APPENDICES

Appendix-1　List of Micro and Pico Hydros Installed by NGO

No.	Village	Township	Capacity	Unit	Type of Turbin	Year of Commis-sioning	Capital Cost (current)		kW Cost	Remark
							K. 1,000	US$	US$/kW	
1	MONG NAUNG	KYAAY SI	20	kW	Crossflow	1984	500	10,000	500	
2	PAN OUNT	HSI SENG	10	kW	Crossflow	1984	250	5,000	500	
3	MONG PON	LOI LEM	20	kW	Crossflow	1985	500	10,000	500	
4	MONG PON	LOI LEM	20	kW	Kaplan	1989	1,620	18,000	900	Nyaung Kyao
5	PIN DAWK	KENG TONG	20	kW	Crossflow	1986	500	1,000	50	
6	TI TAIN	TAUNGGYI	10	kW	Crossflow	1986	250	5,000	500	
7	PAN SAUK	HO PONE	7.5	kW	Crossflow	1987	270	4,500	600	
8	NAM KOKE	HO PONE	10	kW	Kaplan	1990	495	5,500	550	Monastery
9	DADAH GYI	PIN DAYA	14	HP	Kaplan	1990	504	5,600	560	U Soe New (oil mill)
10	DADAH GYI	PIN DAYA	15	HP	Kaplan	1990	540	6,000	560	U Aung Win (rice mill)
11	DADAH GYI	PIN DAYA	16	HP	Kaplan	1991	576	6,400	560	U Than Pe (sugar mill)
12	DADAH GYI	PIN DAYA	16	HP	Kaplan	1991	576	6,400	560	U Kyaw Kyaw (oil mill)
13	OH KONE	KUT KAI	12	HP	Kaplan	1992	528	4,800	560	Rice mill (home lighting)
14	MISSION SCHOOL	HSEN WI	12.5	kW	Kaplan	1992	688	6,250	500	
15	PONE TOON	HSEN WI	20	kW	Crossflow	1993	1,200	10,000	500	Owner Aik Yee
16	38TH MILE	HSEN WI	7.5	kW	Crossflow	1993	450	3,750	500	Owner B.K. Duo
17	HSEN WI	HSEN WI	50	kW	Francis	1994	3,000	25,000	500	
18	203 COMMAND	HSEN WI	10	kW	Kaplan	1995	600	5,000	500	
19	HOT SPRING	HSEN WI	10	kW	Kaplan	1995	600	5,000	500	Owner Mar Gum
20	MONG KNOWN	MONG KUCK	15	kW	Kaplan	1995	900	7,500	500	Monastery
21	WIN BO	KENG TONG	20	kW	Pelton	1996	1,200	10,000	500	
22	SAUNG HPOO	TAUNGGYI	75	kW	Francis	1996	4,500	37,500	500	
23	NAM BAY	TAUNGGYI	5	kW	Crossflow	2000	2,640	8,000	1,600	
24	P.N.O FARM	HSI SENG	15	kW	Crossflow	2000	2,475	7,500	500	
25	NAUNG BO	HSI SENG	5	kW	Crossflow	2001	1,050	3,000	600	
26	MONG SI	KUT KAI	10	kW	Kaplan	1999	1,584	4,800	480	
27	DAH MOE NYE	KUT KAI	10	kW	Kaplan	1999	1,584	4,800	480	
28	PAUNG SENG	KOO KANG	10	kW	Kaplan	2000	1,680	4,800	480	
29	LOI SAO	HSI SENG	5	kW	Crossflow	2000	1,050	3,000	600	
30	4TH MILE	HO PONE	16	HP	Crossflow	1989	768	6,400	560	Owner Htun Han
31	NAM PA MU	PIN LAUNG	5	kW	Crossflow	1999	990	3,000	600	Owner Myint Oo
32	SHWE PA SONE	BAHTOO	20	kW	Kaplan	1997	1,200	10,000	500	
33	Pin Bu	KYAW BA	15	kW	Crossflow	2001	2,450	7,000	470	
34	Thale U	NYAUNG SHWE	15	kW	Crossflow	2002	6,500	7,936	529	
35	Upper Nammye	TAUNGGYI	5	kW	Kaplan	2002	2,050	2,500	500	
36	Lower Nammye	TAUNGGYI	3	kW	Kaplan	2002				
37	Hon Po	TAUNGGYI	10	kW	Crossflow	2001	4,180	5,000	500	
38	Mai Te	HSI SENG	25	kW	Crossflow	2003	12,000	12,000	480	
39	Bone Shwe Pin	TAUNGGYI	30	kW	Crossflow	2003	12,500	12,500	417	
40	Nam Blin	PIN LAUNG	15	kW	Crossflow	2003	8,000	8,000	533	
41	Kyauk Ku	LAWK SAUK	5	kW	Propeller	2003	800	800	160	Power line is excluded
(Planning)										
42	Kyauktalone	HO PONE	125	kW	Francis	203				
43	Baw Lakae	KAYAH State	5	kW	Crossflow	2003	500	500	100	Distribution line is excluded

Source: U Khun Kyaw, Rural Development and Hydroelectric Implementation Group, Taunggyi, Shan State

Appendix-2 Features of Those Renewable Energy Not Dealt with in the Guidelines

No.	Source of Energy	Features
1.	**Geothermal Power**	● The potential sites are limited although there are volcanoes and hot springs in Myanmar. ● A large scale and costly drilling investigations will be required for potential study. Not suitable for Village Schemes.
2.	**Biogass Power**	● High temperature fermentation - central processing type of biogas power generation technology is expensive. Not suitable for RE. ● About 1,000 units of biogas engines are generating electricity in Germany. ● Medium temperature fermentation - isolated processing type biogas technology are used for gas lighting and cooking widely in China and India and is considered prospective also in Myanmar. However, it is beyond the scope of the present Study for RE.
3.	**RDF (Refuse Derived Fuel) Power**	● As part of the urban environmental measures, this uses urban solid waste as fuel. Not suitable for RE.
4.	**Wave Power**	● Potential sites are limited to the western and peninsular coasts (average potential in Japan is reportedly 6 kW per meter of sea coast). ● In order to save high capital costs, installation onto breakwater etc. would be required. Not suitable for RE.
5.	**Solar Heat Power**	● Although there are solar tower type, solar pond type, etc., these are of large scale requiring advanced technology. Not suitable for RE. ● Use of solar water heater is practical and recommended.

出典： 調査団

Appendix-3 Unit Husk Consumption of Rice Husk Gas Engine

Younetalin Village, Hinthada District, Ayeyarwady Division installed a RH-14 (140 HP) rice husk gas engine and 135 kVA generator of MIC in April 2001. It has been supplying power to 420 households for 5 hours a day from 18:00 to 23:00.

The unit husk consumption was roughly preliminarily in the two ways as described below:

5 baskets of husk = 1 gallon of diesel

According to MIC, the typical husk consumption may be said that 5 baskets of husk = 1 gallon of diesel.

