.29	7.94	0.50	0.50	0.50	0.30	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	
Total		5.02	5.20	5.99	0.55	7.10	/.04	8.20	8.20	8.20	0.20	8.20	0.20	0.20	8.20	0.20	8.20	8.20	0.20	
(Tariff receivable, \$/yr)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
· · · · ·	kg-CO <sub>2</sub> /kWł	1																		
(CER saleable) (to-0	CO <sub>2</sub> ) 1.3	81	145	168	184	201	220	231	233	233	233	233	233	233	233	233	233	233	233	6,576
(\$/yı	r) <u>1/</u> \$7	565	1,014	1,175	1,285	1,406	1,540	1,614	1,628	1,628	1,628	1,628	1,628	1,628	1,628	1,628	1,628	1,628	1,628	46,033
First two concerns of the second		7.0	12.0	16.1	177	10.2	21.1	22.2	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	(22
I and noguined to supply for the	nin)	/.8	15.9	10.1	1/./	19.3	21.1	22.2	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	032
Land required to supply fuel tre	res (III)	9.3	10./	19.4	21.2	25.2	25.4	20.0 122	∠0.8 124	∠0.8 124	20.8 124	20.8	20.8	∠0.8 124	∠0.8 124	20.8	∠0.8 124	∠0.8 124	20.8	
Payment to fuel tree formers (0.2 ha	formor/mer)	4/	04 2.2	27	2 2	2.2	12/	22	154	154	22	154	154	154	134	154	154	2.2	154	
Total payment to fuel tree farmers (5/	narmer/month	1 062	2 2 4 4	2.5	2.5 4 227	2.5	5.076	5 2 2 0	5.5	5.3	5.5	5 266	5 266	5.5	5.5	5.5	5.3	5.5 5.266	5.5	151 759
i otai payment to fuel tree farmo	cis (3/yr)	1,803	3,344	3,874	4,237	4,037	3,076	3,320	3,300	3,300	3,300	3,300	3,300	3,300	3,300	3,300	3,300	3,300	3,300	131,/38
Ratio of tariff collected and bill	led= 100%		Note: <u>1</u> /	Assume	ed at %4/	ton-CO <sub>2</sub> /	yr deduct	ing costs	required	for prepi	ation of I	PDD, app	lication a	nd monit	oring.					

Final Report

Appendix-H Evaluation Sheet for Biomass Pilot Projects
Final
Report

# Appendix-H Evaluation Sheet for Biomass Pilot Projects

### Diesel Operation Unit Power Electricity Nos. of Total Demand Demand Consumption Demand Hour Demand Customers No. liter/month kWh/month hr/month kW kW kWh/month Load Factor 1 BCS 200 600 50 12.00 5 60.00 3,000 6.9% Water supply 60 180 15 12.00 120.00 1,800 2.1% 2 10 Rice-mill 30 3.00 90.00 2,700 4.2% 3 90 30 30 Ice factory 30 30 3.00 3.00 90 4.2% 90 1 4 Workshop 25 75 8.3% 5 60 1.25 1 1.25 75 Café 115 345 1.17 1.17 345 41.1% 6 296 1 Monthly total 460 1,380 481 48 82.50 8,010 13.5% \_ Annual total 5520 16,560 5,772 82.50 96,120 13.5% \_ \_

# Community Electrication Project, Cambodia, soft Ioan @ 3% - 15 yr including 3-yr grace Table A3 Potential Daytime Users and Demand

Source: The potential daytime users above are candidates in Kampong Kor for reference purpose.

# Potential irrigation demand in the dry season

Unit land to irrigate	0.1	ha/hh
Ratio of irrigation hh	50.0%	
Total land area to irrigate	30	ha
Depth of irrigation	500	mm
Total irrigation water	0.150	mcm/yr
Irrigation period	4	month
Daily operation hour	8	hr/day
Total pump discharge	0.043	$m^3/s$
Pumping head	15.0	m
Combined efficiency	0.70	
Total power required	9	kW
Total energy required	9	MWh

# Community Electrication Project, Cambodia, soft loan @ 3% - 15 yr including 3-yr grace Table A4 Cost Estimate

Construction Costs	Unit Price (\$)	Q'ty	Unit	Amount(\$)	Total (\$)	%
Power Station						
Biomass gasification power generating equipment (FOB)	1,300	83	kW	107,250		
Ocean freight & insurance (FOBx8%)	104	83	kW	8,580		
Inland transportation & installation (FOB x (2%+5%))	91	83	kW	7,508		
Switching equipment, main transformer		103	kVA	46,970		
					170,308	4
Civil and substation works						
Road improvement works for dry season use	24	0.10	km	2 400		
to be further improved to all weather road in Phase 2	24	0.10	KIII	2,400		
Land, powerhouse, water tank, etc. (10%FOB)	130	83	kW	10,725		
					13,125	
Fuel tree preparation for 2nd year demand	0	17	1.	105		
Scarined seeds of Leucaena of 0.4-0.5 kg/na and \$15/kg	8	1/	na	125		
Nursery	1	170	m <sup>2</sup>	170		
Watering of nursery for the first 3 months	100	3	month	300		
Bush clearing	40	17	ha	669		
Land preparation	40	17	ha	669		
Transplanting	80	17	ha	1,338		
Maintenance for initital 6 months @ \$60/ha/mon	360	17	ha	6,020		
Ŭ					9,291	
Sub-total of power station and fuel preparation					192,724	4
Miscellaneous of power station (5%, consumables, gas detector.	,					
fire distinguisher, water content meter computer set etc.)				8,500		
Power station sub-total (before tax)					201.224	5
Customs & VAT (CIF x 25%)	351	83	kW	28 958	, .	
Power station sub-total (including tax)				.,	230,182	5
Distribution Facilities						
MV lines	6,000	3.0	km	18,000		
MV-LV lines	10,700		km	0		
LV lines	7,100	9.0	km	63,900		
Pole-mounted distribution transformers	.,			<i>y</i> •		
15 kVA-1P	6 200		set	0		
25 kVA-3P	7 300	3	set	21 900		
50 kVA_3P	8 100	5	set	21,900		
Distribution line transformer sub total (including tox)	8,100		set	0	103 800	1
Misseller source (5% strest lights, sto.)				<b>5 100</b>	105,800	4
Miscentaneous (5%, street rights, etc.)				5,190	100.000	
Distribution line - transformer sub-total (including tax)					108,990	2
Service wire, etc.				30,000		
Domestic cutomers	50	600	hh	30,000		
Daytime customers (to be fixed individually)	0		customers	0		
Distribution line - transformer - service wires, etc. sub-total					138,990	3
(including tax)					· · ·	
Sub-total					360 172	
Contingecy (5%)					18,459	
					· ·	
Construction costs total					387,631	1
Costs for CEC summarts	Unit Drive (f)	0.4	T Tanàn	۸		
Costs for CEC supports	Unit Price (\$)	Qty	Unit	Amount(\$)		
Losis for CEC supports and training	500	0.00	104	19,000		
2.1 Facilitation for CEC setting up and management	500	8.00	MM	4,000		
2.2 Technical supports	500	10.00	MM	5,000		
2.3 Vehicles and lodging	1,000	10.00	month	10,000		
Oneration and maintenance costs						
Demonstration and maintenance costs	Colom ( ture )	Nos. of	104	A	Tatal (0)	
rersonnel costs of UEU staff	salary (\$/mon)	person	MM	Amount(\$)	ı otal (\$)	
Operation Chief	\$80	1	12.00	960		
Operator	\$40	1	12.00	480		
Fuel preparation workers	\$30	2	12.00	720		
Director and accountant	\$40	2	12.00	960		
Personnel costs sub-total					\$3,120	
Maintenance costs of gasifier and engine-generator	CIF (\$)		Ratio of	Amount (\$)	Total (\$)	
Capifor and anging generator seats (CE)	170.200		O&M Costs		( <i>\</i> )	
Gasmer and engine-generator costs (UIF)	1/0,308		5.00/	2 840		
Heat resistant cone of gasifier (replacement at ever 2 000 br	30,769		5.0%	2,840		
operation/every one year 4-6%	113,539		5.0%	5,680		
Replacement of lamp of street lights, office stationery and						
consumables				1,040		
Maintenance costs of powerhouse (% of powerhouse)	10,725		2.0%	210		
Maintenance costs sub-total					9,770	
Operation and maintenance costs sub-total					12,890	
Payment for technical supports (\$/yr for 15 years from 1st year)					1,980	
	Unit fuel cost	Energy			<b>F</b> 1	
Items	(\$/kWh)	generation	unit		Fuel costs (\$)	
Annual fuel costs	0.03	197	MWh/yr		5,902	
					10 504	
peration, maintenance and fuel costs sub-total					18,792	
•						
Maintenance costs of distribution facilities						

	\$	\$	\$	\$	
1. Hard costs	205,601	182,030	387,631	334,449	SCF
1.1 Generating equip. excl. tax	115,830	7,508	123,338	122,587	0.90
1.2 Customs & VAT	0	28,958	28,958	0	LCF
1.3 Road and powerhouse		13,125	13,125	6,563	0.50 <u>1</u> /
1.4 Growing fuel trees	125	9,166	9,291	4,708	
1.5 Swichyard equip.		46,970	46,970	42,273	
1.6 Powerhouse miscellaneous		8,500	8,500	7,650	
1.7 Distribution lines	69,546	34,254	103,800	100,375	
1.8 Service wires, etc.	20,100	9,900	30,000	29,010	
1.9 Distri. Lines miscellaneous		5,190	5,190	4,671	
1.10 Contingency (5%)		18,459	18,459	16,613	
2. CEC facilitation costs	0	19,000	19,000	17,100	
Project Costs Total	205,601	201,030	406,631	351,549	
O&M	8,520	10,772	19,292	13,323	
1. Personnel costs	0	3,120	3,120	2,484	
2. Biomass gasifier generator	8,520	1,250	9,770	9,645	
3. Fuel		5,902	5,902	944	0.16 <u>2</u> /
4. Distribution lines	0	500	500	250	

Community Electrication Project, Cambodia, soft loan @ 3% - 15 yr including 3-yr grace Table A5 Economic Costs

Foreign

Currency

Items

Local

Currency

Financial Economi

c Costs

Costs

Remarks

3. Land acquisition

Note: 1/ Economic conversion factor for seasonal jobless labors

	Foreign	Local	Financial	Economic	
Items	Currency	Currency	Costs	Costs	Remarks
	\$	\$	\$	\$	
1. Hard costs	113,503	162,516	276,019	244,514	
1.1 Diesel generator excl. tax	56,017	7,508	63,525	62,774	770 \$/kW
1.2 Customs & VAT		15,881	15,881		
1.3 Road & land preparation		2,400	2,400	1,200	
1.4 Powerhouse & fuel tank (10%)		6,353	6,353	5,717	
1.5 Swichyard equip.		46,970	46,970	42,273	
1.6 Powerhouse miscellaneous (5%)		6,756	6,756	6,081	
1.7 Distribution lines	57,486	28,314	85,800	82,969	
1.8 Service wires, etc.		30,000	30,000	27,000	
1.9 Distri. Lines miscellaneous		5,190	5,190	4,671	
1.10 Contingency (5%)		13,144	13,144	11,829	
2. CEC facilitation costs	0	19,000	19,000	17,100	
Project Costs Total	113,503	181,516	295,019	261,614	
O&M	3,860	48,715	52,575	47,504	
1. Personnel costs	0	2,400	2,400	2,160	
2. Diesel generator	3,860	566	4,426	4,370	5%
3. Fuel	0	45,249	45,249	40,724	0.23 \$/kWh
4. Distribution lines	0	500	500	250	
Adjsutment for Kampong Kor diesel pov	ver station				
1. Road powerhouse	24	0.10	km	2,400	
2. Embankment of station yard	0	1,400	m <sup>2</sup>	0	

0 1,400

m<sup>2</sup>

0

**Table A6 Economic Benefits** 

### Community Electrication Project, Cambodia, soft loan @ 3% - 15 vr including 3-vr grace Table A7 U

Items	with tax (\$)	with tax exemption and subsidy (\$)
1. Capital Costs	453,601	318,482
2. CEC facilitation costs	19,000	19,000
3. Total construction costs excluding design, tes	sting, etc.	337,482
Interest rate	3.0%	
Repayment period	10 yr	
CRF (3.0%, 10 yr) =	0.1172	
4. Annual costs excluding design, etc.	53,176	39,563
5. O&M costs in 10th year	20,844	20,844
5.1 O&M	12,890	12,890
5.2 Fuel costs	5,902	5,902
5.3 EAC license fee	72	72
5.4 Yearly monitoring fee by DIME	1,980	1,980
6. Annual total costs	74,019	60,407
7. Annual energy sales from 7th year (MWh)	178.9	178.9
8. Unit cost of electricity from 7th year (\$/kWh	) 0.414	0.338
9. NPV of energy sold	MWh	3,219
10. NPV of finacial costs excluding tax	\$	899,127
11. Average cost of electricity	\$/kWh	0.279

### Items \$ Riel Unit cost of electricity from 7th year (\$/kWh) 0.279 1,117 Rate of reserve for operational risks (12%) 0.034 134 Average tariff (\$/kWh) \$0.313 1,252 Tariff adopted for nighttime demand \$0.350 1,400 Tariff adopted for street lights \$0.350 1,400 Tariff adopted for industrial demand \$0.300 1,200 Tariff adopted for irrigation demand \$0.300 1.200 \$4,955 Monthly revenue (US\$/mon) from nighttime users \$3,150 for street lights \$236 from industrial users \$1,350 \$219 from irrigation pump users Average monthly tariff @ 15 kWh per HH (\$) \$5.25 21,000 Tariff for street lights \$0.39 1,600 Total @ 15 kWh/hh including street lights \$5.64 22,600 Average monthly tariff @ 10 kWh per HH (\$) \$3.89 15,600 including street lights Tariff of poor household (\$/mon/hh) (a) 40 W x 4h x 30 days = 4.8 kWh/month + \$2.07 8.300 street lights Tariff of poorest household (US\$/mon/hh) \$0.69 2,800 (a) 7 W x 4h x 30 days = 0.84 kWh/mon + street Monthly Costs ATP for monthly tariff \$ Riel Diesel oil lamp (100%) \$1.46 5,844 Battery lighting (70%, incl. Riel 4,000 per \$3.12 12,470 month for battery purchase) Total \$4.58 18,314

Table A8 Tariff Setting

Appendix-H Evaluation Sheet for Biomass Pilot Projects

# Community Electrication Project, Cambodia, soft Ioan @ 3% - 15 yr including 3-Table 1 Adopted Conditions for Economic and Finacial Analyses

- 1. Energy sold See attached Table A2
- 2. Tariff See attached Table A7
- 3. Long-term borrowing from GOC
  - 3% per year
  - 25 years repayment period including 5 years' grace
- 4. Short-term borrowing from commercial bank
  - 10% per year
  - revolving every year

### 5. Depreciation

- Ratio of depreciation	90%
- Ratio of residual value	10%

Generating equipment

- 5 years' grace and 5 years' depreciation for the first 10 years
- 10 years' depreciation from 11th year onward

Distribution lines, service wires, etc.