1.	Electricity that 1 gallon of diesel oil can generate	10 kWh (standard of MEPE old diesel generators of 100 kW+, corresponds to efficiency at 20.5 % as (860 kcal/kWh x 10 kWh) / (4.546 l x 9,250 kcal/l). New diesel generator of 100 kW+ has efficiency of 32%.)
2.	Unit consumption of husk	5 baskets @ 11 pounds @ 0.454 kg = 25 kg
3.	kWh consumption of husk	25 kg/10 kWh = 2.5 kg/kWh

15 baskets of husk per hour at Younetalin Village

1.	Daily husk consumption for 5 hour operation	60 baskets = 12 baskets/hour on an average
2.	Peak hourly husk consumption (MIC source)	15 basket @ 11 pounds @ 0.454 kg = 75 kg/hr
3.	Average power demand	(20 W lamps x 2 nos.) + 15 W electric appliance on average = 55 W
4.	Streetlights	20W x 40nos. = 0.8 kW
5.	Total power demand in the village	55W x 420 h.h. + 0.8 kW = 23.1 kW
6.	Power to be generated	23.1 kW x 1.05 (5 % loss) = 24.3 kW
7.	kWh husk consumption	75 kg/hr / 24.3 kW = 3.1 kg/kWh

The first estimate of the kWh husk consumption is 2.5 kg/kWh and the second is 3.1 kg/kWh. These figures in China are reported to be 2.0-2.2 kg/kWh. The first estimate of 2.5 kg/kWh is tentatively adopted in the Guidelines for basic planning of the RE schemes by rice husk gas engine. If the actual consumption is 3.0 kg/kWh, the rice husk will be needed by 20 % more.

MIC has a plan to measure the kW consumption more accurately in late 2001.

Appendix-4 Necessary Rice Husk for Village Electrification

Necessary Rice Husk for Power Supply

Assuming one household uses three numbers of 20 W fluorescent lights and electric appliances equivalent to 15 W average consumption, household consumption becomes 75 W. For the convenience of the basic planning, it may be assumed that unit power consumption is 80 W per household including 5% loss of distribution.

With the assumed unit husk consumption rate at 2.5 kg/kWh of the rice husk gas engine (see Appendix-3), the required rice husk for daily power supply for 5 hours would be as shown in Table A4.1.

Table A4.1 Required Husk for Power Supply by Gas Engine

Supply Hour at 5 hour/day

No.	Village Size	Rice Husk Consumption		
		Daily		Monthly
	h.h.	baskets	kg	kg
1	100	20	100	3,000
2	200	40	200	6,000
3	300	60	300	9,000
4	400	80	400	12,000
5	500	100	500	15,000

Source: JICA Study Team

Rice Husk Discharged from Village Rice-Mills

For example, assume a village size at 300 households (actual number of those who wish to receive power supply). Then, the daily rice husk consumption will be 300 kg (notice the same figure as the village size in the case of 5 hour power supply), and the monthly 9 tonnes.

In Myanmar the farmers keep paddy, after selling fixed amount to the Government, in his storage and sell it to the market depending on the market price. These paddy sold to the Government and market will be milled at medium to large scale rice-mills located near large cities or local towns and husks will be discharged there (not in the paddy cultivating region but near the consumption area).

On the other hand, the rice for self-consumption of the farmers will be milled from time to time at small scale village rice-mills mostly having a capacity of 2.5 tonnes/day and sometimes 10-15 tonnes/day. The rice husk produced from this milling will remain in the villages.

The amount of this village husk is estimated below:

Table A4.2 Power Potential of Husks only from Village Rice-Mills

● Average family size	6 persons per family
● Population in the village assumed	6 x 300 h.h. = 1,800
● Per capita rice consumption	Average in Myanmar at 130 kg/yr = 0.36 kg/day
● Total daily rice consumption in the village	0.36 kg/day x 1,800 = 650 kg/day
● The paddy to produce this rice	650 kg/day ÷ 0.61 = 1,060 kg/day
● The husk produced from this paddy	1,060 kg/day x 0.2 = 210 kg/day
● Possible power supply hours per day with this husk	210 kg/day ÷ (300 h.h. x 0.080 kW x 1 hr x 2.5 kg/kWh) = 3.5 hours

Source: JICA Study Team

As shown above, the husks produced from the village rice-mills through milling only for self consumption of the villagers have potential, if all the husks are used for power generation, to generate electricity for supply of 75 W (plus 5% loss) to each household for 3.5 hours a day. In other words, the husks only from the village rice-mills for self consumption are not sufficient for supplying power for 5 hours a day. Sources of rice husks should be sought also from outside the village.

Number of Village Rice-mills

As shown in Table A4.3, the village with 300 households would need 2-3 rice-mills of 2.5 tonnes/day capacity scale only for milling of the paddy for the villagers self consumption.

Table A4.3 Number of Village Rice-Mills Required for Self Consumption

● Operation months of 2.5 tonnes/day scale rice-mills	10 months a year except for September and October
● Operation days of the rice-mills	30 days x 10 months x 50% = 150 days
● Average rice production of one mill	2,500 kg/day x 12 hr/24 hr x 150 days/365 days = 514 kg/day
● Nos. of required 2.5 tonnes/day scale rice-mills in the village	650 kg/day ÷514 kg/day/rice-mill = 1.3 nos. → 2 rice-mills required.

Source: JICA Study Team

Existing Uses of Rice Husk

There are various kinds of uses of the rice husks as listed below:

- Cooking: 12 baskets of husks per family per month, equivalent to 12 x 11 pounds x 0.454 kg/pound = 60 kg/month = 2.5 kg/kWh x 24 kWh = 80 W x 10 hr x 30 days.

The husk consumed for cooking is almost equivalent to that consumed for power generation of 80 W for 10 hours a day.

- Rice-mills, oil-mills, vermicelli drying factory, ice plant: rice husk gas engine is used as source of power and electricity for the plant. Some supply power also to the neighbouring households.
- Poultry: used for bedding materials and old ones are used as fertilizer.
- Brick, spirits distillery, pottery (water tanks): used as fuel for heating.
- Others (textile dying, some industry for heating, etc.)

In the case of rice-mills using husk gas engine as source of power, it consumes about one half of the husks produced. Accordingly, the greatest issue of the RE scheme with rice husk gas engine is to find and secure the source of husk supply nearby the village.

As biomass gas engine, it is theoretically possible to use, in addition to rice husk, wood chip, sawdust, comb of maize, aged rubber trees, etc. However, except for rice husk there is only one example of application of wood chip being used in a gold mine in Kachin State.

Appendix-5 Characteristics of Rural Area in Myanmar

(1) Rural Population

The population in Myanmar was 46,400,000 in 1997 and 75% lived in rural area[i].

(2) Agriculture as Major Industry

The agriculture sector shared 34% of the GDP at constant value, followed by the trade sector at 20%, and the processing and manufacturing sector at 9%[1].

The processing and manufacturing sector showed a low growth rate at 0.2%/year in the last 10 years. The insufficient power supply has been one of the causes of this very low growth rate[ii].

(3) Population movement

Inflow of people into Yangon was recorded at 410,000, and 50,000 into Mandalay (labor force survey 1990). However, 500,000 people moved from urban to rural areas on the other hand. The ratio of urban and rural population has been almost unchanged. Such industrialization accompanied by the population movement from rural to urban areas as had been observed in the Asian countries in the past 20 years may have not taken place in Myanmar[iii].

(4) Effect of Market Economy

In Myanmar the land belongs to the Government. The Government provides people with cultivating or utilizing rights of the farming land with registration. The people reportedly cannot sell such right or put it in pawn (*There is opposite information that people can sell and buy the right on the use of land*). However, the rental of such rights to other farmers was observed for short duration like within the dry season. For example, when the registered farmer has difficulty to implement the farming plan to follow the notices of the Government, he may lend his land temporarily to those who have necessary machines and fertilizer. These effects had been observed in the rural area after introduction of the change in the economic policy from the planned economy to the market economy in 1988[iv].

(5) Township Chairman as Core of Rural Administration

The township SPDC are controlled and managed by the district and or divisional PDC. The township SPDC manages the township including quarters and village tracts. The chairman of township PDC is the center of the rural administration. The chairman is on volunteer basis[v].

(6) Donation to Monastery

Villagers in Myanmar have deep religious minds. Based on the understanding that donation is the most virtuous thing in the human’s life, people have habit to donate all the reserve to monastery or monk at the end of each year. They keep the reserve when they need contribution to a village project like repairing school building, reconstruction of houses got fired, etc. There may be social and cultural background in Myanmar that supports promotion of RE on a self-help basis with villagers' leadership and contribution both in financing and labor[vi].

(7) Average Education at Primary School

The Government implements the education system in three courses; Basic, Higher, and the Vocational Education. The Basic course starts from entering kindergarten at the age of 5 years, followed by 5 years of Primary School, 4 years for Middle, and 2 years for High School, resulting in a total of 11 years education. This is often referred to as 5-4-2 system. Those children who cannot attend Primary School may get education from private Monastic School system which is provided free of charge by monks at monasteries. Myanmar has preserved this education system since long years ago. There is a record showing 31 such schools were operated in 1867. The Ministry of Social Welfare, Relief and Resettlement provides night schools.

The 11 year education is referred to by continuous "Grade" from the First of Primary School to Tenth (first grade of High School). The Government provides the national examination called BEHS (Basic Education High School) to the students before graduation from High School. The students who passed the BEHS examination are graded "A" and are entitled to receive higher education at Universities or Institutes, and "B" to receive higher education for Teacher Training, Government Technical Institute, etc.

According to the Household Income and Expenditure Survey (1997), 70% of villagers completed Primary School, 16% not educated at all, 9% completed Middle School, and 3% completed High School. The ratio of higher education completed was at 1%, and vocational education at 0.2%[vii].

(8) Medical and Healthcare

The Government provides medical and healthcare services in three stages. The primary stage consists of state hospital (SH), rural health center (RHC), sub center (SC) under RHC, and maternal and child health center. The second stage consists of district hospital (DH) and township hospital (TH). The tertiary stage consists of general hospital and specialized hospital. The district hospital and township Hospital are the centers of rural medical and healthcare services. There are 1,402 RHCs nationwide, equivalent to 17 times the primary and secondary service facilities in urban areas. However, the number of RHC may be small compared with the number of Primary School estimated at around 26,000[viii].

(9) Income and Expenditure Levels

Monthly Income and Expenditure Survey was executed on 25,470 households nationwide including 45 townships both urban and rural in November 1997. The average monthly household income level was K13,006 for urban and K8,906 for rural. The average monthly household expenditure level was K15,266 for urban and K13,091 for rural. Countermeasures taken to fill the gap of the income and expenditure were not clear. In terms of the monthly rural household expenditure, Tanintharyi division was ranked at top at K19,041, followed by Shan State at K15,815, Kachin State at K15,494, and Kayin State at K14,947. All the top four states/divisions have international borders.

One of the characteristics of the expenditure is high Engel's coefficient; 68% in urban and 72% in rural[ix].

(10) Expenditure for Lighting and Heat

The average monthly household fuel and lighting expenditure was K638 or 4.9% of the total expenditure. That for urban was K736 or 4.8%. The fuel type for cooking in rural households was firewood at 93%, charcoal at 4%, and electricity at 1%. Lighting source of rural household was 18% by electricity, 32% by battery, and 50% by others[9].

(11) Consumption Expenditure Level in 1999

CSO (Central Statistical Organization) of the Ministry of National Planning and Economic Development surveyed the monthly expenditure in 1999 on 3,240 urban and rural households in the six border townships. Though the surveyed townships were different from those surveyed in 1997, the expenditure was compared with the rural average of those states/division which the six townships belong to. The Engel's coefficient was at a similar level of 72%. The fuel and lighting expenditure was 1.6 point higher than the previous 5.0%. The expenditure figure was K27,107, being much higher than K15,015 in 1997[1].

(12) Income and Expenditure level in 2001

A village social survey was executed under the Study in order to get the latest data/information regarding the living conditions, villagers' needs for electricity, and their will for electrification. The survey was executed in May-June 2001. It was executed in Southern Shan, Northern Shan, and Kachin State.

The number of households surveyed is 1,348 in total comprising non-electrified (956) and electrified (392) households. Table A5.1 shows income and expenditure.

Table A5.1 Income, Expenditure, Saving, and Donation

(Units: Kyat/year/household)

Items	Non-electrified	Electrified	Total
1. Income	266,329	380,447	289,440
2. Expenditure	226,756	310,269	243,670
3. Saving	39,572	70,178	45,771
4.Donation	10,213	15,346	11,253
5. Per Capita Expenditure	39,782	43,700	40,612

Source: JICA Study Team

The income level in electrified villages was higher than that in non-electrified villages for all the three areas surveyed. It was K380,000 in electrified and K270,000 in non-electrified villages on an average, resulting in an overall average of K290,000 a year. The average per capita expenditure was K41,000 per year (K44,000 in electrified and K40,000 in non-electrified).