- 5 years' grace and 20 years' depreciation
- 6. Interest earning
  - Interest of saving deposit at 10% per year

		Co	mmunit	y Electr	ication	Project,	Cambo	dia, sof	t loan @	) 3% - 1	5 yr inc	luding 3	-yr grac	e							Fina
	0	1	2	3	4	5	6 C	<b>папсіа</b> 7		9	10	11	12	19	20	21	22	29	30	(unit: \$) Total	l Repo
(Expenditure)		1	2	5		5	0	,	0	,	10	11	12	17	20	21	22	27	50	1011	ort
Initital costs																					
Construction costs excluding tax	358,673											123,338				123,338				605,349	
Supports to CEC	14,250	4,750																			
Operation and maintenance costs		11,066	15,413	16,967	18,033	19,205	20,494	21,211	21,344	21,344	21,344	21,344	21,344	21,344	21,344	21,344	21,344	21,344	21,344	613,290	
Personnel costs		3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	93,600	
O&M of biomass gasification power plant		3,392	6,090	7,054	7,715	8,443	9,243	9,688	9,770	9,770	9,770	9,770	9,770	9,770	9,770	9,770	9,770	9,770	9,770	276,334	
Maintenance of distribution lines, etc.		500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	15,000	
Biomass fuel cost		2,049	3,679	4,261	4,661	5,100	5,583	5,852	5,902	5,902	5,902	5,902	5,902	5,902	5,902	5,902	5,902	5,902	5,902	166,932	
EAC license fee @ Riel 1.6/kWh		25	45	52	56	62	68	71	72	72	72	72	72	72	72	72	72	72	72	2,023	
Payment for technical supports		1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	59,400	
Total expenditure	372,923	15,816	15,413	16,967	18,033	19,205	20,494	21,211	21,344	21,344	21,344	144,682	21,344	21,344	21,344	144,682	21,344	21,344	21,344	1,237,639	
(Revenue)																					Ap
Operating revenue through electricity sales		21,735	37,448	43,105	47,132	51,562	56,434	59,009	59,460	59,460	59,460	59,460	59,460	59,460	59,460	59,460	59,460	59,460	59,460	1,684,005	pe
Sales of CER		565	1,014	1,175	1,285	1,406	1,540	1,614	1,628	1,628	1,628	1,628	1,628	1,628	1,628	1,628	1,628	1,628	1,628	46,033	nd
Residual value of equipment											12,334				12,334				38,763		iх-Н
Total revenue		22,300	38,462	44,280	48,417	52,968	57,974	60,623	61,088	61,088	73,421	61,088	61,088	61,088	73,421	61,088	61,088	61,088	99,851	1,793,469	Evalu
(Net operating income)	-372,923	6,484	23,049	27,313	30,385	33,764	37,480	39,412	39,744	39,744	52,078	-83,594	39,744	39,744	52,078	-83,594	39,744	39,744	78,507	555,830	ation S
FIRR	6.4%																				heet fo
																					r Bic
																					oma
																					ss P
																					'ilot
																					Pr
																					ojec
																					S

		Co	mmunit	y Electr	ication	Project, <b>Tabl</b>	, Cambo le 2 Fi	dia, sof <b>nanci</b> a	t loan @ al Anal	) 3% - 1 I <b>ysis</b>	5 yr inc	luding 3	-yr grac	ce						
Including taxes, excluding CER sales	0	1	2	3	4	5	6	7	8	9	10	11	12	19	20	21	22	29	30	(unit: \$) Total
(Expenditure)		1	2			5	0	,	0	,	10		12	15	20	21		27	50	Totur
Initital costs																				
Construction costs	387,631											123,338				123,338				634,307
Supports to CEC	14,250	4,750																		
Operation and maintenance costs		11,066	15,413	16,967	18,033	19,205	20,494	21,211	21,344	21,344	21,344	21,344	21,344	21,344	21,344	21,344	21,344	21,344	21,344	613,290
Personnel costs		3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	93,600
O&M of biomass gasification power plant		3,392	6,090	7,054	7,715	8,443	9,243	9,688	9,770	9,770	9,770	9,770	9,770	9,770	9,770	9,770	9,770	9,770	9,770	276,334
Maintenance of distribution lines, etc.		500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	15,000
Biomass fuel cost		2,049	3,679	4,261	4,661	5,100	5,583	5,852	5,902	5,902	5,902	5,902	5,902	5,902	5,902	5,902	5,902	5,902	5,902	166,932
EAC license fee @ Riel 1.6/kWh		25	45	52	56	62	68	71	72	72	72	72	72	72	72	72	72	72	72	2,023
Payment for technical supports		1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	59,400
Total expenditure	401,881	15,816	15,413	16,967	18,033	19,205	20,494	21,211	21,344	21,344	21,344	144,682	21,344	21,344	21,344	144,682	21,344	21,344	21,344	1,266,597
(Revenue)																				
Operating revenue through electricity sales Sales of CER		21,735	37,448	43,105	47,132	51,562	56,434	59,009	59,460	59,460	59,460	59,460	59,460	59,460	59,460	59,460	59,460	59,460	59,460	1,684,005 0
Residual value of equipment											12,334				12,334				38,763	
Total revenue		21,735	37,448	43,105	47,132	51,562	56,434	59,009	59,460	59,460	71,794	59,460	59,460	59,460	71,794	59,460	59,460	59,460	98,223	1,747,436
(Net operating income)	-401,881	5,919	22,035	26,138	29,099	32,357	35,941	37,798	38,116	38,116	50,450	-85,222	38,116	38,116	50,450	-85,222	38,116	38,116	76,880	480,839
FIRR	5.4%																			

		Co	mmunit	y Electr	rication	Project,	Cambo	dia, sof	t loan @	) 3% - 1	5 yr inc	luding 3	-yr grac	e						
Evaluding taxes and subsidy from costs	and inch	udina (	TED col	06		I abl	e 2 Fi	nancia	I Anal	ysis										(unit: \$)
Excluding taxes and subsidy from costs,	0	uunng C	2 LIN SAL	3	4	5	6	7	8	9	10	11	12	19	20	21	22	29	30	(unit. 5) Total
(Expenditure)																				
Initital costs																				
Construction costs	252,512											123,338				123,338				499,188
Supports to CEC	14,250	4,750																		
Operation and maintenance costs		11,066	15,413	16,967	18,033	19,205	20,494	21,211	21,344	21,344	21,344	21,344	21,344	21,344	21,344	21,344	21,344	21,344	21,344	613,290
Personnel costs		3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	93,600
O&M of biomass gasification power plant		3,392	6,090	7,054	7,715	8,443	9,243	9,688	9,770	9,770	9,770	9,770	9,770	9,770	9,770	9,770	9,770	9,770	9,770	276,334
Maintenance of distribution lines, etc.		500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	15,000
Biomass fuel cost		2,049	3,679	4,261	4,661	5,100	5,583	5,852	5,902	5,902	5,902	5,902	5,902	5,902	5,902	5,902	5,902	5,902	5,902	166,932
EAC license fee @ Riel 1.6/kWh		25	45	52	56	62	68	71	72	72	72	72	72	72	72	72	72	72	72	2,023
Payment for technical supports		1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	59,400
Total expenditure	266,762	15,816	15,413	16,967	18,033	19,205	20,494	21,211	21,344	21,344	21,344	144,682	21,344	21,344	21,344	144,682	21,344	21,344	21,344	1,131,478
(Revenue)																				
Operating revenue through electricity sales		21,735	37,448	43,105	47,132	51,562	56,434	59,009	59,460	59,460	59,460	59,460	59,460	59,460	59,460	59,460	59,460	59,460	59,460	1,684,005
Sales of CER		565	1,014	1,175	1,285	1,406	1,540	1,614	1,628	1,628	1,628	1,628	1,628	1,628	1,628	1,628	1,628	1,628	1,628	46,033
Residual value of equipment											12,334				12,334				38,763	
Total revenue		22,300	38,462	44,280	48,417	52,968	57,974	60,623	61,088	61,088	73,421	61,088	61,088	61,088	73,421	61,088	61,088	61,088	99,851	1,793,469
(Net operating income)	-266,762	6,484	23,049	27,313	30,385	33,764	37,480	39,412	39,744	39,744	52,078	-83,594	39,744	39,744	52,078	-83,594	39,744	39,744	78,507	661,991
FIRR	9.7%																			

		Co	ommuni	ty Elect	rication	Project	, Cambo	odia, sot	ft loan (d	1) 3% - 1	5 yr inc	luding 3	-yr grac	e						
Table 3 Economic Evaluation																				
	0	1	2	2	4	5	6	7	0	0	10	11	12	10	20	21	22	20	20	(unit: \$) Total
(Economic costs) Initital costs Economic costs Supports to CEC	334,449 12,825	4,275	2	5	4	5	0	1	0		10	122,587	12	19	20	122,587		29	30	579,624
<b>Operation and maintenance costs</b> Personenel costs O&M of biomass gasification power plant Maintenance of distribution lines, etc. Biomass fuel cost	0	6,735 2,808 3,349 250 328	9,658 2,808 6,012 250 589	10,704 2,808 6,964 250 682	11,420 2,808 7,617 250 746	12,209 2,808 8,335 250 816	13,076 2,808 9,124 250 893	13,558 2,808 9,564 250 936	13,647 2,808 9,645 250 944	84,240 272,799 7,500 26,709										
EAC license fee @ Riel 1.6/kWh Monitoring of CEC by DIME		22 0	$\begin{array}{c} 40\\0\end{array}$	46 0	51 0	56 0	61 0	64 0	1,821 0											
Residual value											-12,259				-12,259				-33,445	-57,962
Total expenditure	347,274	11,032	9,698	10,750	11,471	12,264	13,137	13,622	13,712	13,712	1,453	136,299	13,712	13,712	1,453	136,299	13,712	13,712	-19,733	931,831
(Economic benefits as costs of alternative dies Initital costs Economic costs Supports to CEC	el mini-gric 244,514 12,825	<b>I)</b> 4,275										62,774				62,774				370,063
<b>Operation and maintenance costs</b> Personenel costs O&M of diesel power plant Maintenance of distribution lines, etc. Fuel cost	0	18,067 2,160 1,517 250 14,140	30,516 2,160 2,724 250 25,383	34,969 2,160 3,155 250 29,404	38,020 2,160 3,451 250 32,160	41,377 2,160 3,776 250 35,191	45,070 2,160 4,134 250 38,526	47,125 2,160 4,333 250 40,382	47,504 2,160 4,370 250 40,724	64,800 123,590 7,500 1,151,841										
EAC license fee Payment for technical supports		22 1,782	40 1,782	46 1,782	51 1,782	56 1,782	61 1,782	64 1,782	1,821 53,460											
Residual value											-6,277				-6,277				-24,451	-37,006
Benefits from CER sales		565	1,014	1,175	1,285	1,406	1,540	1,614	1,628	1,628	1,628	1,628	1,628	1,628	1,628	1,628	1,628	1,628	1,628	46,033
Total benefits	257,339	24,712	33,353	37,972	41,138	44,621	48,452	50,585	50,978	50,978	44,700	113,752	50,978	50,978	44,700	113,752	50,978	50,978	26,526	1,799,202
(Net benefits)	-89,935	13,680	23,655	27,222	29,667	32,357	35,316	36,963	37,266	37,266	43,247	-22,547	37,266	37,266	43,247	-22,547	37,266	37,266	46,259	867,371
EIRR	28.8%																			

# Community Electrication Project, Cambodia, soft Ioan @ 3% - 15 yr including 3-yr grace **Table 4 Financing Plan**

				(unit: \$)
Financial Resources			Financial Application	
Equity - CEC			Power Plant before tax	248,194
Cash (@ \$50/hh)	30,000	7.1%	Biomass gasification power equipment	170,308
In kind ( @ \$40/MM)	33,696	7.9%	Road improvement works	2,400
842 MM			Powerhouse, etc.	10,725
Grant			Switching equip. & transformer	46,970
REF	106,161	25.0%	Growing fuel trees	9,291
(25% of capital costs)			Misecellaneous equipment	8,500
Borrowing for capitals			Distribution facilities, service wires, etc.	138,990
Long-term	254,786	60.0%		
(15 yr including 3-year grace, 3%/yr)			Contingecy	18,459
			Capital costs before tax	405,643
Total fund for capital costs and CEC supports	424,643	100.0%	CEC support	19,000
Borrowing for operation	4,000		Operation fund in hand	4,000
Short-term (Revolving, 15%/yr)			•	
Tax exemption	28,958		Customs and tax	28,958
Total Financial Resources	457,601		<b>Total Financial Resources</b>	457,601

		Table 5	Profi	t and ]	Loss S	tatem	ent wi	th Ca	sh Flo	w, 25-	yr rep	aymer	ıt peri	iod witl	h 5-yr g	grace				
		0 1	2	3	4	5	6	7	8	9	10	11	12	20	21	22	24	25	26	30
Operating revenue incl. CER & res	idual value	21,735	37,448	43,105	47,132	51,562	56,434	59,009	59,460	59,460	59,460	59,460	59,460	59,460	59,460	59,460	59,460	59,460	59,460	59,460
Operating costs		11,060	5 15,413	16,967	18,033	19,205	20,494	21,211	21,344	21,344	21,344	21,344	21,344	21,344	21,344	21,344	21,344	21,344	21,344	21,344
Gross profit		10,669	22,035	26,138	29,099	32,357	35,941	37,798	38,116	38,116	38,116	38,116	38,116	38,116	38,116	38,116	38,116	38,116	38,116	38,116
Interests payment																				
Short-term commercial loan (15%/yr)		600	) 600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
Long-term soft loan	3.0%	7,644	7,644	7,644	7,644	7,644	7,261	6,879	6,497	6,115	5,733	5,351	4,968	1,911	1,529	1,147	382	-0		
Deprecitation																				
Generating equipment (5 yr - 10 yr - 10 yr)	153,277						30,655	30,655	30,655	30,655	30,655	15,328	15,328	15,328	15,328	15,328	15,328	15,328	15,328	15,328
Others (20 yr from 6th year)	228,902						11,445	11,445	11,445	11,445	11,445	11,445	11,445	11,445	11,445	11,445	11,445	11,445		
Operating profit before depreciatio	n	2,42	5 13,791	17,894	20,856	24,114	28,079	30,319	31,019	31,402	31,784	32,166	32,548	35,606	35,988	36,370	37,134	37,516	37,516	37,516
Interests received (10%)		(	) 0	1,780	3,864	6,465	8,390	10,917	13,928	17,311	21,071	26,479	31,232	92,776	105,737	118,798	149,088	166,599	187,173	292,207
Residual value upon completion of depreciation	10%										12,334			12,334						38,763
CER received		56	5 1,014	1,175	1,285	1,406	1,540	1,614	1,628	1,628	1,628	1,628	1,628	1,628	1,628	1,628	1,628	1,628	1,628	1,628
Net profit after depreciation		2,990	14,806	20,849	26,006	31,985	-4,092	749	4,474	8,240	24,716	33,500	38,635	115,570	116,579	130,023	161,077	178,970	210,990	354,787
Cash in hand		2,990	14,806	20,849	26,006	31,985	38,009	42,849	46,574	50,340	66,816	60,272	65,408	142,343	143,352	156,796	187,850	205,743	226,317	370,114
Accumulated cash in hand after principal repayment		0 2,990	) 17,796	38,645	64,650	83,896	109,165	139,275	173,110	210,711	264,788	312,321	364,990	1,057,368	1,187,980	1,332,037	1,665,991	1,871,734	2,098,052	3,292,188
Principal repayment	254,786	0 0	) 0	0	0	12,739	12,739	12,739	12,739	12,739	12,739	12,739	12,739	12,739	12,739	12,739	12,739			

254,786 254,786 254,786 254,786 254,786 254,786 254,786 242,047 229,307 216,568 203,829 191,089 178,350 165,611 152,871

Community Electrication Project, Cambodia, soft loan @ 3% - 15 yr including 3-yr grace

Long-term debt balance

(unit: \$)

Total

1,684,005

18,000

110,832

228,902

63,431

46,033

254,786

21,344 613,290

38,116 1,070,715

15,328 459,832

37,516 941,883

292,207 2,495,627

354,787 2,858,241

370,114 3,546,974

600

50,957

38,218

25,479

-0

				Co	mmunity	y Electric	cation Pr	roject, C	ambodia	a, soft lo	an @ 3%	⁄₀ - 15 yr	includir	ng 3-yr g	race							
		Tab	ole 5 P	rofit ۵	and Lo	oss Sta	temen	t with	Cash	Flow,	, 15-yı	r repay	yment	perio	d with	3-yr	grace					( ): <b>(</b> )
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	20	21	22	30	(unit: \$) Total
Operating revenue incl. CER & res	idual va	lue	21,735	37,448	43,105	47,132	51,562	56,434	59,009	59,460	59,460	59,460	59,460	59,460	59,460	59,460	59,460	59,460	59,460	59,460	59,460	1,684,005
Operating costs			11,066	15,413	16,967	18,033	19,205	20,494	21,211	21,344	21,344	21,344	21,344	21,344	21,344	21,344	21,344	21,344	21,344	21,344	21,344	613,290
new land required for tree plantation	1				2.6	1.8	2.0	2.2	1.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.1
tree plantation costs for increasing d	lemand			1,472	1,009	1,110	1,221	680	125	0	0	0	0	0	0	0	0	0	0	0	5,615	11,231
Gross profit			10,669	20,563	25,126	27,988	31,135	35,259	37,672	38,116	38,116	38,116	38,116	38,116	38,116	38,116	38,116	38,116	38,116	38,116	32,501	1,059,474
Interests payment																						
Short-term commercial loan (15%/yr)			600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	18,000
Long-term soft loan	3.0%		7,644	7,644	7,644	7,007	6,370	5,733	5,096	4,459	3,822	3,185	2,548	1,911	1,274	637						64,970
Deprecitation																						
Generating equipment (5 yr - 10 yr - 10 yr)	153,277							30,655	30,655	30,655	30,655	30,655	15,328	15,328	15,328	15,328	15,328	15,328	15,328	15,328	15,328	459,832
Others (20 yr from 6th year)	228,902							11,445	11,445	11,445	11,445	11,445	11,445	11,445	11,445	11,445	11,445	11,445	11,445	11,445		228,902
Operating profit before depreciatio	n		2,425	12,319	16,883	20,381	24,165	28,926	31,976	33,057	33,695	34,332	34,969	35,606	36,243	36,879	37,516	37,516	37,516	37,516	31,901	976,504
Interests received (10%)			0	0	1.632	1.478	1.669	2.270	3.421	4,999	6.844	8.937	12.537	15.327	18.460	21.970	25.894	65.600	77.308	88,953	235.444	1.830.998
Residual value upon completion of	10%				,	,	,	,	- ,	,	.,.	12 334	,	- ,	.,	,	.,	12 334		,	38 763	63 / 31
depreciation	1070		565	1.014	1 175	1 295	1 406	1.540	1 6 1 4	1 629	1 6 2 9	1 6 2 9	1 629	1 629	1 629	1 629	1 629	1 6 2 9	1.629	1 629	1 4 2 9	46 022
CERTeterved			505	1,014	1,175	1,285	1,400	1,540	1,014	1,028	1,028	1,028	1,028	1,028	1,028	1,028	1,028	1,028	1,028	1,028	1,028	40,035
Net profit after depreciation			2,990	13,334	19,690	23,145	27,241	-9,364	-5,090	-2,417	65	15,130	22,360	25,787	29,557	33,704	38,265	90,305	89,679	101,325	292,408	2,228,232
Cash in hand			2,990	13,334	19,690	23,145	27,241	32,736	37,011	39,684	42,166	57,230	49,133	52,560	56,330	60,477	65,038	117,078	116,452	128,097	307,736	2,916,965
Accumulated cash in hand after principal repayment		0	2,990	16,324	14,782	16,695	22,703	34,208	49,986	68,438	89,371	125,369	153,270	184,598	219,696	258,941	323,979	773,083	889,535	1,017,632	2,662,180	
r · r ·····																						
Principal repayment	254,786	0	0	0	21,232	21,232	21,232	21,232	21,232	21,232	21,232	21,232	21,232	21,232	21,232	21,232						254,786
Long-term debt balance	254,786	254,786	254,786	254,786	233,554	212,322	191,089	169,857	148,625	127,393	106,161	84,929	63,696	42,464	21,232	0						

Community Electrication Project, Kampong Kor, Phase 1+2, soft loan @ 3% - 15 yr including 3-yr grace

### **Table A1 Principal Features of Electrification Plan**

## (1) Generating Equipment Planning

Items	Unit	Q'ty	Remarks
Nos. of households	h.h.	4,882	80% of the total 6,1027 households
Unit nighttime domestic demand	W/hh	100	
Nighttime domestic demand	kW	488.2	
Street light demand	kW	22.0	1 light per 40 m of LV lin 1100 street lights
Reserve capacity	kW	146.5	30% of nighttime domestic demand, allocated for station use + reserved power + distribution losses
Required capacity	kW	656.7	
Adopted capacity	kW	640.0	

### (2) Energy Generation Planning for 8th Year Onward

Items	Monthly Unit Energy Sold	Monthly Energy Sold	Annual Energy Sold	Station Use, Losses, etc. (10%)	Annual Energy Generated	Annual Plant Factor	Annual Operation Hours	Remarks (refer to Table A2 for demand growth rates)
	kWh/hh	MWh	MWh	MWh	MWh	%	hr	
Nighttime domestic demand 1/, 2/	15.0	73.2	878.8	87.9	966.6	17.2%	1,510	100% from 8th year onward
Street light demand	0.7	3.3	39.6	4.0	43.6	0.8%	68	100% from the 1st year
Industrial demand <u>3</u> /	7.5	36.6	439.4	43.9	483.3	8.6%	755	100% from 8th year onward
Irrigation pump demand 4/	1.2	17.8	71.2	7.1	78.3	1.4%	122	in 4 dry months, 100% from 8th year onward
Total energy	24.4	130.9	1,428.9	142.9	1,571.8	28.0%	2,456	100% from 8th year onward

### Note:

1/ Typical consumption level of existing mini-grids in rural villages as of 2005 was 10 kWh (= 100W / 1,000 \* 5hrs \* 30 days \* 67%) and assumed to be realized from 2nd year.