Appendix-6 (1/2)　Estimated Unit Power Demand

Object	Accessibility ratio, %	Step		Watt	Simul-taneous use, %	Watt		Watt	Simul-taneous use, %	Watt
1. Household		1-1	a. 3 Lights	90	100		a. 3 Lights	90	15	
Shan South	87		b. Radio	10	30		b. Radio	10	15	
Shan North	84		c. TV (60w)	30	85		c. TV (60w)	30	15	
Kachin	93		Ownership ratio				Ownership ratio			
Total (Un-Ele	87		50%				50%			
ctrified)			Total	130	90%	118	Total	130	15%	20
Total (Electri-	92	1-2	1-1	130	90		1-1	130	15	
fied)			d. Rice Cooker	90	50		d. Rice Cooker	90	30	
Total	88		Ownership ratio				Ownership ratio			
			15%				15%			
			Total	220	70%	163	Total	220	20%	44
2. Public										
2.1 Street Light	100	1. 40w Tube 10/Place		50	100	2,000				0
2.2 Temple	100	1. Light 20wTubex30		600	67		1. Light 20wTubex30	600	0	
		2. TV 1x60w		60	50		2. TV 1x60w	60	0	
		3. Fan 4 x 60w		240	20		3. Fan 4 x 60w	240	50	
		4. Refrigerator(100w)		100	50		4. Refrigerator(100w)	100	100	
		5. A/C:1x1KW		1,000	0		5. A/C:1x1KW	1,000	50	
			Total	2,000	30%	528	Total	2,000	40%	720
2.3 Hospital	100	1. Outer light					1.Outer light			
		20w Tube x 1		20	100		20w Tube x 1	20	0	
		2. Inner light					2. Inner light			
		40w Tube x 5rooms		200	50		Night demand x 50%	200	25	
		3. Refrigerator					3. Refrigerator			
		130w x 1		130	100		130w x 1	130	100	
			Total	350	70%	250	Total	350	50%	180
2.4 Clinic	100	1. Outer light					1.Outer light	20	0	
		20w Tube x 1		20	100					
		2. Inner light					2. Inner light			
		40w Tube x 4rooms		160	50		Night demand x 50%	160	25	
		3. Refrigerator					3. Refrigerator			
		130w x 1		130	100		130w x 1	130	100	
			Total	310	70%	230	Total	310	50%	170
2.5 High School	100	1. Outer light		20			1.Outer light	20	0	
		20w Tube x 1								
		2. Inner light		5,760			2. Inner light	5,760	20	
		Class room (36)					For cloudy, rainy day			
		40w Tube x 4 x 36					use: 5,760x20% use			
		3. Head Master room					(50days/250days/year)			
		40w Tube x 1		40			3. Head Master room	40	20	
		4.Copy machine					4. Copy machine			
		300w x 10%		300			300w x 10%	300	10	
		5. Computer room					5. Computer room	80	100	
		40w x 2		80			40w x 2			
			Total	6,200	0%	0	Total	6,200	20%	1,270
2.6 Middle School	100	1. Outer light		20			1.Outer light	20	0	
		20w Tube x 1								
		2. Inner light		1,280			2. Inner light	1,280	20	
		Class room (8)					For cloudy, rainy day			
		40w Tube x 4 x 8					1.280x20%			
		3 Head Master room					(50days/250days/year)			
		40w Tube x 1		40			3. Head Master room	40	20	
		4 Copy machine		300			4. Copy machine	300	10	
		300w x 10%					300w x 10%			
			Total	1,640	0%	0	Total	1,640	20%	290

Source: JICA Study Team

Appendix-6 (2/2) Estimated Unit Power Demand

Object	Accessibility ratio, %	Step		Watt	Simul-taneous use, %	Watt		Watt	Simul-taneous use, %	Watt
1. Household		1-1	a. 3 Lights	90	100		a. 3 Lights	90	15	
Shan South	87		b. Radio	10	30		b. Radio	10	15	
Shan North	84		c. TV (60w)	30	85		c. TV (60w)	30	15	
Kachin	93		Ownership ratio				Ownership ratio			
Total (Un-Ele	87		50%				50%			
ctrified)			Total	130	90%	118	Total	130	15%	20
Total (Electri-	92	1-2	1-1	130	90		1-1	130	15	
fied)			d. Rice Cooker	90	50		d. Rice Cooker	90	30	
Total	88		Ownership ratio				Ownership ratio			
			15%				15%			
			Total	220	70%	163	Total	220	20%	44
2. Public										
2.1 Street Light	100		1. 40w Tube 10/Place	50	100	2,000				0
2.2 Temple	100		1. Light 20wTubex30	600	67		1. Light 20wTubex30	600	0	
			2. TV 1x60w	60	50		2. TV 1x60w	60	0	
			3. Fan 4 x 60w	240	20		3. Fan 4 x 60w	240	50	
			4. Refrigerator(100w)	100	50		4. Refrigerator(100w)	100	100	
			5. A/C:1x1KW	1,000	0		5. A/C:1x1KW	1,000	50	
			Total	2,000	30%	528	Total	2,000	40%	720
2.3 Hospital	100		1. Outer light				1.Outer light			
			20w Tube x 1	20	100		20w Tube x 1	20	0	
			2. Inner light				2. Inner light			
			40w Tube x 5rooms	200	50		Night demand x 50%	200	25	
			3. Refrigerator				3. Refrigerator			
			130w x 1	130	100		130w x 1	130	100	
			Total	350	70%	250	Total	350	50%	180
2.4 Clinic	100		1. Outer light				1.Outer light	20	0	
			20w Tube x 1	20	100					
			2. Inner light				2. Inner light			
			40w Tube x 4rooms	160	50		Night demand x 50%	160	25	
			3. Refrigerator				3. Refrigerator			
			130w x 1	130	100		130w x 1	130	100	
			Total	310	70%	230	Total	310	50%	170
2.5 High School	100		1. Outer light	20			1.Outer light	20	0	
			20w Tube x 1							
			2. Inner light	5,760			2. Inner light	5,760	20	
			Class room (36)				For cloudy, rainy day			
			40w Tube x 4 x 36				use: 5,760x20% use			
			3. Head Master room				(50days/250days/year)			
			40w Tube x 1	40			3. Head Master room	40	20	
			4.Copy machine				4. Copy machine			
			300w x 10%	300			300w x 10%	300	10	
			5. Computer room				5. Computer room	80	100	
			40w x 2	80			40w x 2			
			Total	6,200	0%	0	Total	6,200	20%	1,270
2.6 Middle School	100		1. Outer light	20			1.Outer light	20	0	
			20w Tube x 1							
			2. Inner light	1,280			2. Inner light	1,280	20	
			Class room (8)				For cloudy, rainy day			
			40w Tube x 4 x 8				1.280x20%			
			3 Head Master room				(50days/250days/year)			
			40w Tube x 1	40			3. Head Master room	40	20	
			4 Copy machine	300			4. Copy machine	300	10	
			300w x 10%				300w x 10%			
			Total	1,640	0%	0	Total	1,640	20%	290

Object	Accessibility ratio, %	Step	Watt	Simul-taneous use, %	Watt		Watt	Simul-taneous use, %	Watt
2.7 Primary School	100	1. Outer light 20w Tube x 1	20			1.Outer light	20	0	
		2. Inner light Class room (8) 40w Tube x 8	320			2. Inner light For cloudy, rainy day use: (50days/250days/year)	320	20	
		3 Head master room 40w Tube x 1	40			3. Head Master room	40	0	
		Total	380	0%	0	Total	380	20%	65
3. Business									
3.1 Restaurant		1. Inner light 40w Tube x 4	160	100		1. Inner light	160	0	
		2. 21" CTV (95w)	95	100		2. 21" CTV (95w)	95	100	
		3. Refrigerator 130w x 1	130	100		3. Refrigerator 130w x 1	130	100	
		4. Rice Cooker 600w x 2	1,200	30		4. Rice Cooker 600w x 2	1,200	30	
		5. Hot plate 800w x 2	1,600	20		5. Hot plate 800w x 2	1,600	20	
		Total	3,185	30%	1,070	Total	3,185	30%	905
3.2 Guest House	100	1 Tube 20w x 22 room	4,400	50		1 Tube 20w x 22 room	4,400	20	
		2. 20w x 2 Toilet	40	20		2. 20w x 2 Toilet	40	20	
		3. Refrigerator 130 w x1	130	100		3. Refrigerator 130 w x1	130	100	
		4 Fan 60w x 4	240	50		4 Fan 60w x 4	240	50	
		5 21"TV 95w x 1	95	100		5 21"TV 95w x 1	95	100	
		Total	4,905	50%	2,550	Total	4,905	30%	1,230
3.3 Hotel	100	All facilities for 22 rooms/Hotel	7,000	80%	5,600	All facilities for 22 rooms/Hotel	7,000	70%	4,900
4. Cottage or Household Industry									
4.1 Rice Mill			5,000	0%	0	1. Motor	5,000	80%	5,000
4.2 Oil Mill			7,000	0%	0	1. Motor	7,000	80%	7,000
4.3 Powder Mill			5,000	0%	0	1. Motor	5,000	80%	5,000
4.4 Sugarcane Processing			5,000	0%	0	1. Motor	5,000	80%	5,000
4.5 Saw Mill			5,000	0%	0	1. Motor	5,000	80%	5,000
4.6 Paper Mill			5,000	0%	0	1. Motor	5,000	80%	5,000
4.7 Tofu Manufacturing			4,000	0%	0	1. Motor	4,000	80%	4,000
4.8 Noodle Mill			7,000	0%	0	1. Motor	7,000	80%	7,000
4.9 Furniture Manufacturing			5,000	0%	0	1. Motor	5,000	80%	5,000
4.10 Iron Work (including car, Trawlergyi, boa etc.repair shop)			4,000	0%	0	1. Motor	4,000	80%	4,000
4.11 Battery Charge Station (BCS)			1,500	0%	0	1. Motor	1,500	80%	1,500
4.12 Weaving			5,000	0%	0	1. Motor	5,000	80%	5,000
4.13 Water Pump			200	0%	0	1. Motor	200	80%	200

Note: It is assumed 15% of household will have 600 W Rice Cooker certain years after electrification.
For Namlan Village, 2 Saw Mills have total 4 machines at 20kW

Source: The Study Team

Appendix-7 (1/4) Selection Criteria for RE by Small and Mini Hydros (>50 kW)

No.	Parameters	Criteria for Selction (Qualification)
1	Possibility of extension of distribution lines from Grid	L > 30 km or Grid has no extra power for RE --> then by hydro
2	Possibility of power supply by rehabilitation of existing small hydros nearby	Not exist, or not possible to rehabilitate --> then by new hydro
3	Length of new access road	L < 10 km
4	Length of road from site to target villages	L < 0 km
5	Number of households in the target villages	n > approximately 500
6	Installed capacity P_i	50 kW < P_i < 10,000 kW
7	Intake weir height	H < 15 m
8	Storage dam height	H < 50 m
9	Pond/reservoir surface area	A < 5 km^2
10	Headrace tunnel	L < 2,000 m
11	Headrace channel	L < 5,000 m
12	Penstock	L < 1,000 m
13	Design head of turbines	H_d < 500 m
14	Design discharge of one turbine	Q_d < 2.0 m^3/s
15	Type of powerhouse	surface

Souce: JICA Study Team.

Appendix-7 (2/4) Selection Criteria for RE by Micro and Pico Hydros (<50 kW)

No.	Parameters	Criteria for Selction (Qualification)
1	Possibility of extension of distribution lines from Grid	L > 10 km or Grid has no extra power for RE
2	Possibility of power supply by rehabilitation of existing small hydros nearby	Not exist, or not possible to rehabilitate
3	Length of new access road	L < 1 km
4	Length of road from site to target villages	L < 1 km, if it exceeds 1 km, costs of transmission lines will significantly increase.
5	Number of households in the target villages	n < 300-500
6	Installed capacity P_i	P_i < 50 kW
7	Design head of turbines	H_d < 30 m
8	Design discharge of one turbine	Preferably Q_d < 0.5 m^3/s in general, refer to Design Manual-Village Hydros in Vol. 4 for required discharge by head and village size.

Souce: JICA Study Team.

Appendix-7 (3/4) Selection Criteria for RE by Solar-Wind BCS

No.	Parameters	Criteria for Selction (Qualification)
1	Possibility of extension of distribution lines from Grid	L > 1 km
2	Existence of ricemills or sawmills nearby	Not exists nearby except for small scale ones which cannot meet fuel requirement of Biomass Gas Engine
3	Existence of adequate hydro potential nearby	Not exists.
4	Accessibility to the target villages (road driving hours from Yangon, Mandalay, or other large urban centers nearby in the rainy season)	T > 3 hr or road not passable in the rainy season
5	Number of households in the target one village	n < approximately 100

Souce: JICA Study Team.

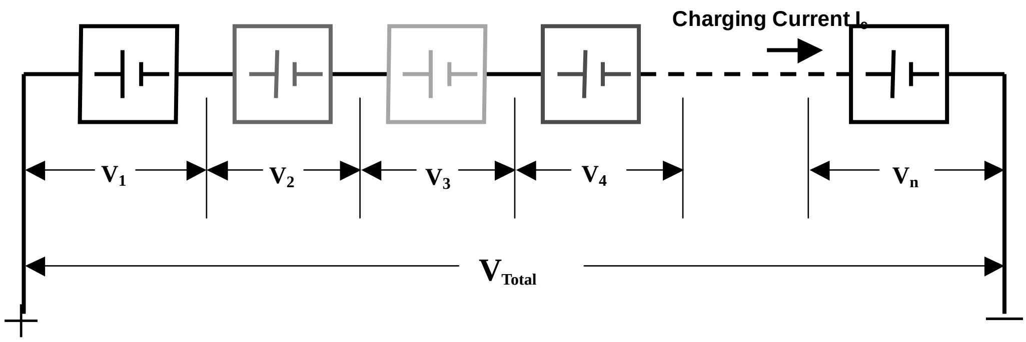
Appendix-7 (4/4) Selection Criteria for RE by Biomass Gas Engine

No.	Parameters	Criteria for Selction (Qualification)
1	Possibility of extension of distribution lines from Grid	L > 1 km or Grid has no extra power for RE
2	Existence of suitabe hydro potential nearby	Not exists.
3	Existence of ricemills or sawmills	Exists nearby and can meet the fuel requirement of Biomass Gas Engine
4	Number of households in the supply area	500 > n > 100, a village of smaller size would increase unit cost per household beyond affordable range.

Source: JICA Study Team.

Appendix-8 Common Issues of Battery Charging for Lighting and Recommended Parallel Charging

It is quite common that batteries are serially connected for charging at BCSs in Myanmar. However, this serial charging will deteriorate batteries. All of the batteries connected would have different conditions in charging impedance, state of remaining energy, and voltage capacity. Life expectancy of each battery is also different. A deteriorated battery has large impedance. When these batteries are charged under serial connection, some deteriorated batteries will be over-charged and the others will get insufficient power for charging. Repetition of the over-charging or under-charging will shorten the life of the batteries. Charging should be executed to the full charged revel.