2/ Average consumption of existing REE mini-grids supplying to rural towns as of 2005 was 15 kWh (= 100 W / 1,000 \* 7.5hrs \* 30days \* 67%) and was assumed to be realized in 7th year.

 $\underline{3}$ / Power demand of BCS, rice-mills, water supply stations, ice factory, workshop of boat engines, etc. Assumed to be 50% of the nighttime demand based on the actual demand of existing Anlong Ta Mey mini-grid (700 kWh at nighttime, 300 kWh for BCS at daytime) and potential daytime users in the villages shown in Table A3.

 $\underline{4}$ / see Table A3 for irrigation power demand.

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Community Electrication Project, Kampong Kor, Phase 1+2, soft loan (a) 3% - 15 yr including 3-yr grace Table A2 Energy and CER Sold																				
Table A2   Energy and CER Sold																				
		1	2	3	4	5	6	7	8	9	10	11	12	19	20	21	22	29	30	Total
(Annual energy sold)	-	-		-					÷									-/		
Demand growth	Growth rate																			
Domestic	1.10	50%	67%	73%	81%	89%	98%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Street lights	0.00	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Industrial	1.10	0%	50%	67%	73%	81%	89%	98%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Irrigation	1.10	0%	50%	67%	73%	81%	89%	98%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Energy sold (MWh/yr)	Demand																			
Domestic	878.8	439.4	585.8	644.4	708.9	779.8	857.7	878.8	878.8	878.8	878.8	878.8	878.8	878.8	878.8	878.8	878.8	878.8	878.8	25,106
Street lights	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	1,188
Industrial	439.4	0.0	219.7	292.9	322.2	354.4	389.9	428.9	439.4	439.4	439.4	439.4	439.4	439.4	439.4	439.4	439.4	439.4	439.4	12,114
Irrigation	71.2	0.0	35.6	47.5	52.2	57.4	63.2	69.5	71.2	71.2	71.2	71.2	71.2	71.2	71.2	71.2	71.2	71.2	71.2	1,963
Total	1,428.9	479.0	880.7	1,024.4	1,122.9	1,231.2	1,350.4	1,416.7	1,428.9	1,428.9	1,428.9	1,428.9	1,428.9	1,428.9	1,428.9	1,428.9	1,428.9	1,428.9	1,428.9	40,371
Unit energy sold (kWh per househ	nold per mor	nth)																		
Domestic	15.0	7.5	10.0	11.0	12.1	13.3	14.6	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	
Street lights	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	
Industrial	7.5	0.0	3.8	5.0	5.5	6.1	6.7	7.3	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	
Irrigation	1.2	0.0	0.6	0.8	0.9	1.0	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	
Total	24.4	8.2	15.0	17.5	19.2	21.0	23.1	24.2	24.4	24.4	24.4	24.4	24.4	24.4	24.4	24.4	24.4	24.4	24.4	
(Operating revenue from electricity	sales, \$)																			
	Tariff																			
Domestic	\$0.31	136,208	181,610	199,771	219,749	241,723	265,896	272,416	272,416	272,416	272,416	272,416	272,416	272,416	272,416	272,416	272,416	272,416	272,416	7,782,932
Street lights	\$0.31	12,276	12,276	12,276	12,276	12,276	12,276	12,276	12,276	12,276	12,276	12,276	12,276	12,276	12,276	12,276	12,276	12,276	12,276	368,280
Industrial	\$0.27	0	59,316	79,088	86,997	95,697	105,267	115,793	118,633	118,633	118,633	118,633	118,633	118,633	118,633	118,633	118,633	118,633	118,633	3,270,709
Irrigation	\$0.27	0	9,611	12,815	14,097	15,506	17,057	18,763	19,223	19,223	19,223	19,223	19,223	19,223	19,223	19,223	19,223	19,223	19,223	529,976
Total		148,484	262,814	303,951	333,119	365,203	400,496	419,248	422,547	422,547	422,547	422,547	422,547	422,547	422,547	422,547	422,547	422,547	422,547	11,951,896
(Monthly tariff, \$ per household)																				
Domestic		2.33	3.10	3.41	3.75	4.13	4.54	4.65	4.65	4.65	4.65	4.65	4.65	4.65	4.65	4.65	4.65	4.65	4.65	
Street lights		0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	
Industrial		0.00	1.01	1.35	1.49	1.63	1.80	1.98	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03	
Irrigation		0.00	0.16	0.22	0.24	0.26	0.29	0.32	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	
Total		2.53	4.49	5.19	5.69	6.23	6.84	7.16	7.21	7.21	7.21	7.21	7.21	7.21	7.21	7.21	7.21	7.21	7.21	
(Tariff receivable, \$/yr)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(	kg-CO <sub>2</sub> /kWh																			
(CER saleable) (to-CO <sub>2</sub> )	) 13	623	1 145	1 332	1 460	1 601	1 755	1 842	1 858	1 858	1 858	1 858	1 858	1 858	1 858	1 858	1 858	1 858	1 858	52,482
(CELIC Surcusic) (CC CC2, (\$/yr) 1/	\$7	4 359	8 015	9 322	10 218	11 204	12 288	12 892	13,003	13,003	13,003	13,003	13,003	13 003	13 003	13,003	13,003	13,003	13 003	367 375
(\$, 91) <u>1</u>	φ,	1,557	0,015	,522	10,210	11,201	12,200	12,072	15,005	15,005	15,005	15,005	15,005	15,005	15,005	15,005	15,005	15,005	15,005	501,515
Fuel tree consumed (ton per month)	)	59.9	110.1	128.1	140.4	153.9	168.8	177.1	178.6	178.6	178.6	178.6	178.6	178.6	178.6	178.6	178.6	178.6	178.6	5 046
Land required to supply fuel trees (	ha)	71.8	132.1	153.7	168.4	184.7	202.6	212.5	214.3	214.3	214.3	214.3	214.3	214.3	214.3	214.3	214.3	214.3	214.3	-,
Nos. of fuel tree farmers (0.2 ha ner	farmer)	359	661	768	842	923	1.013	1.063	1.072	1.072	1.072	1.072	1.072	1.072	1.072	1.072	1.072	1.072	1.072	
Payment to fuel tree farmers (\$/far	mer/month	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	
Total payment to fuel tree farmers (	(\$/vr)	14,369	26,422	30,732	33,687	36,937	40,511	42,501	42,868	42,868	42,868	42,868	42,868	42,868	42,868	42,868	42,868	42,868	42,868	1,211,125
		,- ,-	-,	,	,	,		,	,	,	,	,	,	,	,	,	,	,	,	, , -

Note: 1/ Assumed at %4/ton-CO2/yr deducting costs required for prepration of PDD, application and monitoring.

June 2006

Vor Dhage 1+2 and lean @ 20/ 15 yr including 2 

Ratio of tariff collected and billed= 100%

No.	Demand	Diesel Consumption	Electricity Demand	Operation Hour	Unit Power Demand	Nos. of Customers		Total Demai	nd
		liter/month	kWh/month	hr/month	kW		kW	kWh/month	Load Factor
1	BCS	200	600	50	12.00	5	60.00	3,000	6.9%
2	Water supply	60	180	15	12.00	10	120.00	1,800	2.1%
3	Rice-mill	30	90	30	3.00	30	90.00	2,700	4.2%
4	Ice factory	30	90	30	3.00	1	3.00	90	4.2%
5	Workshop	25	75	60	1.25	1	1.25	75	8.3%
6	Café	115	345	296	1.17	1	1.17	345	41.1%
Ν	Aonthly total	460	1,380	481	-	48	640.00	8,010	1.7%
1	Annual total	5520	16,560	5,772	-	-	640.00	96,120	1.7%

# Community Electrication Project, Kampong Kor, Phase 1+2, soft loan @ 3% - 15 yr including 3-yr grace Table A3 Potential Daytime Users and Demand

Source: The potential daytime users above are candidates in Kampong Kor for reference purpose.

# Potential irrigation demand in the dry season

0.1	ha/hh
50.0%	
244.1	ha
500	mm
1.221	mcm/yı
4	month
8	hr/day
0.353	$m^3/s$
15.0	m
0.70	
74	kW
71	MWh
	$\begin{array}{c} 0.1\\ 50.0\%\\ 244.1\\ 500\\ 1.221\\ 4\\ 8\\ 0.353\\ 15.0\\ 0.70\\ 74\\ 71\end{array}$

### Community Electrication Project, Kampong Kor, Phase 1+2, soft loan @ 3% - 15 yr including 3-yr grace Table A4 Cost Estimate