Source: JICA Study Team

Figure A8.1 Constitution of Charging Voltage

$$V_{total} = V_1+V_2+\cdot\cdot\cdot+V_n$$
$$= I_c \times R_1+ \cdot\cdot\cdot I_c \times R_n$$

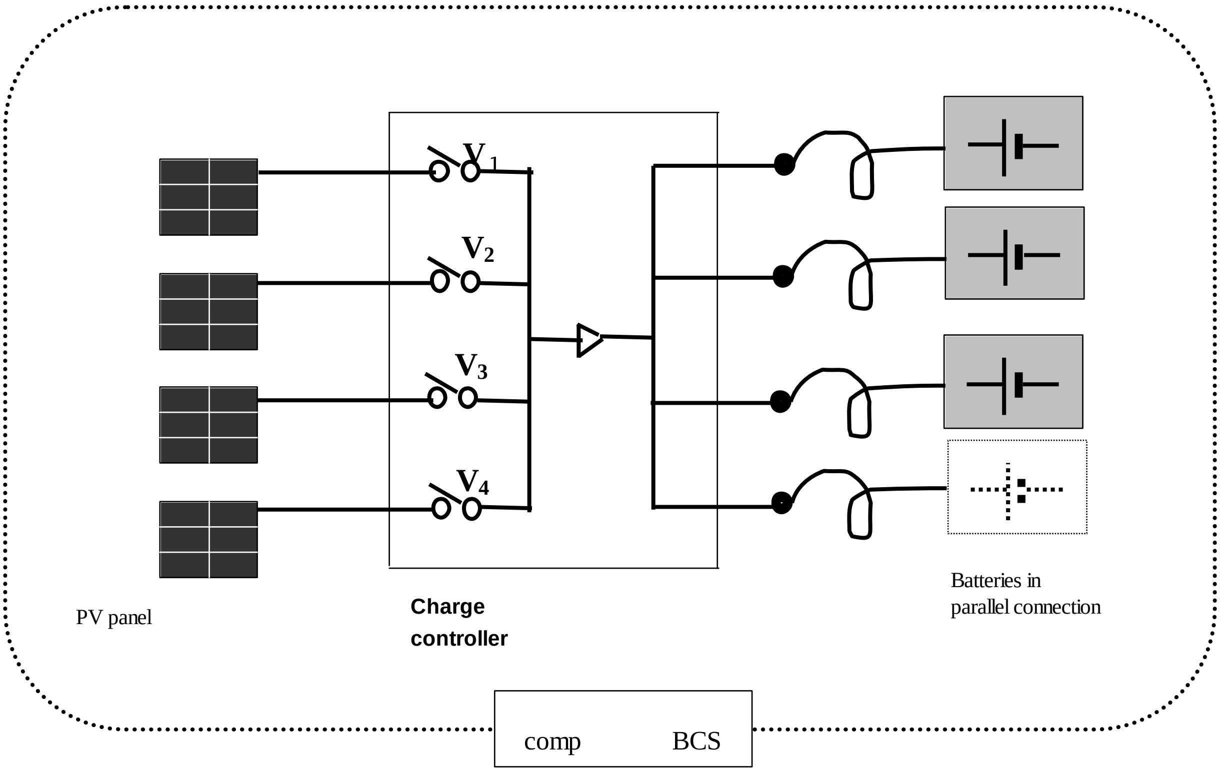
where,

V_{total}:	Tatal voltage
$V_1 \cdot\cdot V_n$:	Battery voltage under charge
I_c :	Charging current
$R_1 \cdot\cdot R_n$:	Charging impedance of batteries

I_c is common among the batteries serially connected. The impedance of a deteriorated battery is higher than rated impedance of normal battery. Mixing an over-used battery of large impedance (ex. R_4) in the serial connection will increase its charging voltage V_4 (= I_c x R_4) exceeding the allowable voltage, which leads to cause electrolysis of the battery water. Energy intended for charging is consumed for the electrolysis, and the charging current I_c of the system is reduced. Then, a longer time is needed for the charging of the other normal batteries. On the other hand, it drops the charging voltage of the other batteries V_1, V_2,…, as V_{total} is constant, and the charging finishes before these are fully charged (since charging at

BCS is usually ended by time elapsed). Half-charging causes the education of lead on the electrode, which shorten the battery life.

To avoid these problems, all of the batteries of the same rated voltage, 12 V for example, should be connected in parallel as shown in Figure A8.2, where all the batteries are to be charged under the same voltage up to the fully charged voltage level. Batteries of different voltage should be separately charged. Otherwise the life of batteries will be significantly shortened.



Source: JICA Study Team

Figure A8.2 Recommended Parallel Connection for Battery Charging

Appendix-9 Forms for Interview Survey for RE with Solar-Wind Power

(1/2) Form for Demand Survey of Each Consumer

Type/Name of Consumer: ______________________________

Date of survey: ____________________

Fill in features like family size for household, number of pupils for school, etc.

No.	Electric Appliances	Type	Power	Number	Voltage	Daily Use	E (Wh/day)
		DC	W		V	hours	
			A	**B**	**C**	**D**	**AxBxD**
1	Lamp	FL	20	1	12	5	100
2	Lamp	Bulb					
3	Lamp						
4	Radio	RadiCasse					
5	TV						
6							
7							
		Total Appliaces No:		1	Total Power Use: **(E)**=		100

2. Calculation of Battery Capacity				
Power Demand, **Pd=**	(E)/0.706/0.87=		163	Wh/day
Battery Voltaga:		V=	12	Volt
Charging Interval:		Int=	4	days
Battery Capacity: Bc=	Pd x Int/V/0.7=		78	Ah
Choose Battery Capacity from here:			10, 20, 30, 5(	Ah
Your Battery Capacity:	50	Ah x	2	Cells
3. Now, Your power consumption is estimated as			3.0	kWh/month.
So, You will have to pay money of		15	Kyat every month,	
since the unit charge will be estimated as		5	Kyat/kWh.	(Note-3)

(light grey)	Data Input Column
(dark grey)	Automatic Calculation

Note: If nothing particular, please select appliances based on 12V, which is highly recommended, and economical. The selection of voltage other than 12V would be rather more expensive than that of 12V.