		Qty	Oint	Tunount(\$)	10tul (\$)	/02
Power Station	1 200	640	1 33 7	022 000		
Biomass gasification power generating equipment (FOB)	1,300	640	kW	832,000		
Ocean freight & insurance (FOBx8%)	104	640	kW	66,560		
Inland transportation & installation (FOB x (2%+5%))	91	640	kW	58,240		
Switching equipment, main transformer		800	kVA	265,700		
Civil and substation marks					1,222,500	41
Road improvement works for dry season use						
to be further improved to all weather road in Phase 2	48	2.50	km	120,000		
Land, powerhouse, water tank, etc. (10%FOB)	130	640	kW	83,200		
· · · · · · · · · · · · · · · · · · ·				,	203,200	
Fuel tree preparation for 2nd year demand					,	
Scarified seeds of Leucaena of 0.4-0.5 kg/ha and \$15/kg	8	132	ha	991		
Nurserv	1	1 320	m <sup>2</sup>	1 320		
Watering of nursery for the first 3 months	500	3	month	1 500		
Bush clearing	80	132	ha	10 569		
L and preparation	80	132	ha	10,569		
Transplanting	80	132	ha	10,569		
Maintenance for initial 6 months @ \$60/ha/mon	360	132	ha	47 559		
	000			,	83.077	
Sub-total of power station and fuel preparation					1,508,777	51
Miscellaneous of power station (5%, consumables, gas detector	r,			(1.100	-,,-	
fire distinguisher, water content meter, computer set, etc.)				61,100		
Power station sub-total (before tax)					1,569,877	53
Customs & VAT (CIF x 25%)	351	640	kW	224,640		
Power station sub-total (including tax)					1,794,517	61
Distribution Facilities						
MV lines	6,000	13.8	km	82,800		
MV-LV lines	10,700	33.0	km	353,100		
LV lines	7,100	11.0	km	78,100		
Pole-mounted distribution transformers						
15 kVA-1P	6,200		set	0		
25 kVA-3P	7,300	22	set	160,600		
50 kVA-3P	8,100	6	set	48,600		
Distribution line - transformer sub-total (including tax)	,			· · · · ·	723,200	24
Miscellaneous (5%, street lights, etc.)				36,160		
Distribution line - transformer sub-total (including tax)					759,360	25
				244 100		8
Service wire, etc.						
Domestic cutomers	50	4 882	hh	244 100		
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually)	50 0	4,882	hh customers	244,100		
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total	50 0	4,882	hh customers	244,100 0		
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax)	50 0	4,882	hh customers	244,100 0	1,003,460	34
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax)	50 0	4,882	hh customers	244,100 0	1,003,460	34
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total	50 0	4,882	hh customers	244,100 0	1,003,460 2,797,977	34
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%)	50 0	4,882	hh customers	244,100 0	1,003,460 2,797,977 139,899	34
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%)	50 0	4,882	hh customers	244,100 0	1,003,460 2,797,977 139,899	34
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%)	50 0	4,882	hh customers	244,100 0	1,003,460 2,797,977 139,899 2,937,876	34 10
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total	50 0	4,882	hh customers	244,100 0	1,003,460 2,797,977 139,899 2,937,876	34 10
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports	50 0 Unit Price (\$)	4,882 Q'ty	hh customers Unit	244,100 0 Amount(\$)	1,003,460 2,797,977 139,899 2,937,876	34 10
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports 2.1 Exciling for CEC wire negative service for the service of the s	50 0 Unit Price (\$)	4,882 Q'ty	hh customers Unit	244,100 0 <u>Amount(\$)</u> 72,000	1,003,460 2,797,977 139,899 2,937,876	34 10
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.0 The distribution	50 0 Unit Price (\$) 500	4,882 Q'ty 36.00	hh customers Unit MM	244,100 0 <u>Amount(\$)</u> 72,000 18,000	1,003,460 2,797,977 139,899 2,937,876	34 10
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports Costs for CEC supports 2.1 Facilitation for CEC setting up and management 2.2 Technical supports	50 0 Unit Price (\$) 500 500	4,882 Q'ty 36.00 36.00	hh customers Unit MM MM	244,100 0 Amount(\$) 72,000 18,000 18,000	1,003,460 2,797,977 139,899 2,937,876	34 10
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging	50 0 Unit Price (\$) 500 500 1,000	4,882 Q'ty 36.00 36.00 36.00	hh customers Unit MM MM month	244,100 0 72,000 18,000 18,000 36,000	1,003,460 2,797,977 139,899 2,937,876	34 100
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs	50 0 Unit Price (\$) 500 500 1,000	4,882 Q'ty 36.00 36.00 36.00	hh customers Unit MM MM month	244,100 0 72,000 18,000 18,000 36,000	1,003,460 2,797,977 139,899 2,937,876	34 100
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports Costs for CEC supports etting up and management 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Deserver a set of CEC strip 7	50 0 Unit Price (\$) 500 500 1,000	4,882 Q'ty 36.00 36.00 36.00 Nos. of	hh customers Unit MM MM month	Amount(\$) 72,000 18,000 36,000	1,003,460 2,797,977 139,899 2,937,876	34 10
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff	50 0 Unit Price (\$) 500 500 1,000 Salary (\$/mon)	4,882 Q'ty 36.00 36.00 36.00 Nos. of person	hh customers Unit MM MM month MM	244,100 0 Amount(\$) 72,000 18,000 36,000 Amount(\$)	1,003,460 2,797,977 139,899 2,937,876 Total (\$)	34
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief	50 0 Unit Price (\$) 500 1,000 Salary (\$/mon) \$80	4,882 Q'ty 36.00 36.00 36.00 Nos. of person 2	hh customers Unit MM MM MM MM 12.00	Amount(\$) 72,000 18,000 18,000 36,000 Amount(\$) 1,920	1,003,460 2,797,977 139,899 2,937,876 Total (\$)	34
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports Costs for CEC supports Costs for CEC supports 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operator	50 0 Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40	4,882 Q'ty 36.00 36.00 36.00 Nos. of person 2 8	hh customers Unit MM MM MM 12.00 12.00	Amount(\$) 72,000 18,000 18,000 36,000 Amount(\$) 1,920 3,840	1,003,460 2,797,977 139,899 2,937,876 Total (\$)	34
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports 2.1 Facilitation for CEC setting up and management 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operator Fuel preparation workers	50 0 Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30	4,882 Q'ty 36.00 36.00 36.00 2 8 5	hh customers Unit MM MM month 12.00 12.00 12.00	Amount(\$) 72,000 18,000 36,000 Amount(\$) 1,920 3,840 1,800	1,003,460 2,797,977 139,899 2,937,876 Total (\$)	34
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operator Fuel preparation workers Director and accountant	50 0 Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$30	4,882 Q'ty 36.00 36.00 36.00 2 8 5 6	hh customers Unit MM MM month 12.00 12.00 12.00 12.00	Amount(\$) 72,000 18,000 36,000 Amount(\$) 1,920 3,840 1,800 2,880	1,003,460 2,797,977 139,899 2,937,876 Total (\$)	34
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operator Fuel preparation workers Director and accountant Personnel costs sub-total	50 0 Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40	4,882 Q'ty 36.00 36.00 36.00 36.00 36.00 2 8 5 6	hh customers Unit MM MM MM 12.00 12.00 12.00 12.00 12.00	Amount(\$) 72,000 18,000 18,000 36,000 Amount(\$) 1,920 3,840 1,800 2,880	1,003,460 2,797,977 139,899 2,937,876 Total (\$) \$10,440	34
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports Costs for CEC supports 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operator Fuel preparation workers Director and accountant Personnel costs sub-total Maintenance costs of casifier and engine-generator	50 0 Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 \$30 \$40	4,882 Q'ty 36.00 36.00 36.00 36.00 Nos. of person 2 8 5 6	hh customers Unit MM MM month 12.00 12.00 12.00 12.00 12.00 12.00	Amount(\$) 72,000 18,000 18,000 36,000 Amount(\$) 1,920 3,840 1,800 2,880	1,003,460 2,797,977 139,899 2,937,876 Total (\$) <b>\$10,440</b> Total (\$)	34
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operator Fuel preparation workers Director and accountant Personnel costs of gasifier and engine-generator	50 0 Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 CIF (\$)	4,882 Q'ty 36.00 36.00 36.00 36.00 Nos. of person 2 8 5 6	hh customers Unit MM MM month 12.00 12.00 12.00 12.00 12.00 2.00 Costs	Amount(\$) 72,000 18,000 18,000 36,000 Amount(\$) 1,920 3,840 1,800 2,880 Amount (\$)	1,003,460 2,797,977 139,899 2,937,876 Total (\$) S10,440 Total (\$)	34
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operator Fuel preparation workers Director and accountant Personnel costs ub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF)	50 0 Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 CIF (\$) 1,222,500	4,882 Q'ty 36.00 36.00 36.00 2 8 5 6	hh customers Unit MM MM month 12.00 12.00 12.00 12.00 12.00 12.00 12.00	Amount(\$) 72,000 18,000 18,000 36,000 Amount(\$) 1,920 3,840 1,800 2,880 Amount (\$)	1,003,460 2,797,977 139,899 2,937,876 Total (\$) S10,440 Total (\$)	34
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operation Chief Operator Fuel preparation workers Director and accountant Personnel costs sub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator set	50 0 0 Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 CIF (\$) 1,222,500 407,500	4,882 Q'ty 36.00 36.00 36.00 36.00 2 8 5 6	hh customers Unit MM MM month 12.00 12.00 12.00 12.00 12.00 12.00 8 Ratio of 0&M Costs 5.0%	Amount(\$) 72,000 18,000 18,000 36,000 Amount(\$) 1,920 3,840 1,800 2,880 Amount (\$) 20,380	1,003,460 2,797,977 139,899 2,937,876 Total (\$) S10,440 Total (\$)	34
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operator Fuel preparation workers Director and accountant Personnel costs sub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr comparison of the costs of the cost	50 0 Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 \$30 \$40 \$20 \$1,222,500 407,500 \$15,000	4,882 Q'ty 36.00 36.00 36.00 36.00 36.00 2 8 5 6	hh customers Unit MM MM MM 12.00 12.00 12.00 12.00 12.00 12.00 12.00 12.00 5.0%	Amount(\$) 72,000 18,000 18,000 36,000 Amount(\$) 1,920 3,840 1,800 2,880 Amount (\$) 20,380 40,750	1,003,460 2,797,977 139,899 2,937,876 Total (\$) S10,440 Total (\$)	34
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operator Fuel preparation workers Director and accountant Personnel costs sub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator costs (CIF) 5% of engine-generator costs (CIF) 5% of engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/every one year, 4-6%) Replacement of lamp of street lights, office stationerv and	50 0 Unit Price (\$) 500 500 1,000 Salary (\$/mon) Salary (\$/mon) Salary (\$/mon) CIF (\$) CIF (\$) 1,222,500 407,500 815,000	4,882 Q'ty 36.00 36.00 36.00 8 5 6	hh customers Unit MM MM MM 12.00 12.00 12.00 12.00 12.00 12.00 12.00 5.0%	Amount(\$) 72,000 18,000 18,000 36,000 Amount(\$) 1,920 3,840 1,800 2,880 Amount (\$) 20,380 40,750	1,003,460 2,797,977 139,899 2,937,876 Total (\$) <b>\$10,440</b> Total (\$)	34
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operation Chief Operator Fuel preparation workers Director and accountant Personnel costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/very one vear, 4-6%) Replacement of lamp of street lights, office stationery and consumables	50 0 Unit Price (\$) 500 500 1,000 Salary (\$/mon) Salary (\$/mon) Salary (\$/mon) 1,000 Salary (\$/mon) Salary (\$/m	4,882 Q'ty 36.00 36.00 36.00 2 8 5 6	hh customers Unit MM MM month 12.00 12.00 12.00 12.00 12.00 12.00 5.0% 5.0%	Amount(\$) 72,000 18,000 18,000 36,000 Amount(\$) 1,920 3,840 1,800 2,880 Amount (\$) 20,380 40,750 3,480	1,003,460 2,797,977 139,899 2,937,876 Total (\$) S10,440 Total (\$)	34
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operator Fuel preparation workers Director and accountant Personnel costs ub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/every one year, 4-6%) Replacement of lamp of street lights, office stationery and consumables Maintenance costs of powerhouse (% of powerhouse)	50 0 Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 CIF (\$) 1,222,500 407,500 815,000 815,000	4,882 Q'ty 36.00 36.00 36.00 36.00 2 8 5 6	hh customers Unit MM MM month 12.000	Amount(\$) 72,000 18,000 36,000 Amount(\$) 1,920 3,840 1,800 2,880 Amount (\$) 20,380 40,750 3,480 1,660	1,003,460 2,797,977 139,899 2,937,876 Total (\$) <b>\$10,440</b> Total (\$)	34
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operation Chief Operation Chief Operation Chief Operation and accountant Personnel costs sub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr operation of lamp of street lights, office stationery and consumables Maintenance costs of powerhouse (% of powerhouse) Maintenance costs of powerhouse (% of powerhouse)	50 0 Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 \$30 \$40 \$1,222,500 407,500 815,000 83,200	4,882 Q'ty 36.00 36.00 36.00 36.00 Nos. of person 2 8 5 6	hh customers Unit MM MM MM 12.00 12.00 12.00 12.00 12.00 12.00 12.00 12.00 5.0% 5.0% 5.0% 5.0%	Amount(\$) 72,000 18,000 18,000 36,000 Amount(\$) 1,920 3,840 1,800 2,880 Amount (\$) 20,380 40,750 3,480 1,660	1,003,460 2,797,977 139,899 2,937,876 Total (\$) \$10,440 Total (\$) 66,270	34
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operator Fuel preparation workers Director and accountant Personnel costs sub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/very one year, 4-6%) Replacement of lamp of street lights, office stationery and consumables Maintenance costs of powerhouse (% of powerhouse) Maintenance costs sub-total	50 0 Unit Price (\$) 500 500 1,000 Salary (\$/mon) Salary (\$/mon) Salary (\$/mon) Salary (\$/mon) 1,222,500 407,500 815,000 815,000	4,882 Q'ty 36.00 36.00 36.00 36.00 8 5 6	hh customers Unit MM MM 12.00 12.00 12.00 12.00 12.00 12.00 5.0% 5.0% 5.0%	Amount(\$) 72,000 18,000 18,000 36,000 Amount(\$) 1,920 3,840 1,800 2,880 Amount (\$) 20,380 40,750 3,480 1,660	1,003,460 2,797,977 139,899 2,937,876 Total (\$) \$10,440 Total (\$) 66,270	34
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operation Chief Operator Fuel preparation workers Director and accountant Personnel costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/very one vear, 4-6%) Replacement of lamp of street lights, office stationery and consumables Maintenance costs of powerhouse (% of powerhouse) Maintenance costs sub-total	50 0 Unit Price (\$) 500 500 1,000 Salary (\$/mon) Salary (\$/mon) Salary (\$/mon) 1,000 Salary (\$/mon) Salary (\$/m	4,882 Q'ty 36.00 36.00 36.00 7 8 5 6	hh customers Unit MM MM MM 12.00 12.	Amount(\$) 72,000 18,000 18,000 36,000 Amount(\$) 1,920 3,840 1,800 2,880 Amount (\$) 20,380 40,750 3,480 1,660	1,003,460 2,797,977 139,899 2,937,876 Total (\$) \$10,440 Total (\$) 66,270 76,710	34
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operator Fuel preparation workers Director and accountant Personnel costs ub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/every one vear, 4-6%) Replacement of lamp of street lights, office stationery and consumables Maintenance costs of powerhouse (% of powerhouse) Maintenance costs sub-total	50 0 Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 CIF (\$) 1,222,500 407,500 815,000 815,000	4,882 Q'ty 36.00 36.00 36.00 36.00 2 8 5 6	hh customers Unit MM MM month 12.000	Amount(\$) 72,000 18,000 36,000 Amount(\$) 1,920 3,840 1,800 2,880 Amount (\$) 20,380 40,750 3,480 1,660	1,003,460 2,797,977 139,899 2,937,876 Total (\$) \$10,440 Total (\$) 66,270 76,710	34
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operator Fuel preparation workers Director and accountant Personnel costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/every one year, 4-6%) Replacement of lamp of street lights, office stationery and consumables Maintenance costs of powerhouse (% of powerhouse) Maintenance costs sub-total Operation and maintenance costs sub-total Payment for technical supports (S/yr for 15 years from 1st year	50 0 Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 \$30 \$40 \$1,222,500 407,500 815,000 83,200	4,882 Q'ty 36.00 36.00 36.00 36.00 8 5 6	hh customers Unit MM MM month 12.00 12.00 12.00 12.00 12.00 12.00 12.00 5.0% 5.0% 5.0% 5.0%	Amount(\$) 72,000 18,000 18,000 36,000 Amount(\$) 1,920 3,840 1,800 2,880 Amount (\$) 20,380 40,750 3,480 1,660	1,003,460 2,797,977 139,899 2,937,876 Total (\$) \$10,440 Total (\$) 66,270 76,710 16,140	34
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operator Fuel preparation workers Director and accountant Personnel costs sub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator costs (CIF) 5% of engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/very one year, 4-6%) Replacement of lamp of street lights, office stationery and consumables Maintenance costs ob-total Operation and maintenance costs sub-total Operation and maintenance costs sub-total Payment for technical supports (\$/yr for 15 years from 1st year	50 0 0 Unit Price (\$) 500 500 1,000 Salary (\$/mon) Salary (\$/mon)	4,882 Q'ty 36.00 36.00 36.00 36.00 8 5 6	hh customers Unit MM MM MM 12.00 12.00 12.00 12.00 12.00 12.00 5.0% 5.0% 5.0%	Amount(\$) 72,000 18,000 18,000 36,000 Amount(\$) 1,920 3,840 1,800 2,880 Amount (\$) 20,380 40,750 3,480 1,660	1,003,460 2,797,977 139,899 2,937,876 Total (\$) \$10,440 Total (\$) 66,270 76,710 16,140	34
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operator Fuel preparation workers Director and accountant Personnel costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator set Hear resistant cone of gasifier (replacement at ever 3,000 hr operation/every one year, 4-6%) Replacement of lamp of street lights, office stationery and consumables Maintenance costs of powerhouse (% of powerhouse) Maintenance costs sub-total Operation and maintenance costs sub-total Payment for technical supports (\$/yr for 15 years from 1st year	50 0 Unit Price (\$) 500 500 1,000 Salary (\$/mon) Salary (\$/mon) \$80 \$40 \$30 \$40 \$1,222,500 407,500 \$1,222,500 407,500 \$15,000 \$15,000 \$15,000	4,882 Q'ty 36.00 36.00 36.00 2 8 5 6	hh customers	Amount(\$) 72,000 18,000 18,000 36,000 Amount(\$) 1,920 3,840 1,800 2,880 Amount (\$) 20,380 40,750 3,480 1,660	1,003,460 2,797,977 139,899 2,937,876 Total (\$) \$10,440 Total (\$) 66,270 76,710 16,140	34
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operator Fuel preparation workers Director and accountant Personnel costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/every one year, 4-6%) Replacement of lamp of street lights, office stationery and consumables Maintenance costs of powerhouse (% of powerhouse) Maintenance costs sub-total Operation and maintenance costs sub-total Payment for technical supports (\$/yr for 15 years from 1st year Items	50 0 Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 CIF (\$) 1,222,500 407,500 815,000 815,000 833,200	4,882 Q'ty 36.00 36.00 36.00 36.00 2 8 5 6	hh customers Unit MM MM month 12.00 10.000	244,100 0 72,000 18,000 36,000 Amount(\$) 1,920 3,840 1,800 2,880 Amount (\$) 20,380 40,750 3,480 1,660	1,003,460 2,797,977 139,899 2,937,876 Total (\$) \$10,440 Total (\$) 66,270 76,710 16,140 Fuel costs (\$)	34
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operator Puel preparation workers Director and accountant Personnel costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/every one year, 4-6%) Replacement of lamp of street lights, office stationery and consumables Maintenance costs of powerhouse (% of powerhouse) Maintenance costs of powerhouse (% of powerhouse) Maintenance costs of powerhouse (% of powerhouse) Maintenance costs sub-total Payment for technical supports (S/yr for 15 years from 1st year Items	50 0 Unit Price (\$) 500 500 1,000 Salary (\$/mon) \$80 \$40 \$30 \$40 \$40 \$30 \$40 \$30 \$40 \$40 \$30 \$40 \$40 \$30 \$40 \$40 \$30 \$40 \$40 \$40 \$30 \$40 \$40 \$40 \$30 \$40 \$40 \$40 \$40 \$30 \$40 \$40 \$40 \$30 \$40 \$40 \$40 \$40 \$40 \$40 \$40 \$40 \$40 \$4	4,882 Q'ty 36.00 36.00 36.00 2 8 5 6	hh customers Unit MM MM month 12.00 10.000	Amount(\$) 72,000 18,000 18,000 36,000 Amount(\$) 1,920 3,840 1,800 2,880 Amount (\$) 20,380 40,750 3,480 1,660	1,003,460 2,797,977 139,899 2,937,876 Total (\$) \$10,440 Total (\$) 66,270 76,710 16,140 Fuel costs (\$) 47,155	34
Service wire, etc. Domestic cutomers Daytime customers (to be fixed individually) Distribution line - transformer - service wires, etc. sub-total (including tax) Sub-total Contingecy (5%) Construction costs total Costs for CEC supports Costs for CEC supports Costs for CEC supports and training 2.1 Facilitation for CEC setting up and management 2.2 Technical supports 2.3 Vehicles and lodging Operation and maintenance costs Personnel costs of CEC staff Operation Chief Operator Fuel preparation workers Director and accountant Personnel costs sub-total Maintenance costs of gasifier and engine-generator Gasifier and engine-generator costs (CIF) 5% of engine-generator set Heat resistant cone of gasifier (replacement at ever 3,000 hr operation/every one year, 4-6%) Replacement of lamp of street lights, office stationery and consumables Maintenance costs of powerhouse (% of powerhouse) Maintenance costs ob-total Operation and maintenance costs sub-total Payment for technical supports (\$/yr for 15 years from 1st years Items	50 0 0 Unit Price (\$) 500 500 1,000 Salary (\$/mon) Salary (\$/mon)	4,882 Q'ty 36.00 36.00 36.00 2 8 5 6	hh customers Unit MM MM 12.00 12.00 12.00 12.00 12.00 12.00 5.0% 5.0% 5.0% 5.0% 5.0% 5.0%	Amount(\$) 72,000 18,000 18,000 36,000 Amount(\$) 1,920 3,840 1,800 2,880 Amount (\$) 20,380 40,750 3,480 1,660	1,003,460 2,797,977 139,899 2,937,876 Total (\$) \$10,440 Total (\$) 66,270 76,710 16,140 Fuel costs (\$) 47,155	34

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Items	Currency	Currency	Costs	c Costs	Remarks
	\$	\$	\$	\$	
1. Hard costs	1,547,642	1,390,234	2,937,876	2,482,562	SCF
1.1 Generating equip. excl. tax	898,560	58,240	956,800	950,976	0.90
1.2 Customs & VAT	0	224,640	224,640	0	LCF
1.3 Road and powerhouse		203,200	203,200	101,600	0.50 <u>1</u> /
1.4 Growing fuel trees	991	82,086	83,077	42,034	
1.5 Swichyard equip.		265,700	265,700	239,130	
1.6 Powerhouse miscellaneous		61,100	61,100	54,990	
1.7 Distribution lines	484,544	238,656	723,200	699,334	
1.8 Service wires, etc.	163,547	80,553	244,100	236,045	
1.9 Distri. Lines miscellaneous		36,160	36,160	32,544	
1.10 Contingency (5%)		139,899	139,899	125,909	
2. CEC facilitation costs	0	72,000	72,000	64,800	
<b>Project Costs Total</b>	1,547,642	1,462,234	3,009,876	2,547,362	
O&M	61,130	66,535	127,665	83,787	
1. Personnel costs	0	10,440	10,440	8,586	
2. Biomass gasifier generator	61,130	5,140	66,270	65,756	
3. Fuel		47,155	47,155	7,545	0.16 <u>2</u> /
4. Distribution lines	0	3,800	3,800	1,900	

Community Electrication Project, Kampong Kor, Phase 1+2, soft loan @ 3% - 15 yr including 3-yr grace 

 Table A5
 Economic Costs

Local

Financial Economi

Foreign

Note: 1/ Economic conversion factor for seasonal jobless labors

Items	Foreign Currency	Local Currency	Financial Costs	Economic Costs	Remarks
1 Hard posts	\$	\$	\$ 2 242 262	\$ 1 003 120	
1. Halu costs	005,020 424 560	1,578,055	2,242,205	1,905,120	770 ¢/LW
1.1 Diesei generator exci. tax	434,300	122 200	122,000	480,970	//U \$/KW
1.2 Customs & VAI		125,200	125,200	112 000	
1.5 Road & fand preparation $1.4$ Descent scale $\Re$ field scale (10%)		220,000	220,000	113,000	
1.4 Powernouse & fuel tank (10%)		49,280	49,280	44,352	
1.5 Swichyard equip.		265,700	265,700	239,130	
1.6 Powerhouse miscellaneous (5%)		57,849	57,849	52,064	
1.7 Distribution lines	429,068	211,332	640,400	619,267	
1.8 Service wires, etc.		244,100	244,100	219,690	
1.9 Distri. Lines miscellaneous		36,160	36,160	32,544	
1.10 Contingency (5%)		106,774	106,774	96,097	
2. CEC facilitation costs	0	72,000	72,000	64,800	
Project Costs Total	863,628	1,450,635	2,314,263	1,967,920	
O&M	27,470	376,271	403,741	364,594	
1. Personnel costs	0	8,640	8,640	7,776	
2. Diesel generator	27,470	2,310	29,780	29,549	5%
3. Fuel	0	361,521	361,521	325,369	0.23 \$/kWh
4. Distribution lines	0	3,800	3,800	1,900	
Adjutment for Kampong Kor diesel po	wer station				
1 Road powerhouse	48	0.50	km	24 000	
2 Embankment of station yard	20	10 000	$m^2$	200,000	

m<sup>2</sup>

2,000

**Table A6 Economic Benefits** 

3. Land acquisition 0.2 10,000 Final Report

June 2006

# Community Electrication Project, Kampong Kor, Phase 1+2, soft loan @ 3% - 15 yr including 3-yr grace **Table A7** Unit Costs of Electricity

# Table A8 Tariff Setting

ATP for monthly tariff

Diesel oil lamp (100%)

month for battery purchase)

Battery lighting (70%, incl. Riel 4,000 per

Total

\$

0.251

0.030

\$0.281

\$0.310

\$0.310

\$0.270 \$0.270

\$35,212 \$22,701 \$1,023

> \$9,886 \$1,602

\$4.65

\$0.21

\$4.86

\$3.31

\$1.70

\$0.47

\$1.46

\$3.12

\$4.58

\$

Monthly Costs

Riel

1,003

120

1,124

1,240 1,240

1,080

1,080

18,600

19,400

13,200

6,800

1,900

5,844

12,470

18,314

Riel

800

Items	with tax (\$)	and subsidy (\$)	Items
1. Capital Costs	3,275,576	2,288,202	Unit cost of electricity from 7th year (\$/kWh)
2. CEC facilitation costs	72,000	72,000	Rate of reserve for operational risks (12%)
3. Total construction costs excluding design, test	ting, etc.	2,360,202	Average tariff (\$/kWh)
Interest rate	3.0%		Tariff adopted for nighttime demand
Repayment period	10 yr		Tariff adopted for street lights
CRF (3.0%, 10 yr) =	0.1172		Tariff adopted for industrial demand
4. Annual costs excluding design, etc.	383,997	276,688	Tariff adopted for irrigation demand
5. O&M costs in 10th year	140,577	140,577	Monthly revenue (US\$/mon)
5.1 O&M	76,710	76,710	from nighttime users
5.2 Fuel costs	47,155	47,155	for street lights
5.3 EAC license fee	572	572	from industrial users
5.4 Yearly monitoring fee by DIME	16,140	16,140	from irrigation pump users
6. Annual total costs	524,574	417,264	Average monthly tariff @ 15 kWh per HH (\$)
7. Annual energy sales from 7th year (MWh)	1,428.9	1,428.9	Tariff for street lights
8. Unit cost of electricity from 7th year (\$/kWh)	0.367	0.292	Total @ 15 kWh/hh including street lights
9. NPV of energy sold	MWh	25,680	Average monthly tariff @ 10 kWh per HH (\$) including street lights
10. NPV of finacial costs excluding tax	\$	6,441,185	<ul> <li>(a) 40 W x 4h x 30 days = 4.8 kWh/month + street lights</li> </ul>
11. Average cost of electricity	\$/kWh	0.251	Tariff of poorest household (US\$/mon/hh) ( $a$ ) 7 W x 4h x 30 days = 0.84 kWh/mon + street

# Community Electrication Project, Kampong Kor, Phase 1+2, soft loan @ 3% - 15 yr including **Table 1 Adopted Conditions for Economic and Finacial Analyses**

1. Energy solu see attached rable A	Ι.	Energy sold	See attached Table	A2
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- 2. Tariff See attached Table A7
- 3. Long-term borrowing from GOC
  - 3% per year
  - 25 years repayment period including 5 years' grace
- 4. Short-term borrowing from commercial bank
  - 10% per year
  - revolving every year
- 5. Depreciation
  - Ratio of depreciation 90%
    Ratio of residual value 10%
  - Generating equipment
  - 5 years' grace and 5 years' depreciation for the first 10 years
  - 10 years' depreciation from 11th year onward

Distribution lines, service wires, etc.

- 5 years' grace and 20 years' depreciation
- 6. Interest earning
  - Interest of saving deposit at 10% per year

Community Electrication Project, Kampong Kor, Phase 1+2, soft loan @ 3% - 15 yr including 3-yr grace																				
						Tabl	le 2 Fi	inancia	al Ana	lysis										(unit: \$)
	0	1	2	3	4	5	6	7	8	9	10	11	12	19	20	21	22	29	30	Total
(Expenditure)																				
Initital costs																				
Construction costs excluding tax	2,713,236											956,800				956,800				4,626,836
Supports to CEC	54,000	18,000																		
Operation and maintenance costs		68,592	100,642	112,104	119,961	128,603	138,110	143,402	144,377	144,377	144,377	144,377	144,377	144,377	144,377	144,377	144,377	144,377	144,377	4,132,075
Personnel costs		10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	313,200
O&M of biomass gasification power plant		22,214	40,846	47,509	52,076	57,100	62,627	65,703	66,270	66,270	66,270	66,270	66,270	66,270	66,270	66,270	66,270	66,270	66,270	1,872,285
Maintenance of distribution lines, etc.		3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	114,000
Biomass fuel cost		15,806	29,064	33,806	37,055	40,630	44,563	46,752	47,155	47,155	47,155	47,155	47,155	47,155	47,155	47,155	47,155	47,155	47,155	1,332,241
EAC license fee @ Riel 1.6/kWh		192	352	410	449	492	540	567	572	572	572	572	572	572	572	572	572	572	572	16,148
Payment for technical supports		16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	484,200
Total expenditure	2,767,236	86,592	100,642	112,104	119,961	128,603	138,110	143,402	144,377	144,377	144,377	1,101,177	144,377	144,377	144,377	1,101,177	144,377	144,377	144,377	8,830,911
(Revenue)																				
Operating revenue through electricity sales		148,484	262,814	303,951	333,119	365,203	400,496	419,248	422,547	422,547	422,547	422,547	422,547	422,547	422,547	422,547	422,547	422,547	422,547	11,951,896
Sales of CER		4,359	8,015	9,322	10,218	11,204	12,288	12,892	13,003	13,003	13,003	13,003	13,003	13,003	13,003	13,003	13,003	13,003	13,003	367,375
Residual value of equipment											95,680				95,680				293,788	
Total revenue		152,843	270,829	313,273	343,337	376,407	412,784	432,140	435,550	435,550	531,230	435,550	435,550	435,550	531,230	435,550	435,550	435,550	729,338	12,804,419
(Net operating income)	-2,767,236	66,251	170,187	201,169	223,376	247,804	274,674	288,738	291,174	291,174	386,854	-665,626	291,174	291,174	386,854	-665,626	291,174	291,174	584,961	3,973,508
FIRR	6.3%																			

Community Electrication Project, Kampong Kor, Phase 1+2, soft loan @ 3% - 15 yr including 3-yr grace <b>Table 2 Financial Analysis</b>														Final							
Including taxes, excluding CER sales	0	1	2	3	4	5	6	7	8	9	10	11	12	19	20	21	22	29	30	(unit: \$) Total	Rep
(Expenditure)																					ort
Initital costs																					
Construction costs	2,937,876											956,800				956,800				4,851,476	
Supports to CEC	54,000	18,000																			
Operation and maintenance costs		68,592	100,642	112,104	119,961	128,603	138,110	143,402	144,377	144,377	144,377	144,377	144,377	144,377	144,377	144,377	144,377	144,377	144,377	4,132,075	
Personnel costs		10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	313,200	
O&M of biomass gasification power plant		22,214	40,846	47,509	52,076	57,100	62,627	65,703	66,270	66,270	66,270	66,270	66,270	66,270	66,270	66,270	66,270	66,270	66,270	1,872,285	
Maintenance of distribution lines, etc.		3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	114,000	
Biomass fuel cost		15,806	29,064	33,806	37,055	40,630	44,563	46,752	47,155	47,155	47,155	47,155	47,155	47,155	47,155	47,155	47,155	47,155	47,155	1,332,241	
EAC license fee @ Riel 1.6/kWh		192	352	410	449	492	540	567	572	572	572	572	572	572	572	572	572	572	572	16,148	
Payment for technical supports		16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	484,200	
Total expenditure	2,991,876	86,592	100,642	112,104	119,961	128,603	138,110	143,402	144,377	144,377	144,377	1,101,177	144,377	144,377	144,377	1,101,177	144,377	144,377	144,377	9,055,551	
(Revenue)																					
Operating revenue through electricity sales		148,484	262,814	303,951	333,119	365,203	400,496	419,248	422,547	422,547	422,547	422,547	422,547	422,547	422,547	422,547	422,547	422,547	422,547	11,951,896	
Sales of CER																				0	⊳
Residual value of equipment											95,680				95,680				293,788		ppe
Total revenue		148,484	262,814	303,951	333,119	365,203	400,496	419,248	422,547	422,547	518,227	422,547	422,547	422,547	518,227	422,547	422,547	422,547	716,335	12,437,044	endix-
(Net operating income)	-2,991,876	61,892	162,172	191,847	213,158	236,600	262,386	275,846	278,171	278,171	373,851	-678,629	278,171	278,171	373,851	-678,629	278,171	278,171	571,958	3,381,493	ा म
FIRR	5.2%																				valua

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Community Electrication Project, Kampong Kor, Phase 1+2, soft loan @ 3% - 15 yr including 3-yr grace																				
							Table	2 Fina	ncial A	nalysis										
Excluding taxes and subsidy from costs,	and inclue	ling CEI	x sales	3	4	5	6	7	8	9	10	11	12	19	20	21	22	29	30	(unit: \$) Total
(Expenditure)																				
Initial costs																				
Construction costs	1,950,502											956,800				956,800				3,864,102
Supports to CEC	54,000	18,000																		
Operation and maintenance costs		68,592	100,642	112,104	119,961	128,603	138,110	143,402	144,377	144,377	144,377	144,377	144,377	144,377	144,377	144,377	144,377	144,377	144,377	4,132,075
Personnel costs		10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	10,440	313,200
O&M of biomass gasification power plant		22,214	40,846	47,509	52,076	57,100	62,627	65,703	66,270	66,270	66,270	66,270	66,270	66,270	66,270	66,270	66,270	66,270	66,270	1,872,285
Maintenance of distribution lines, etc.		3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	114,000
Biomass fuel cost		15,806	29,064	33,806	37,055	40,630	44,563	46,752	47,155	47,155	47,155	47,155	47,155	47,155	47,155	47,155	47,155	47,155	47,155	1,332,241
EAC license fee @ Riel 1.6/kWh		192	352	410	449	492	540	567	572	572	572	572	572	572	572	572	572	572	572	16,148
Payment for technical supports		16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	16,140	484,200
Total expenditure	2,004,502	86,592	100,642	112,104	119,961	128,603	138,110	143,402	144,377	144,377	144,377	1,101,177	144,377	144,377	144,377	1,101,177	144,377	144,377	144,377	8,068,177
(Revenue)																				
Operating revenue through electricity sales		148,484	262,814	303,951	333,119	365,203	400,496	419,248	422,547	422,547	422,547	422,547	422,547	422,547	422,547	422,547	422,547	422,547	422,547	11,951,896
Sales of CER		4,359	8,015	9,322	10,218	11,204	12,288	12,892	13,003	13,003	13,003	13,003	13,003	13,003	13,003	13,003	13,003	13,003	13,003	367,375
Residual value of equipment											95,680				95,680				293,788	
Total revenue		152,843	270,829	313,273	343,337	376,407	412,784	432,140	435,550	435,550	531,230	435,550	435,550	435,550	531,230	435,550	435,550	435,550	729,338	12,804,419
(Net operating income)	-2,004,502	66,251	170,187	201,169	223,376	247,804	274,674	288,738	291,174	291,174	386,854	-665,626	291,174	291,174	386,854	-665,626	291,174	291,174	584,961	4,736,242
FIRR	9.4%																			

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Final
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Community Electrication Project, Kampong Kor, Phase 1+2, soft loan @ 3% - 15 yr including 3-yr grace <b>Table 3 Economic Evaluation</b>																				
	0	1	2	3	4	5	6	7	8	9	10	11	12	19	20	21	22	29	30	(unit: \$) Total
(Economic costs) Initital costs Economic costs Supports to CEC	2,482,562 48,600	16,200	2	2	-	5	0	7	0	,	10	950,976	12	17	20	950,976	22	27	50	4,384,514
Operation and maintenance costs Personenel costs O&M of biomass gasification power plant Maintenance of distribution lines, etc. Biomass fuel cost	0	35,866 9,396 22,041 1,900 2,529	56,475 9,396 40,529 1,900 4,650	63,846 9,396 47,141 1,900 5,409	68,897 9,396 51,672 1,900 5,929	74,454 9,396 56,658 1,900 6,501	80,567 9,396 62,141 1,900 7,130	83,970 9,396 65,194 1,900 7,480	84,597 9,396 65,756 1,900 7,545	281,880 1,857,764 57,000 213,159										
EAC license fee @ Riel 1.6/kWh Monitoring of CEC by DIME		172 0	317 0	369 0	404 0	443 0	486 0	510 0	514 0	14,534 0										
Residual value											-95,098				-95,098				-248,256	-438,451
Total expenditure	2,531,162	52,239	56,792	64,214	69,302	74,898	81,053	84,480	85,111	85,111	-9,986	1,036,087	85,111	85,111	-9,986	1,036,087	85,111	85,111	-163,145	6,435,199
Economic benefits as costs of alternative diesel mini-grid) nitital costs																				
Economic costs Supports to CEC	1,903,120 48,600	16,200										486,976				486,976				2,877,072
<b>Operation and maintenance costs</b> Personenel costs O&M of diesel power plant Maintenance of distribution lines, etc. Fuel cost	0	128,645 7,776 9,905 1,900 109,064	228,430 7,776 18,213 1,900 200,542	264,117 7,776 21,184 1,900 233,258	288,578 7,776 23,220 1,900 255,682	315,485 7,776 25,460 1,900 280,348	345,082 7,776 27,925 1,900 307,481	361,559 7,776 29,296 1,900 322,586	364,594 7,776 29,549 1,900 325,369	233,280 834,830 57,000 9,192,441										
EAC license fee Payment for technical supports		172 14,526	317 14,526	369 14,526	404 14,526	443 14,526	486 14,526	510 14,526	514 14,526	14,534 435,780										
Residual value											-48,698				-48,698				-190,312	-287,707
Benefits from CER sales		4,359	8,015	9,322	10,218	11,204	12,288	12,892	13,003	13,003	13,003	13,003	13,003	13,003	13,003	13,003	13,003	13,003	13,003	367,375
Total benefits	1,951,720	163,902	251,288	288,334	313,727	341,658	372,383	389,487	392,637	392,637	343,940	879,613	392,637	392,637	343,940	879,613	392,637	392,637	202,325	13,789,404
(Net benefits)	-579,442	111,663	194,496	224,120	244,425	266,760	291,329	305,007	307,526	307,526	353,926	-156,474	307,526	307,526	353,926	-156,474	307,526	307,526	365,470	7,354,205
EIRR	35.6%																			

# Community Electrication Project, Kampong Kor, Phase 1+2, soft loan @ 3% - 15 yr including 3-yr grace Table 4 Financing Plan

				(unit: \$)
Financial Resources			Financial Application	
Equity - CEC			Power Plant before tax	1,835,577
Cash (@ \$50/hh)	244,100	8.0%	Biomass gasification power equipment	1,222,500
In kind ( @ \$40/MM)	213,540	7.0%	Road improvement works	120,000
5339 MM			Powerhouse, etc.	83,200
Grant			Switching equip. & transformer	265,700
REF	762,734	25.0%	Growing fuel trees	83,077
(25% of capital costs)			Misecellaneous equipment	61,100
Borrowing for capitals			Distribution facilities, service wires, etc.	1,003,460
Long-term	1,830,562	60.0%		
(15 yr including 3-year grace, 3%/yr)			Contingecy	139,899
			Capital costs before tax	2,978,936
Total fund for capital costs and CEC supports	3,050,936	100.0%	CEC support	72,000
Borrowing for operation	30,000		Operation fund in hand	30,000
Short-term (Revolving, 15%/yr)				
Tax exemption	224,640		Customs and tax	224,640
Total Financial Resources	3,305,576		Total Financial Resources	3,305,576

Community Electrication Project, Samlout, Phase 1+2 bio only, soft loan @ 3% - 15 yr including 3-yr grace

### Table A1 Principal Features of Electrification Plan

### (1) Generating Equipment Planning

Items	Unit	Q'ty	Remarks
Nos. of households	h.h.	4,216	
Unit nighttime domestic demand	W/hh	100	
Nighttime domestic demand	kW	421.6	
Street light demand	kW	17.9	1 light per 40 m of LV lir 895 street lights
Reserve capacity	kW	126.5	30% of nighttime domestic demand, allocated for station use + reserved power + distribution losses
Required capacity	kW	566.0	
Adopted capacity	kW	550.0	

### (2) Energy Generation Planning for 8th Year Onward

Items	Monthly Unit Energy Sold	Monthly Energy Sold	Annual Energy Sold	Station Use, Losses, etc. (10%)	Annual Energy Generated	Annual Plant Factor	Annual Operation Hours	Remarks (refer to Table A2 for demand growth rates)
	kWh/hh	MWh	MWh	MWh	MWh	%	hr	- 、
Nighttime domestic demand 1/, 2/	15.0	63.2	758.9	75.9	834.8	17.3%	1,518	100% from 8th year onward
Street light demand	0.6	2.7	32.2	3.2	35.4	0.7%	64	100% from the 1st year
Industrial demand <u>3</u> /	7.5	31.6	379.4	37.9	417.4	8.7%	759	100% from 8th year onward
Irrigation pump demand 4/	6.1	76.9	307.4	30.7	338.2	7.0%	615	in 4 dry months, 100% from 8th year onward
Total energy	29.2	174.4	1,478.0	147.8	1,625.8	33.7%	2,956	100% from 8th year onward

### Note:

1/ Typical consumption level of existing mini-grids in rural villages as of 2005 was 10 kWh (= 100W / 1,000 \* 5hrs \* 30 days \* 67%) and assumed to be realized from 2nd year.