(2/2) Form for Village Summary

Sheet No: /

Village Name ____________________ **Township:**____________________

Total No of Household ______________ **State:** ____________________

No.	Name	Power Demand	Required Nos. of Batteries by Siz			Remarks
			Standard, 12V			
		Wh/day	50Ah	30Ah		
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
Total for Housholds Use:						
	Monastery					
	Primary School					
	Village Office					
	Clinic					
	Community Center					
Total for Public Facilities Use:						
Grand Total						

Appendix-10 Planning Sheets for RE by SHS

Table A10.1 Past Example of SHS Installations in Foreign Countries

1	Name of Country	Sri Lanka	Indonesia	Nambia	Brazil	Bolivia		
2	Reported Year	Started from 1997	Started from 1997	Started from 1997	Started from 1995	Started from 1996	Started from 1998	Started form 2001
3	Fund	GEF,RB	WB	SUSAID, Covernment, etc	GTZ/CEMIC	Government of Spain	USAID	JICA
4	System Configuration							
	1) PV Panel	50W x 1 set	50W x 1 set	50W x 1 set, 100 W x 1 set	50W x 1 set	50 W x 1	53W x 1 set	50W x 1 set
	2) Battery	100Ah x 1set	70 Ah x 1 set	100 Ah x 1 set	100Ah x 1set	100 Ah x 1 set	100 Ah x 1 set	99.12Ah
	3) Controller	1 set	1 set	1set	1 set			1 set
	4) Lamp	10W x 7 sets				15W x 3 sets	7 W x 3 sets	15W x 3 sets
	5) Wall Sockets	8 sets						
	6) Internal Wiring	1 set for all above						
5	Way of Operation	Personal Ownership	Personal Ownershi	Personal Ownership	Rental to Users	Rental to Users	Personal Ownership	
6	Bank Loan System							
	1) Initial Installment	Rp 115.75 [*1]	US$ 75-100	20% of capital cost			USD 90	Bs.600[*3]
	2) Monthly Payments	Rp 13.89	up to US$ 10	Payment to be finished		US$ 2	None	Bs. 22
	3) Payment Months	36 Months	48 Months	within 5 years			None	
	4) Maintenance Cost	Included above						
	5) Monthly Rental Fee				US$ 5			
	6) Payment Condition			Yearly interest at 5%			No interest	
7	Others							
	1) Total Repayment by Loan System	Rp 615.75		US$ 892, USD 1,700		US$ 700	US$ 720	Bs.5300
	2) Cost of Lump-sum Payment	Rp 509.26						
8	Data Source	Direct Interview in October, 2001	JEPEA Report, March, 2001	JEPEA Report, March, 2001	JEPEA Report, March, 2001	JICA Report, September, 2001	JICA Report, September, 2001	JICA Report, September,2001

*1 Japan Photovolatic Energy Association
*2 US$1 = Rp 86.4 as of October 10, 2001
*3 US$1 = Bs.5.98 as of September, 2001

Table A10.2 Planning Sheet for SHS

	Calculation for	Village of :						
	Calculation Item							
	1.	Name of System	Numbers	Unit		Power, W	Hour	No.	Wh/day
Demand		Village "Sample"	50	Sets	Lamp	20	5	1	100
					Lamp				0
					Radio	5	5	1	25
					Others	6	0		0
					Total	＊	＊	2	125
		Daily Total Power Demmand:		P_{DD}	125	Wh/day			
		Monthly Total Power Demand:		P_{MD}	4.7	kWh/Month			(Note-4)

	2.	**Battery**			
Battery Capacity	a)	Type of Battery		Acid-lead (A/L) battery, recyclable batteries commonly used in Myanmar	
	b)	Ah-Capacity Ah	C_B	50	Ah
	c)	Nominal Voltage	V_N	12	Volt
	d)	Total Capacity of Battery Bank	C_{BB}	600	Wh X Nos of battery
Battery Efficiency	e)	Charge-discharge efficiency of L/A Battery	K_3	83%	
	f)	Inferiority against L/A Battery	K_{INF}	85%	
	g)	Total Efficiency of Charge-discharge	K_{total}	70.6%	
	h)	Circuit Loss Factor	K_4	0.87	
	i)	Interval of Battery Charge:	D_A	4	days
	j)	Depth of Discharge	B_{DOD}	70%	
Battery require mnet	k)	Required Capacity of Battery	C_{CB} *1	97.0	Ah (Note-3)
	l)	Nos of Battery	N_B	2	Cells
	3.	**Calculation of PV Array Capacity**			
Factors peculiar to PV	a)	Unit Capacity of PV Panel	C_P	50	W
	b)	Conv. Efficiency of PV Panel	E_P	12.5%	
	c)	Area of PV Panel	A_P	0.4	m^2
Factors dependedt on area condition	d)	Irradiation	R_M	4.35	$kWh/m^2/day$ (Note-1)
	e)	Margin Factor for PV Capacity	M	1.25	
	f)	Temp Degradation Factor	K_1	0.84	
	g)	Panel Contamination Factor	K_2	1.00	0.9 , if necessary (Note-2)
	h)	Other Loss Factor	K_M	0.90	
	4.	**Array Capacity**			
	a)	Calculated No of PV Module:	N_P	2	Sheets
	b)	Calculated PV Array capacity:	C_{PV} *2	100	W
	5.	**Durability of Battery**			
	a)	Calculated Interval		4.12464	days
	b)	Durability		OK	
	6.	**Total Capacity**			
	a)	No. of Household		50	household
	b)	Total Batteries used in theVillage		100	Sets
	c)	Total PV Capacity for Village		5	kW
	d)	Total Wind Turbine Capacity			kW X (Note-5)

needed for PV only

***1** $C_{CB}= P_{DD} \times D_A/V_N/(K_3 \times K_{INF})/K_4/B_{DOD}$

***2** $C_{PV}= C_P{*}N_P= C_P \times P_{DD} \times M/1000/R_M/(K_3 \times K_{INF})/K_4/K_1/K_2/K_M/E_P/A_P$

Note-1: Yearly Mean Irradiation Data of DOMH at Myitkyna (Max:5.60, Min:3.25kWh/m2/day)

Note-2: If necessary, to be replaced with "0.9" in stead of "1.0"

Note-3: Margin Factor(**M**) is not included here. If necessary, to be included.

Note-4: Margin Factor(**M**) is included here.

Note-5: For rough information, Wind Turbine Capacity to be estimated by referring Table A11.2 & Table A

Data of Typical PV Panel Specification								
Output	Wp		50	52	54	56	60	64
Efficiency	%		12.5	13.0%	13.5%	14.0%	12.3%	11.5%
Area	m2		0.40	0.40	0.40	0.40	0.490	0.5583
Manufacture		Mono-Silicon Type					Kyosera	MSK

Note for Input:	
	Data Input Column
	Coefficient, fixed
	Coefficient, variable
	Automatic Calculation