2/ Average consumption of existing REE mini-grids supplying to rural towns as of 2005 was 15 kWh (= 100 W / 1,000 \* 7.5hrs \* 30days \* 67%) and was assumed to be realized in 7th year.

 $\underline{3}$ / Power demand of BCS, rice-mills, water supply stations, ice factory, workshop of boat engines, etc. Assumed to be 50% of the nighttime demand based on the actual demand of existing Anlong Ta Mey mini-grid (700 kWh at nighttime, 300 kWh for BCS at daytime) and potential daytime users in the villages shown in Table A3.

 $\underline{4}$ / see Table A3 for irrigation power demand.

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	Community Electrication Project, Samlout, Phase 1+2 bio only, soft loan @ 3% - 15 yr including 3-yr grace																			
						,	Table A	2 Ene	røv and	I CER	Sold									
									- 8,											
		1	2	3	4	5	6	7	8	9	10	11	12	19	20	21	22	29	30	Total
(Annual energy sold)																				
Demand growth	Growth r	ate																		
Domestic	1.1	0 50%	67%	73%	81%	89%	98%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Street lights	0.0	0 100%	6 100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Industrial	1.1	0 0%	50%	67%	73%	81%	89%	98%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Irrigation	1.1	0 0%	<b>50%</b>	67%	73%	81%	89%	98%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Energy sold (MWh/yr)	Demand																			
Domestic	758	9 379.4	505.9	556.5	612.2	673.4	740.7	758.9	758.9	758.9	758.9	758.9	758.9	758.9	758.9	758.9	758.9	758.9	758.9	21,681
Street lights	32	2 32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	967
Industrial	379	4 0.0	189.7	253.0	278.3	306.1	336.7	370.4	379.4	379.4	379.4	379.4	379.4	379.4	379.4	379.4	379.4	379.4	379.4	10,461
Irrigation	307	4 0.0	153.7	204.9	225.4	248.0	272.8	300.1	307.4	307.4	307.4	307.4	307.4	307.4	307.4	307.4	307.4	307.4	307.4	8,475
Total	1,478	.0 411.7	881.6	1,046.6	1,148.1	1,259.7	1,382.4	1,461.5	1,478.0	1,478.0	1,478.0	1,478.0	1,478.0	1,478.0	1,478.0	1,478.0	1,478.0	1,478.0	1,478.0	41,585
Unit energy sold (kWh p	er household per	month)																		
Domestic	15	0 7.5	10.0	11.0	12.1	13.3	14.6	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	
Street lights	0	.6 0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
Industrial	7	5 0.0	3.8	5.0	5.5	6.1	6.7	7.3	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	
Irrigation	6	1 0.0	3.0	4.1	4.5	4.9	5.4	5.9	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	
Total	29	2 8.1	17.4	20.7	22.7	24.9	27.3	28.9	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	
(Operating revenue from e																				
	Tariff	,																		
Domestic	\$0.3	115,729	154,306	169,736	186,710	205,381	225,919	231,458	231,458	231,458	231,458	231,458	231,458	231,458	231,458	231,458	231,458	231,458	231,458	6,612,782
Street lights	\$0.3	9,827	9,827	9,827	9,827	9,827	9,827	9,827	9,827	9,827	9,827	9,827	9,827	9,827	9,827	9,827	9,827	9,827	9,827	294,813
Industrial	\$0.23	3 0	52,173	69,564	76,520	84,172	92,590	101,849	104,346	104,346	104,346	104,346	104,346	104,346	104,346	104,346	104,346	104,346	104,346	2,876,826
Irrigation	\$0.2	3 0	42,270	56,360	61,996	68,195	75,015	82,516	84,540	84,540	84,540	84,540	84,540	84,540	84,540	84,540	84,540	84,540	84,540	2,330,762
Total		125,556	258,575	305,487	335,053	367,576	403,350	425,650	430,171	430,171	430,171	430,171	430,171	430,171	430,171	430,171	430,171	430,171	430,171	12,115,183
(Monthly tariff, \$ per hous	sehold)																			
Domestic		2.29	3.05	3.36	3.69	4.06	4.47	4.58	4.58	4.58	4.58	4.58	4.58	4.58	4.58	4.58	4.58	4.58	4.58	
Street lights		0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	
Industrial		0.00	1.03	1.38	1.51	1.66	1.83	2.01	2.06	2.06	2.06	2.06	2.06	2.06	2.06	2.06	2.06	2.06	2.06	
Irrigation		0.00	0.84	1.11	1.23	1.35	1.48	1.63	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	
Total		2.48	5.11	6.04	6.62	7.27	7.97	8.41	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	
(Tariff receivable, \$/vr)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	kg-CO <sub>2</sub> /	Wh																		
(CER saleable)	(to-CO <sub>2</sub> )	.3 535	1.146	1.361	1,493	1.638	1,797	1,900	1.921	1.921	1.921	1.921	1.921	1.921	1.921	1.921	1.921	1.921	1.921	54.060
()	(\$/yr) <u>1</u> / \$	7 3,746	8,022	9,524	10,448	11,463	12,580	13,300	13,449	13,449	13,449	13,449	13,449	13,449	13,449	13,449	13,449	13,449	13,449	378,419
Fuel tree consumed (ter m	w month)	51 5	110.2	120.9	142 5	1575	172.9	102 7	1017	1017	1017	1017	1017	1047	1017	1017	1047	1017	1047	5 109
I and required to sumply for	ri montii)	51.5	122.2	150.8	145.5	137.5	1/2.8	184.7	184./	184./	184./	184./	184./	184./	184./	184./	184./	184./	184./	5,198
Nos of fuel tree formers (	iei trees (iia)	) 200	132.2	137.0	1/2.2	100.9	207.4	219.2	221./	221./	221.7	221./	1 100	1 100	221./ 1 100	221./ 1 100	221./ 1 100	221.7	1 100	
Payment to fuel tree farmers (0	na per larmel	j 309 nth 2.2	3 2	165	3 2	945 3 2	1,05/	1,090	1,108	1,108	1,108	1,108	1,108	1,108	1,108	1,108	1,108	1,108	1,108	
Total navmont to fuel tree	formore (C/v-)	10 3.3	5.5 ) 26.447	21 200	21 112	27 700	3.5	J. S 12 916	2.5	3.3	2.5	2.5	3.3	3.3 44.220	2.2	3.3	3.3	3.5	3.3	1 247 526
i otai payment to idel tree	iai mers (5/yr)	12,33	20,447	51,599	34,442	57,790	41,472	43,840	44,539	44,539	44,339	44,339	44,559	44,539	44,339	44,339	44,539	44,539	44,559	1,247,330

Ratio of tariff collected and billed= 100%

Note: 1/ Assumed at %4/ton-CO2/yr deducting costs required for prepration of PDD, application and monitoring.

No.	Demand	Diesel Consumption	Electricity Demand	Operation Hour	Unit Power Demand	Nos. of Customers		Total Demai	nd
		liter/month	kWh/month	hr/month	kW		kW	kWh/month	Load Factor
1	BCS	200	600	50	12.00	5	60.00	3,000	6.9%
2	Water supply	60	180	15	12.00	10	120.00	1,800	2.1%
3	Rice-mill	30	90	30	3.00	30	90.00	2,700	4.2%
4	Ice factory	30	90	30	3.00	1	3.00	90	4.2%
5	Workshop	25	75	60	1.25	1	1.25	75	8.3%
6	Café	115	345	296	1.17	1	1.17	345	41.1%
N	Ionthly total	460	1,380	481	-	48	550.00	8,010	2.0%
1	Annual total	5520	16,560	5,772	-	-	550.00	96,120	2.0%

# Community Electrication Project, Samlout, Phase 1+2 bio only, soft loan @ 3% - 15 yr including 3-yr grace Table A3 Potential Daytime Users and Demand

Source: The potential daytime users above are candidates in Kampong Kor for reference purpose.

# Potential irrigation demand in the dry season

0.5	ha/hh
50.0%	
1054	ha
500	mm
5.270	mcm/yr
4	month
8	hr/day
1.525	m <sup>3</sup> /s
15.0	m
0.70	
320	kW
307	MWh
	$\begin{array}{c} 0.5\\ 50.0\%\\ 1054\\ 500\\ 5.270\\ 4\\ 8\\ 1.525\\ 15.0\\ 0.70\\ 320\\ 307\\ \end{array}$

### Community Electrication Project, Samlout, Phase 1+2 bio only, soft Ioan @ 3% - 15 yr including 3-yr grace Table A4 Cost Estimate

1,300 104 91 24 130 40 80 300 40 80 360 351 6,000 10,700 7,100 6,200 7,300 8,100 6,200 7,300 8,100 6,200 7,300 8,100	550 550 688 0.20 550 132 1,320 132 132 132 132 132 132 132 132 132 132	kW kW kVA km kW ha ha ha ha ha ha kw kW km km km km set set set set set	715,000 57,200 50,050 354,100 4,800 71,500 992 1,320 1,500 5,289 10,579 10,579 47,605 58,800 193,050 361,200 281,410 67,450 0 80,300 89,100 43,973 210,800 210,800 0	1,176,350 76,300 77,864 <b>1,330,514</b> 1,389,314 <b>1,582,364</b> 879,460 923,433	4 4 5
1,300 104 91 24 130 8 1 500 40 80 80 351 6,000 10,700 7,100 6,200 7,300 8,100 500 500 500 500 500 500 500	550 550 688 0.20 550 132 1,320 132 132 132 132 132 132 132 132 132 132	kW kW kW kVA km kW ha m <sup>2</sup> month ha ha ha ha ha kw kW km km km km set set set set set	715,000 57,200 50,050 354,100 4,800 71,500 992 1,320 1,500 5,289 10,579 10,579 47,605 58,800 193,050 361,200 281,410 67,450 0 80,300 89,100 43,973 210,800 210,800 0	1,176,350 76,300 77,864 <b>1,330,514</b> 1,389,314 <b>1,582,364</b> 879,460 923,433	4 4 5
104 91 24 130 8 1 500 40 80 80 360 351 6,000 10,700 7,100 6,200 7,300 8,100 500 0 1,000	550 550 688 0.20 550 132 132 132 132 132 132 132 132	kW kW kVA km kW ha m <sup>2</sup> month ha ha ha ha ha ka kw kW km km km km set set set set set	57,200 50,050 354,100 4,800 71,500 992 1,320 1,500 5,289 10,579 10,579 10,579 47,605 58,800 193,050 361,200 281,410 67,450 0 80,300 89,100 43,973 210,800 210,800 0	1,176,350 76,300 77,864 <b>1,330,514</b> 1,389,314 <b>1,582,364</b> 879,460 923,433	4 4 5
91 24 130 8 1 500 40 80 80 80 360 351 6,000 10,700 7,100 6,200 7,300 8,100 500 0 1,000	688 0.20 550 132 1,320 3 132 132 132 132 132 132 132	kW kVA km kW ha m <sup>2</sup> month ha ha ha ha ha kw kW km km km km set set set set set	354,100 4,800 71,500 992 1,320 1,500 5,289 10,579 47,605 58,800 193,050 361,200 281,410 67,450 0 89,100 43,973 210,800 210,800 0	1,176,350 76,300 77,864 <b>1,330,514</b> 1,389,314 <b>1,582,364</b> 879,460 923,433	4 4 5.
24 130 8 1 500 40 80 80 360 351 6,000 10,700 7,100 6,200 7,300 8,100 500 0 1,000	0.20 550 132 1,320 3 132 132 132 132 132 550 60.2 26.3 9,5 0 11 11	k VA km kW ha m <sup>2</sup> month ha ha ha ha ha kW kW km km km km set set set set	4,800 71,500 992 1,320 1,500 5,289 10,579 47,605 58,800 193,050 361,200 281,410 67,450 0 80,300 89,100 43,973 210,800 210,800 0	1,176,350 76,300 77,864 <b>1,330,514</b> 1,389,314 <b>1,582,364</b> 879,460 923,433	4 4 5.
24 130 8 1 500 40 80 80 360 360 10,700 7,100 6,200 7,300 8,100 6,200 7,300 8,100 6,200 7,300 8,100	0.20 550 132 1,320 3 132 132 132 132 132 550 60.2 26.3 9,5 0 11 11	km kW ha month ha ha ha kW kW km km km set set set set	4,800 71,500 992 1,320 1,500 5,289 10,579 10,579 47,605 58,800 193,050 361,200 281,410 67,450 0 80,300 89,100 43,973 210,800 210,800 0	76,300 77,864 <b>1,330,514</b> 1,389,314 <b>1,582,364</b> 879,460 923,433	4
24 130 8 1 500 40 80 360 351 6,000 10,700 7,100 6,200 7,300 8,100 500 0 1,000	0.20 550 132 1,320 3 132 132 132 132 550 60.2 26.3 9.5 0 11 11 4,216	km kW ha m <sup>2</sup> month ha ha ha kW kW kW km km km set set set set set	4,800 71,500 1,320 1,500 5,289 10,579 10,579 47,605 58,800 193,050 361,200 281,410 67,450 0 80,300 89,100 43,973 210,800 210,800 0	76,300 77,864 <b>1,330,514</b> 1,389,314 <b>1,582,364</b> 879,460 923,433	4
24 130 8 1 500 400 80 360 351 6,000 10,700 7,100 6,200 7,300 8,100 500 0 1,000	6.20 550 132 1,320 3 132 132 132 132 132 132 132	km kW ha m <sup>2</sup> month ha ha ha ha kw kW kW km km km set set set set set set	4,800 71,500 992 1,320 1,500 5,289 10,579 47,605 58,800 193,050 361,200 281,410 67,450 0 80,300 89,100 43,973 210,800 210,800 0	76,300 77,864 <b>1,330,514</b> 1,389,314 <b>1,582,364</b> 879,460 923,433	4 4: 5:
130 8 1 500 40 80 80 360 351 6,000 10,700 7,100 6,200 7,300 8,100 50 0 1,000	550 132 1,320 3 132 132 132 132 132 132 132	kW ha m <sup>2</sup> month ha ha ha ha kW kW kW km km km set set set set set	71,500 992 1,320 1,500 5,289 10,579 47,605 58,800 193,050 361,200 281,410 67,450 0 80,300 89,100 43,973 210,800 210,800 0	76,300 77,864 <b>1,330,514</b> <b>1,389,314</b> <b>1,582,364</b> 879,460 923,433	44 42 5.
8 1 500 40 80 80 360 351 6,000 10,700 7,300 6,200 7,300 8,100 500 0 1,000	132 1,320 3 132 132 132 132 132 550 60.2 26.3 9.5 0 0 11 11	ha m <sup>2</sup> month ha ha ha kW kW km km km km km set set set set set	992 1,320 1,500 5,289 10,579 47,605 58,800 193,050 361,200 281,410 67,450 0 80,300 89,100 43,973 210,800 210,800 0	76,300 77,864 <b>1,330,514</b> 1,389,314 <b>1,582,364</b> 879,460 923,433	4 4 5.
8 1 500 40 80 80 360 10,700 7,100 6,200 7,300 8,100 500 0 1,000	132 1,320 3 132 132 132 132 132 132 132 132 132 1	ha m <sup>2</sup> month ha ha ha kW kW km km km km km set set set set set	992 1,320 1,500 5,289 10,579 47,605 <b>58,800</b> 193,050 361,200 281,410 67,450 0 80,300 89,100 43,973 210,800 210,800 0	77,864 1,330,514 1,389,314 1,582,364 879,460 923,433	4 4 5
8 1 500 40 80 360 351 6,000 10,700 7,100 6,200 7,300 8,100 500 0 500 500 1,000	132 1,320 3 132 132 132 132 132 132 132 132 132 1	ha m <sup>2</sup> month ha ha ha ha kW kW km km km km km set set set set set	992 1,320 1,500 5,289 10,579 10,579 47,605 58,800 193,050 361,200 281,410 67,450 0 80,300 89,100 43,973 210,800 210,800 0	77,864 1,330,514 1,389,314 1,582,364 879,460 923,433	44 45 5.
1 500 40 80 360 351 6,000 10,700 7,100 6,200 7,300 8,100 500 0 1,000	1,320 3 132 132 132 132 132 132 132	m <sup>*</sup> month ha ha ha kW kW kW km km km km set set set set set	1,320 1,500 5,289 10,579 47,605 58,800 193,050 361,200 281,410 67,450 0 80,300 89,100 43,973 210,800 210,800 0	77,864 1,330,514 1,389,314 1,582,364 879,460 923,433	4 4 5.
500 40 80 360 351 6,000 10,700 7,100 6,200 7,300 8,100 500 0 500 500 1,000	3 1322 1322 132 132 132 132 132 132 132	month ha ha ha kW kW km km km km km set set set set set	1,500 5,289 10,579 10,579 47,605 58,800 193,050 281,410 67,450 0 80,300 89,100 43,973 210,800 210,800 0	77,864 1,330,514 1,389,314 1,582,364 879,460 923,433	44 41 5:
40 80 80 360 351 6,000 10,700 7,100 6,200 7,300 8,100 500 0 1,000	132 132 132 132 132 132 132 132 132 132	ha ha ha kW kW km km km km set set set set set	3,289 10,579 10,579 47,605 58,800 193,050 361,200 281,410 67,450 0 80,300 89,100 43,973 210,800 210,800 0	77,864 1,330,514 1,389,314 1,582,364 879,460 923,433	44 41 5:
80 80 360 351 6,000 10,700 7,100 6,200 7,300 8,100 500 0 1,000	132 132 132 550 60.2 26.3 9.5 0 11 11 11 4,216	ha ha kW km km km km km set set set set set	10,579 10,579 47,605 58,800 193,050 281,410 67,450 0 80,300 89,100 43,973 210,800 210,800 0	77,864 1,330,514 1,389,314 1,582,364 879,460 923,433	44 41 5:
350 360 351 6,000 10,700 7,100 6,200 7,300 8,100 500 500 500 500 500 500 1,000	60.2 26.3 9.5 0 11 11 4,216	ha ha kW km km km km set set set set set	47,605 58,800 193,050 361,200 281,410 67,450 0 80,300 89,100 43,973 210,800 210,800 0	77,864 1,330,514 1,389,314 1,582,364 879,460 923,433	44 41 5:
351 6,000 10,700 7,100 6,200 7,300 8,100 500 500 500 500 500 1,000	550 60.2 26.3 9.5 0 11 11 4,216	kW km km km set set set set hh customers	58,800 193,050 361,200 281,410 67,450 0 80,300 89,100 43,973 210,800 210,800 0	77,864 1,330,514 1,389,314 1,582,364 879,460 923,433	4 4 5.
351 6,000 10,700 7,100 6,200 7,300 8,100 500 500 500 500 1,000	550 60.2 26.3 9.5 0 11 11 4,216	kW km km km set set set set set	58,800 193,050 281,410 67,450 0 80,300 89,100 43,973 210,800 210,800 0	<ul> <li>1,330,514</li> <li>1,389,314</li> <li>1,582,364</li> <li>879,460</li> <li>923,433</li> </ul>	4/ 4/ 5.
351 6,000 10,700 7,100 6,200 7,300 8,100 500 500 500 500 1,000	550 60.2 26.3 9.5 0 11 11 4,216	kW km km set set set set	58,800 193,050 361,200 281,410 67,450 0 80,300 89,100 43,973 210,800 210,800 0	1,389,314 1,582,364 879,460 923,433	4 5. 31
351 6,000 10,700 7,100 6,200 7,300 8,100 500 0 500 500 1,000	550 60.2 26.3 9.5 0 11 11 11 4,216	kW km km set set set hh customers	361,200 281,410 67,450 0 80,300 89,100 43,973 210,800 210,800 0	1,389,314 <b>1,582,364</b> 879,460 923,433	44 5: 30
351 6,000 10,700 7,100 6,200 7,300 8,100 500 0 it Price (\$) 500 500 500 1,000	550 60.2 26.3 9.5 0 11 11 11 4,216	kW km km set set set set	193,050 361,200 281,410 67,450 0 80,300 89,100 43,973 210,800 210,800 0	1,389,314 1,582,364 879,460 923,433	41 5: 31
351 6,000 10,700 7,100 6,200 7,300 8,100 500 500 500 500 500 1,000	550 60.2 26.3 9.5 0 11 11 4,216	kW km km set set set set	193,050 361,200 281,410 67,450 0 80,300 89,100 43,973 210,800 210,800 0	<b>1,582,364</b> 879,460 923,433	5:
6,000 10,700 7,100 6,200 7,300 8,100 500 0 it Price (\$) 500 500 1,000	60.2 26.3 9.5 0 11 11 4,216	km km set set set set	361,200 281,410 67,450 0 80,300 89,100 43,973 210,800 210,800 0	1 <b>,582,364</b> 879,460 923,433	5:
6,000 10,700 7,100 6,200 7,300 8,100 500 500 500 500 1,000	60.2 26.3 9.5 0 11 11	km km set set set set	361,200 281,410 67,450 0 80,300 89,100 43,973 210,800 210,800 0	879,460 923,433	30
6,000 10,700 7,100 6,200 7,300 8,100 500 0 1,000	60.2 26.3 9.5 0 11 11 4,216	km km set set set	361,200 281,410 67,450 0 80,300 89,100 43,973 210,800 210,800 0	879,460 923,433	30
10,700 7,100 6,200 7,300 8,100 500 500 500 500 1,000	26.3 9.5 0 11 11 4,216	km km set set set set	281,410 67,450 0 80,300 89,100 43,973 210,800 210,800 0	879,460 923,433	30
500 7,100 6,200 7,300 8,100 500 500 500 500 1,000	9,5 0 11 11 4,216	km set set set hh	201,410 67,450 0 80,300 89,100 43,973 210,800 210,800 0	879,460 923,433	31
6,200 7,300 8,100 50 0 it Price (\$) 500 500 1,000	0 11 11 4,216	set set set hh	0 80,300 89,100 43,973 210,800 210,800 0	879,460 923,433	30
6,200 7,300 8,100 50 0 it Price (\$) 500 500 1,000	0 11 11 4,216	set set hh customers	0 80,300 89,100 43,973 210,800 210,800 0	879,460 923,433	30
7,300 8,100 50 0 it Price (\$) 500 500 1,000	4,216	set set hh customers	80,300 89,100 43,973 210,800 210,800 0	879,460 923,433	30
\$,100 50 0 it Price (\$) 500 500 1,000	4,216	set hh customers	89,100 43,973 210,800 210,800 0	879,460 923,433	30
50 0 it Price (\$) 500 500 1,000	4,216	hh customers	43,973 210,800 210,800 0	879,460 923,433	30
50 0 it Price (\$) 500 500 1,000	4,216	hh customers	<b>43,973</b> 210,800 210,800 0	923,433	
50 0 it Price (\$) 500 500 1,000	4,216	hh customers	210,800 210,800 0	923,433	
50 0 it Price (\$) 500 500 1,000	4,216	hh customers	210,800 210,800 0		32
50 0 it Price (\$) 500 500 1,000	4,216	hh customers	210,800 0		7
0 it Price (\$) 500 500 1,000		customers	0		
it Price (\$) 500 500 1,000					
it Price (\$) 500 500 1,000				1,134,233	3
tit Price (\$) 500 500 1,000					
it Price (\$) 500 500 1,000				2,716,597	
it Price (\$) 500 500 1,000				135,830	
500 500 1,000					
500 500 1,000				2,852,427	10
500 500 1,000	O'ty	Unit	Amount(\$)		
500 500 1,000	Qty	Unit	72 000		
500 1,000	36.00	MM	18 000		
1,000	36.00	MM	18,000		
,	36.00	month	36.000		
			,		
ary (\$/mon)	Nos. of	MM	Amount(\$)	Total (\$)	
eoo	person	12.00	1.020		
\$80	2	12.00	1,920		
\$40	5	12.00	5,640		
\$30	14	12.00	6 720		
340	14	12.00	0,720	\$14 280	
		Ratio of	A	T-4-1 (0)	
CIF (\$)		O&M Costs	Amount (\$)	Total (\$)	
1,176,350					
392,117		5.0%	19,610		
784,233		5.0%	39,210		
			4,760		
71,500		2.0%	1,430		
				65,010	
				79,290	
				12.0.40	
				17	
				13,940	
it fuel cost	Energy			13,940	
it fuel cost \$/kWh)	Energy	unit	1	13,940 Fuel costs (\$)	
it fuel cost <u>\$/kWh)</u> 0.03	Energy generation 1,626	unit MWh/yr	1	13,940 Fuel costs (\$) 48,773	
it fuel cost <u>\$/kWh</u> ) 0.03	Energy generation 1,626	unit MWh/yr	]	13,940 Fuel costs (\$) 48,773	
CIF 1,: 3	\$40 \$30 \$40 7 (\$) 176,350 392,117 84,233	\$40         8           \$30         5           \$40         14           \$7(\$)         \$392,117           \$84,233         \$71,500	\$40         8         12.00           \$30         5         12.00           \$40         14         12.00           \$6(\$)         Ratio of O&M Costs           \$176,350         392,117         5.0%           \$84,233         5.0%         5.0%           71,500         2.0%         2.0%	\$40         8         12.00         3,840           \$30         5         12.00         1,800           \$40         14         12.00         6,720           (\$)         Ratio of O&M Costs         Amount (\$)           \$7(5)50         5.0%         19,610           \$84,233         5.0%         39,210           71,500         2.0%         1,430	\$40         8         12.00         3,840         1,800         6,720         \$14,280         \$10,610

	Foreign	Local	Financial	Economic	
Items	Currency	Currency	Costs	Costs	Remarks
	\$	\$	\$	\$	
1. Hard costs	1,503,666	1,348,761	2,852,427	2,482,537	SCF
1.1 Generating equip. excl. tax	772,200	50,050	822,250	817,245	0.90
1.2 Customs & VAT	0	193,050	193,050	0	LCF
1.3 Road and powerhouse		76,300	76,300	38,150	0.50 <u>1</u> /
1.4 Growing fuel trees	992	76,872	77,864	39,428	
1.5 Swichyard equip.		354,100	354,100	318,690	
1.6 Powerhouse miscellaneous		58,800	58,800	52,920	
1.7 Distribution lines	589,238	290,222	879,460	850,438	
1.8 Service wires, etc.	141,236	69,564	210,800	203,844	
1.9 Distri. Lines miscellaneous		43,973	43,973	39,576	
1.10 Contingency (5%)		135,830	135,830	122,247	
2. CEC facilitation costs	0	72,000	72,000	64,800	
Project Costs Total	1,503,666	1,420,761	2,924,427	2,547,337	
O&M	58,820	73,843	132,663	86,537	
1. Personnel costs	0	14,280	14,280	12,042	
2. Biomass gasifier generator	58,820	6,190	65,010	64,391	
3. Fuel		48,773	48,773	7,804	0.16 <u>2</u> /
4. Distribution lines	0	4,600	4,600	2,300	

Community Electrication Project, Samlout, Phase 1+2 bio only, soft loan @ 3% - 15 yr including 3-yr grace **Table A5 Economic Costs** 

Note: 1/ Economic conversion factor for seasonal jobless labors

Table A6 I	Economic	Benefits
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	Foreign	Local	Financial	Economic	
Items	Currency	Currency	Costs	Costs	Remarks
	\$	\$	\$	\$	
1. Hard costs	720,684	1,117,015	1,837,699	1,628,790	
1.1 Diesel generator excl. tax	373,450	50,050	423,500	418,495	770 \$/kW
1.2 Customs & VAT		105,875	105,875		
1.3 Road & land preparation		4,800	4,800	2,400	
1.4 Powerhouse & fuel tank (10%)		42,350	42,350	38,115	
1.5 Swichyard equip.		354,100	354,100	318,690	
1.6 Powerhouse miscellaneous (5%)		46,531	46,531	41,878	
1.7 Distribution lines	347,234	171,026	518,260	501,157	
1.8 Service wires, etc.		210,800	210,800	189,720	
1.9 Distri. Lines miscellaneous		43,973	43,973	39,576	
1.10 Contingency (5%)		87,509	87,509	78,759	
2. CEC facilitation costs	0	72,000	72,000	64,800	
Project Costs Total	720,684	1,189,015	1,909,699	1,693,590	
O&M	24,759	393,609	418,368	377,167	
1. Personnel costs	0	12,480	12,480	11,232	
2. Diesel generator	24,759	2,606	27,365	27,104	5%
3. Fuel	0	373,923	373,923	336,531	0.23 \$/kWh
4. Distribution lines	0	4,600	4,600	2,300	
Adjsutment for Kampong Kor diesel pov	ver station				
1. Road powerhouse	24	0.20	km	4,800	
2. Embankment of station vard	0	2,000	$m^2$	0	
3. Land acquisition	0	2,000	m <sup>2</sup>	0	

# Community Electrication Project, Samlout, Phase 1+2 bio only, soft loan @ 3% - 15 yr including 3-yr grace **Table A7** Unit Costs of Electricity

Table A8 Tariff Setting

Battery lighting (70%, incl. Riel 4,000 per

Total

month for battery purchase)

Items	with tax (\$)	with tax exemption and subsidy (\$)	Items	\$	Riel
1. Capital Costs	3,278,527	2,314,108	Unit cost of electricity from 7th year (\$/kWh)	0.237	949
2. CEC facilitation costs	72,000	72,000	Rate of reserve for operational risks (12%)	0.028	114
3. Total construction costs excluding design, ter	sting, etc.	2,386,108	Average tariff (\$/kWh)	\$0.266	1,064
Interest rate	3.0%		Tariff adopted for nighttime demand	\$0.305	1,220
Repayment period	10 yr		Tariff adopted for street lights	\$0.305	1,220
CRF (3.0%, 10 yr) =	0.1172		Tariff adopted for industrial demand	\$0.275	1,100
4. Annual costs excluding design, etc.	384,343	279,725	Tariff adopted for irrigation demand	\$0.275	1,100
5. O&M costs in 10th year	142,594	142,594	Monthly revenue (US\$/mon)	\$35,848	
5.1 O&M	79,290	79,290	from nighttime users	\$19,288	
5.2 Fuel costs	48,773	48,773	for street lights	\$819	
5.3 EAC license fee	591	591	from industrial users	\$8,696	
5.4 Yearly monitoring fee by DIME	13,940	13,940	from irrigation pump users	\$7,045	
6. Annual total costs	526,938	422,319	Average monthly tariff @ 15 kWh per HH (\$)	\$4.58	18,300
7. Annual energy sales from 7th year (MWh)	1,478.0	1,478.0	Tariff for street lights	\$0.19	800
8. Unit cost of electricity from 7th year (\$/kWh	0.357	0.286	Total @ 15 kWh/hh including street lights	\$4.77	19,100
9. NPV of energy sold	MWh	26,402	Average monthly tariff @ 10 kWh per HH (\$) including street lights	\$3.24	13,000
10. NPV of finacial costs excluding tax	\$	6,265,331	( $3/mon/hh$ ) ( $2/mon/hh$ ) ( $2/mon/hh$ ) ( $2/mon/hh$ ) ( $2/mon/hh$ ) ( $3/mon/hh$ ) (	\$1.66	6,600
11. Average cost of electricity	\$/kWh	0.237	Tariff of poorest household (US\$/mon/hh) ( $a$ ) 7 W x 4h x 30 days = 0.84 kWh/mon + street	\$0.45	1,800
			ATP for monthly tariff	\$	Riel
			Diesel oil lamp (100%)	\$1.46	5,844

\$3.12

\$4.58

12,470

18,314

# Community Electrication Project, Samlout, Phase 1+2 bio only, soft loan @ 3% - 15 yr includ **Table 1 Adopted Conditions for Economic and Finacial Analyses**

- 1. Energy sold See attached Table A2
- 2. Tariff See attached Table A7
- 3. Long-term borrowing from GOC
  - 3% per year
  - 25 years repayment period including 5 years' grace
- 4. Short-term borrowing from commercial bank
  - 10% per year
  - revolving every year

### 5. Depreciation

-	Ratio of depreciation	90%
-	Ratio of residual value	10%

Generating equipment

- 5 years' grace and 5 years' depreciation for the first 10 years
- 10 years' depreciation from 11th year onward

Distribution lines, service wires, etc.

- 5 years' grace and 20 years' depreciation
- 6. Interest earning
  - Interest of saving deposit at 10% per year

Community Electrication Project, Samlout, Phase 1+2 bio only, soft loan @ 3% - 15 yr including 3-yr grace <b>Table 2 Financial Analysis</b>																				
	0	1	2	3	4	5	6	7	8	9	10	11	12	19	20	21	22	29	30	(unit: \$) Total
Expenditure)																				
nitital costs																				
Construction costs excluding tax	2,659,377											822,250				822,250				4,303,877
Supports to CEC	54,000	18,000																		
Dperation and maintenance costs		64,677	101,042	113,816	121,666	130,301	139,800	145,922	147,194	147,194	147,194	147,194	147,194	147,194	147,194	147,194	147,194	147,194	147,194	4,202,690
Personnel costs		14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	428,400
0&M of biomass gasification power plant		18,107	38,777	46,038	50,500	55,408	60,807	64,287	65,010	65,010	65,010	65,010	65,010	65,010	65,010	65,010	65,010	65,010	65,010	1,829,154
Aaintenance of distribution lines, etc.		4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	138,000
Biomass fuel cost		13,585	29,092	34,539	37,887	41,569	45,620	48,231	48,773	48,773	48,773	48,773	48,773	48,773	48,773	48,773	48,773	48,773	48,773	1,372,302
AC license fee (a) Riel 1.6/kWh		165	353	419	459	504	553	585	591	591	591	591	591	591	591	591	591	591	591	16,634
ayment for technical supports		13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	418,200
<b>Total expenditure</b>	2,713,377	82,677	101,042	113,816	121,666	130,301	139,800	145,922	147,194	147,194	147,194	969,444	147,194	147,194	147,194	969,444	147,194	147,194	147,194	8,578,567
Revenue)																				
Operating revenue through electricity sales	S	125,556	258,575	305,487	335,053	367,576	403,350	425,650	430,171	430,171	430,171	430,171	430,171	430,171	430,171	430,171	430,171	430,171	430,171	12,115,183
ales of CER		3,746	8,022	9,524	10,448	11,463	12,580	13,300	13,449	13,449	13,449	13,449	13,449	13,449	13,449	13,449	13,449	13,449	13,449	378,419
Residual value of equipment											82,225				82,225				285,243	
fotal revenue		129,302	266,598	315,011	345,500	379,038	415,930	438,950	443,620	443,620	525,845	443,620	443,620	443,620	525,845	443,620	443,620	443,620	728,863	12,943,295
Net operating income)	-2,713,377	46,625	165,556	201,196	223,835	248,737	276,130	293,028	296,426	296,426	378,651	-525,824	296,426	296,426	378,651	-525,824	296,426	296,426	581,669	4,364,728
FIRR	6.8%																			

		Com	munity E	lectricati	on Proje	ct, Samlo	ut, Phas	e 1+2 bio	only, so	ft loan @	3% - 15	5 yr includ	ling 3-yr	grace						
						Ta	ble 2	Tinancia	al Anal	ysis										
Including taxes, excluding CER sales	0	1	2	3	4	5	6	7	8	9	10	11	12	19	20	21	22	29	30	(unit: \$) Total
(Expenditure)		•	-	5		Ū	Ū	,	Ū	, í	10			.,	20	2.	22	27	50	Total
Initial costs																				
Construction costs	2,852,427											822,250				822,250				4,496,927
Supports to CEC	54,000	18,000										,								
Operation and maintenance costs		64,677	101,042	113,816	121,666	130,301	139,800	145,922	147,194	147,194	147,194	147,194	147,194	147,194	147,194	147,194	147,194	147,194	147,194	4,202,690
Personnel costs		14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	428,400
O&M of biomass gasification power plant		18,107	38,777	46,038	50,500	55,408	60,807	64,287	65,010	65,010	65,010	65,010	65,010	65,010	65,010	65,010	65,010	65,010	65,010	1,829,154
Maintenance of distribution lines, etc.		4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	138,000
Biomass fuel cost		13,585	29,092	34,539	37,887	41,569	45,620	48,231	48,773	48,773	48,773	48,773	48,773	48,773	48,773	48,773	48,773	48,773	48,773	1,372,302
EAC license fee @ Riel 1.6/kWh		165	353	419	459	504	553	585	591	591	591	591	591	591	591	591	591	591	591	16,634
Payment for technical supports		13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	418,200
Total expenditure	2,906,427	82,677	101,042	113,816	121,666	130,301	139,800	145,922	147,194	147,194	147,194	969,444	147,194	147,194	147,194	969,444	147,194	147,194	147,194	8,771,617
(Revenue)																				
Operating revenue through electricity sales		125.556	258.575	305.487	335.053	367.576	403.350	425.650	430,171	430.171	430,171	430.171	430.171	430.171	430.171	430,171	430,171	430.171	430.171	12.115.183
Sales of CER		- ,	,	,	,	,		- ,	, .	,	,	,	, .		,	,		,	,	0
Residual value of equipment											82,225				82,225				285,243	0
Total revenue		125,556	258,575	305,487	335,053	367,576	403,350	425,650	430,171	430,171	512,396	430,171	430,171	430,171	512,396	430,171	430,171	430,171	715,414	12,564,876
	2 006 427	40.070	157 524	101 671	212 207	227.274	262 550	270 729	282.077	282 077	265 202	520 272	282.077	282.077	265 202	520 272	282.077	282.077	569 220	2 702 250
(Net operating income)	-2,906,427	42,879	157,534	191,6/1	213,387	237,274	263,550	279,728	282,977	282,977	365,202	-539,273	282,977	282,977	365,202	-539,273	282,977	282,977	568,220	3,193,259
FIRR	5.8%																			

Final Report

Community Electrication Project, Samlout, Phase 1+2 bio only, soft loan @ 3% - 15 yr including 3-yr grace Table 2 Financial Analysis																				
Excluding taxes and subsidy from costs,	and inclu	ding CE	R sales	2	4	10		7	аї ЛПАІ 0	y 515	10	11	12	10	20	21	22	20	20	(unit: \$)
(Expenditure)	0	1	2	3	4	5	0	/	0	9	10	11	12	19	20	21	22	29		10181
Initial costs																				
Construction costs	1 888 008											822 250				822 250				3 532 508
Supports to CEC	54.000	18 000										022,250				022,230				5,552,500
Supports to CEC	34,000	18,000																		
Operation and maintenance costs		64,677	101,042	113,816	121,666	130,301	139,800	145,922	147,194	147,194	147,194	147,194	147,194	147,194	147,194	147,194	147,194	147,194	147,194	4,202,690
Personnel costs		14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	14,280	428,400
O&M of biomass gasification power plant		18,107	38,777	46,038	50,500	55,408	60,807	64,287	65,010	65,010	65,010	65,010	65,010	65,010	65,010	65,010	65,010	65,010	65,010	1,829,154
Maintenance of distribution lines, etc.		4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	138,000
Biomass fuel cost		13,585	29,092	34,539	37,887	41,569	45,620	48,231	48,773	48,773	48,773	48,773	48,773	48,773	48,773	48,773	48,773	48,773	48,773	1,372,302
EAC license fee @ Riel 1.6/kWh		165	353	419	459	504	553	585	591	591	591	591	591	591	591	591	591	591	591	16,634
Payment for technical supports		13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	13,940	418,200
Total expenditure	1,942,008	82,677	101,042	113,816	121,666	130,301	139,800	145,922	147,194	147,194	147,194	969,444	147,194	147,194	147,194	969,444	147,194	147,194	147,194	7,807,198
(Revenue)																				
Operating revenue through electricity sales		125,556	258,575	305,487	335,053	367,576	403,350	425,650	430,171	430,171	430,171	430,171	430,171	430,171	430,171	430,171	430,171	430,171	430,171	12,115,183
Sales of CER		3,746	8,022	9,524	10,448	11,463	12,580	13,300	13,449	13,449	13,449	13,449	13,449	13,449	13,449	13,449	13,449	13,449	13,449	378,419
Residual value of equipment											82,225				82,225				285,243	
Total revenue		129,302	266,598	315,011	345,500	379,038	415,930	438,950	443,620	443,620	525,845	443,620	443,620	443,620	525,845	443,620	443,620	443,620	728,863	12,943,295
(Net operating income)	-1,942,008	46,625	165,556	201,196	223,835	248,737	276,130	293,028	296,426	296,426	378,651	-525,824	296,426	296,426	378,651	-525,824	296,426	296,426	581,669	5,136,097
FIRR	10.1%																			

Final Report

Appendix-H Evaluation Sheet for Biomass Pilot Projects

Final
Report

						Ta	ble 3 I	Econom	ic Eval	uation										
						-	ć	-			4.0				•					(unit: \$)
(Economic costs) Initital costs Economic costs Supports to CEC	0 2,482,537 48,600	1 16,200	2	3	4	5	6	7	8	9	10	11 817,245	12	19	20	21 817,245	22	29	30	Total 4,117,027
<b>Operation and maintenance costs</b> Personenel costs O&M of biomass gasification power plant Maintenance of distribution lines, etc. Biomass fuel cost	0	35,261 12,852 17,935 2,300 2,174	58,215 12,852 38,408 2,300 4,655	66,278 12,852 45,599 2,300 5,526	71,233 12,852 50,019 2,300 6,062	76,684 12,852 54,881 2,300 6,651	82,679 12,852 60,228 2,300 7,299	86,544 12,852 63,675 2,300 7,717	87,347 12,852 64,391 2,300 7,804	385,560 1,811,738 69,000 219,568										
EAC license fee @ Riel 1.6/kWh Monitoring of CEC by DIME		148 0	317 0	377 0	413 0	453 0	498 0	526 0	532 0	14,970 0										
Residual value											-81,725				-81,725				-248,254	-411,703
Total expenditure	2,531,137	51,609	58,532	66,654	71,646	77,137	83,177	87,070	87,879	87,879	6,154	905,124	87,879	87,879	6,154	905,124	87,879	87,879	-160,375	6,270,961
(Economic benefits as costs of alternative di Initital costs Economic costs Supports to CEC	iesel mini-grid 1,628,790 48,600	<b>I)</b> 16,200										418,495				418,495				2,465,780
<b>Operation and maintenance costs</b> Personenel costs O&M of diesel power plant Maintenance of distribution lines, etc. Fuel cost	0	114,816 11,232 7,549 2,300 93,735	230,432 11,232 16,167 2,300 200,733	271,046 11,232 19,194 2,300 238,319	296,004 11,232 21,055 2,300 261,417	323,459 11,232 23,101 2,300 286,825	353,659 11,232 25,352 2,300 314,774	373,123 11,232 26,803 2,300 332,788	377,167 11,232 27,104 2,300 336,531	336,960 762,624 69,000 9,468,799										
EAC license fee Payment for technical supports		148 12,546	317 12,546	377 12,546	413 12,546	453 12,546	498 12,546	526 12,546	532 12,546	14,970 376,380										
Residual value											-41,850				-41,850				-162,879	-246,578
Benefits from CER sales		3,746	8,022	9,524	10,448	11,463	12,580	13,300	13,449	13,449	13,449	13,449	13,449	13,449	13,449	13,449	13,449	13,449	13,449	378,419
Total benefits	1,677,390	147,457	251,318	293,493	319,411	347,921	379,282	399,495	403,695	403,695	361,845	822,190	403,695	403,695	361,845	822,190	403,695	403,695	240,816	13,691,155
(Net benefits)	-853,747	95,848	192,786	226,838	247,765	270,784	296,105	312,425	315,816	315,816	355,691	-82,934	315,816	315,816	355,691	-82,934	315,816	315,816	401,191	7,420,194
EIRR	25.6%																			

Community Electrication Project, Samlout, Phase 1+2 bio only, soft loan @ 3% - 15 yr including 3-yr grace

Appendix-H Evaluation Sheet for Biomass Pilot Projects

# Community Electrication Project, Samlout, Phase 1+2 bio only, soft loan @ 3% - 15 yr including 3-yr grace **Table 4 Financing Plan**

(unit: \$) **Financial Resources Financial Application Equity - CEC** 1,743,414 **Power Plant before tax** Cash (@ \$50/hh) 210,800 6.8% Biomass gasification power equipment 1,176,350 In kind ( @ \$40/MM) 252,022 8.2% Road improvement works 4,800 Powerhouse, etc. 71,500 6301 MM Switching equip. & transformer 354,100 Grant REF Growing fuel trees 77,864 771,369 25.0% (25% of capital costs) Misecellaneous equipment 58,800 **Borrowing for capitals** Distribution facilities, service wires, etc. 1,134,233 1,851,286 Long-term 60.0% (15 yr including 3-year grace, 3%/yr) Contingecy 135,830 Capital costs before tax 3,013,477 **Total fund for capital costs and CEC supports** 3,085,477 **CEC** support 72,000 100.0% 30,000 **Operation fund in hand Borrowing for operation** 30,000 Short-term (Revolving, 15%/yr) Tax exemption 193,050 Customs and tax 193,050 **Total Financial Resources** 3,308,527 3,308,527 **Total Financial Resources**
				Comn	nunity Ele	ectrication	Project,	Samlout, I	Phase 1+2	bio only	, soft loar	n @ 3% -	15 yr inc	luding 3-y	r grace							
				Tal	ole 5 P	rofit an	id Loss	Staten	ient wi	th Casl	1 Flow	, 15-yr	repayr	nent pe	riod							(unit: \$)
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	20	21	22	30	Total
Operating revenue incl. CER & resi	idual valu	ie	125,556	258,575	305,487	335,053	367,576	403,350	425,650	430,171	430,171	430,171	430,171	430,171	430,171	430,171	430,171	430,171	430,171	430,171	430,171	12,115,183
						101 ///		120.000														1 202 (00
Operating costs			64,677	101,042	113,816	121,666	130,301	139,800	145,922	147,194	147,194	147,194	147,194	147,194	147,194	147,194	147,194	147,194	147,194	147,194	147,194	4,202,690
new land required for tree plantation	,				24.8	15.2	16.7	18.4	11.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	89.5
tree plantation costs for increasing demand	d		(0.070	14,580	8,960	9,856	10,841	6,987	1,452	0	0	0	0	0	0	0	0	0	0	0	52,676	105,351
Gross profit			60,879	142,954	182,687	203,516	226,416	256,545	278,265	282,974	282,977	282,977	282,977	282,977	282,977	282,977	282,977	282,977	282,977	282,977	230,301	7,807,052
Interests payment																						
Short-term commercial loan (15%/yr)			4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	135,000
Long-term soft loan	3.0%		55,539	55,539	55,539	50,910	46,282	41,654	37,026	32,398	27,769	23,141	18,513	13,885	9,256	4,628						472,078
Deprecitation																						
Generating equipment (5 yr - 10 yr - 10 yr)	1,058,715							211,743	211,743	211,743	211,743	211,743	105,872	105,872	105,872	105,872	105,872	105,872	105,872	105,872	105,872	3,176,145
Others (20 yr from 6th year)	1,718,214							85,911	85,911	85,911	85,911	85,911	85,911	85,911	85,911	85,911	85,911	85,911	85,911	85,911		1,718,214
Operating profit before depreciation	n		841	82,916	122,648	148,106	175,634	210,391	236,739	246,077	250,708	255,336	259,964	264,592	269,220	273,849	278,477	278,477	278,477	278,477	225,801	7,199,974
Interests received (10%)			0	0	9,552	8,298	9,555	13,793	22,042	33,823	47,730	63,492	89,515	110,380	133,795	160,014	189,318	483,122	568,849	654,927	1,737,737	13,462,800
Residual value upon completion of depreciation	10%											82,225						82,225			285,243	449,693
CER received			3,746	8,022	9,524	10,448	11,463	12,580	13,300	13,449	13,449	13,449	13,449	13,449	13,449	13,449	13,449	13,449	13,449	13,449	13,449	378,419
Net profit after depreciation			4,587	90,938	141,725	166,851	196,652	-60,890	-25,573	-4,305	14,234	116,848	171,146	196,639	224,682	255,530	289,462	665,491	668,993	755,071	2,156,359	16,596,527
Cash in hand			4,587	90,938	141,725	166,851	196,652	236,764	272,081	293,349	311,887	414,502	362,928	388,422	416,465	447,312	481,244	857,273	860,775	946,853	2,262,230	21,490,887
Accumulated cash in hand after principal repayment		0	4,587	95,525	82,976	95,553	137,931	220,421	338,228	477,304	634,917	895,145	1,103,799	1,337,947	1,600,138	1,893,176	2,374,420	5,688,491	6,549,266	7,496,119	19,639,600	
Principal repayment	1,851,286	0	0	0	154,274	154,274	154,274	154,274	154,274	154,274	154,274	154,274	154,274	154,274	154,274	154,274						1,851,286
Long-term debt balance	1,851,286	1,851,286	1,851,286	1,851,286	1,697,012	1,542,739	1,388,465	1,234,191	1,079,917	925,643	771,369	617,095	462,822	308,548	154,274	-0						

# **APPENDIX-I**

Unit Price and Cost Estimate

#### THE MASTER PLAN STUDY ON RURAL ELECTRIFICATION BY RENEWABLE ENERGY IN THE KINGDOM OF CAMBODIA

#### FINAL REPORT VOLUME 5 : APPENDICES

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#### APPENDIX-I UNIT PRICE AND COST ESTIMATE

۱.	Unit prices applied for Pre-FS	AI-	1
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# Appendix-I Unit Price and Cost Estimate

### 1. UNIT PRICES APPLIED FOR PRE-FS

As to unit prices for cost estimate of pre-feasibility studies, the following items and prices were adopted through data collection and quotation, interviews to suppliers and referring to past projects etc.:

No.	Work Item	Unit	Unit Price
1	Excavation	\$/m <sup>3</sup>	5
2	Embankment, Backfilling	$m^{3}$	6
3	Mass Concrete	\$/m <sup>3</sup>	80
4	Structural Concrete	\$/m <sup>3</sup>	130
5	Reinforcement Bar	\$/ton	700
6	Steel Material	\$/ton	1,200
7	Turbine and Generator	\$/kW	660
8	Biomass Gasifier and Engine Generator	\$/kW	1,950

#### (1) Unit Prices for Civil Works, Turbines and Generators etc.

Note: Including customs, taxes, indirect costs.

#### (2) Unit Prices for Distribution Lines and Transformers

No	Work Item	Unit	Unit Price			
			For less than	For more		
			500	than 500		
			households	households		
1	22 kV Medium Voltage Line	\$/km	5,100 (35mm <sup>2</sup> )	6,000 (50mm <sup>2</sup> )		
2	22 kV Medium Voltage Line plus Low Voltage Line (Dual use of transmission poles)	\$/km	9,800	10,700		
3	Low Voltage Line*	\$/km	6,500 (50mm <sup>2</sup> )	7,100 (70mm <sup>2</sup> )		
4	Transformer 15kVA Single-Phase (To be installed at the edge of community)	\$/set	6,2	200		
5	Transformer 25kVA Single-Phase (To be installed at the edge of community)	\$/set	6,6	500		
6	Transformer 25kVA Three-Phase (To be installed at the center of community)	\$/set	7,3	600		
7	Transformer 50kVA Three-Phase (To be installed at the center of community)	\$/set	8,1	00		

\* Three-phase 4 lines (50%) and Single-phase 2 lines (50%), coated wire.