Appendix-11 Planning Sheets for RE by Solar BCS

Calculation Model: | **50** housholds | **20** W x | **5** hr/da | **1** set |

	Calculation Item	Case Study		Notes and Calculation Form
1.	Village Facilities	Total Power Demar		Note for Input:
1)	Power Demand for Public Facilities			Data Input Column
a)	Primary School	215	wh/day	Coefficient, fixed
b)	Village Office	210	wh/day	Coefficient, variable
c)	Clinic	180	wh/day	Automatic Calculation
d)	Community Center	0	wh/day	
	Power Demmand for P-facilities	605	wh/day	
	No of allotted batteries	11	Batteries	
2)	Households Use	No. of Households: 50	HH	
	Total Power Dmand	6250	wh/day	
	No of allotted batteries	100	Batteries	
3)	Grand Total of Power Demand	6855	wh/day	
	Total No of Batteries	111	Batteries	
2.	Battery			
a)	Type of Battery	Recyclable Batteries commonly used in Myanmar		
b)	Ah-Capacity and Nos Ah		Ah	(Note-3) (Note-4)
	Nos		Cells	
c)	Nominal Voltage	12	Volt	
d)	Capacity	67	kWh	=E23*E25
e)	Charge-discharge efficiency of L/A battery	83.0%		Degradation Factor
f)	Inferiority against L/A Battery	85.0%		Assumption Factor
g)	Total Efficiency of Charge-discharg	70.6%		=E27*E28
h)	Circuit Loss Factor	0.87		=ROUND(1-(1.5/12)*1.05,2)
f)	DOD	70%		
3.	Calculation of PV Array Capacity			
a)	Unit Capacity of PV Panel	54	W	PV Caracteristic
b)	Conv. Efficiency of PV Panel	13.5%		PV Caracteristic
c)	Area of PV Panel	0.4	M2	PV Caracteristic
b)	Interval of Battery Charge:	4	days	
c)	Irradiation	4.35	$kWh/m^2/c$	Note-3
d)	Margin Factor for PV Capacity	1.25		0capacity Margin
e)	Temp Degradation Factor	0.84		Degradation Factor
f)	Other Loss Factor	0.90		Degradation Factor

Power Demand for Public Facilities furnished with Lamps and Radio & Others

		Power	Duration	No	Total
		W	hour/day	set	Wh/day
Primary School	Lamp	20	5	2	200
Village Office	Lamp	20	3	3	180
Clinic	Lamp	20	3	2	120
Community Center	Lamp				0
Total				7	500

	Power	Duration	No	Total
Load	W	hour/day	set	Wh/day
Radio	5	3	1	15
Radio	5	3	2	30
Radio	5	3	4	60
Radio				0
Total			7	105

Power Demand for Households

	Power	Duration	No	Total
	W	hour/day	set	Wh/day
Lamp	20	5	1	100
Lamp				0
Cassette	5	5	1	25
Total			2	125

Calculation of Battery Capa

Demand Objects	Battery Cap & No Ah Cap.	Ah	Nos	Total No
H/H	97	50	2	100
P School	166.9	50	4	4
V Office	163	50	4	4
Clinic	139.7	50	3	3
C Center	0			
Total				111

Battery Nos & Capacity Ah-Class		Nos	Wh Capacity	
30	Ah	0	0	
40	Ah		0	
50	Ah	111	66600	
75	Ah	0	0	
100	Ah	0	0	
150	Ah			
200	Ah			
Total		111	67	kWh

Data Sheet: PV Panel Specification

Output	Wp	52	54	56	60	64
Efficiency	%	13.0%	13.5%	14.0%	12.3%	11.5%
Area	m2	0.40	0.40	0.40	0.490	0.5583
Manufacture		Mono-Silicon Type			Kyosera	MSK

		(Total for BCS)	(BCS/Household)	(SHS/P School)	(SHS/V Office)	(SHS/Clinic)	(SHS/C Center)	**(Total for BCS+SHS)**	Notes and Calculation Form
4.	Array Capacity								
a)	Calculated No of PV Module:	79 Sheets	72 Sheets	3 Sheets	3 Sheets	3 Sheets	0 Sheets	81 Sheets	Note-1
b)	Calculated PV Array capacity:	4.27 kW	3.89 kW	0.16 kW	0.16 kW	0.16 kW	0 kW	4.37 kW	=ROUND(E42*E33/1000,2)

			(Household)	(P School)	(V Office)	(Clinic)	(C Center)	Notes and Calculation Form
5.	Durability of Battery for H/H							
a)	Calculated Interval		4.12 days	4.80 days	4.91 days	4.30 days	days	Note-2
b)	Durability		OK	OK	OK	OK		=IF(E46/$E36>1,"OK","No Good")

Note-1: =ROUNDUP(E19*E38/1000/E37/E29/E30/E39/E40/E34/E35,0)
Note-2: =(Battery Capacity in use)x12x(DOD/100)/(Daily Power Demand)
Note-3: =IF(K23<50,10*ROUNDDOWN((K23/10+1),0),10*ROUNDDOWN((K23/2/10+1),0))
Note-4: =1+ROUNDDOWN(K23/E23,0)

Table A11.1 Planning Sheet of Solar PV Array for BCS (Sample for 50 Households Village)

Table A11.2 (1/2) Cost Estimate for Solar BCS (Sample for 50 Households Village)

No.	Items	Specification	nos.	Unit	Unit Price			Price
					Kyat or Yen		US$	US$
(A)	**BCS**							
(1)	PV Array							**7,562**
1)	PV Module	54W	79	set	30,000	Yen	60	4,740
2)	Terminal Box		32	set	40,000	Yen	80	2,560
3)	Arrester		77	pce	400	Yen	0.8	62
4)	Array Structure	Wooden & Aluminum Structure	1	set	100,000	Ky	200	200
							0	0
(2)	Controll Units							**4,920**
1a)	Charging Controller	1P/4P-12V, 20A Normal Ver.	20	set	80,000	Yen	160	3,200
1b)	Charging Controller	1P/4P-Variable V, 20A	12	set	20,000	Yen	40	480
1c)	Charging Controller	4P/4P-Variable V, 20A: Eco-Charge	3	set	200,000	Yen	400	1,200
2)	Management Board		1	set	20,000	Yen	40	40
							0	0
(3)	Domestic Utensils							**7,149**
1a)	Mobile Battery	Recyclable 12V, 50Ah made-in-Mya	134	set	17,000	Ky	34	4,556
1b)	Mobile Battery	Recyclable 12V, 75Ah	0		21,000	Ky	42	0
2a)	Lighting Kit	FL-20W	69	set	6,500	Ky	13	897
2b)	Lighting Kit	FL-10W			4,000	Ky		
2c)	Lighting Kit	FL-8W		set	3,500	Ky	7	0
3)	Radio for Public Use	No inclusion for personal use	8	set	25,000	Ky	50	400
4)	Internal Wiring Set		72	set	9,000	Ky	18	1,296
5)	Others		1	set		Ky	0	0
						Ky	0	0
(4)	Construction Work							**3,404**
1)	Erection Materials							1,428
a)	Cable & Wire	817,500	1	set	355,900	Ky	711.8	712
b)	Miscellaneous cabling materials	262,500	1	set	114,300	Ky	228.6	229
c)	Supportstructure & basement	560,000	1	set	243,800	Ky	487.6	488
2)	Workers	100	76	M-D	2,000	Ky	4	304
3)	Foreman	Electrician 15	12	M-D	4,000	Ky	8	96
4)	Manager	Engineer 15	12	M-D	9,000	Ky	18	216
5)	Designer	Engineer 15	12	M-D	15,000	Ky	30	360
6)	Transportation	1	1	set		Ky	1000	1,000
							0	0
(5)	Miscellaneous							**0**
1)						Ky	0	0
						Ky	0	0
	Total Summation for Item A							23,035
B	Battery Recycling Shop							
(1)	Necessary utensils, tools, working tables., etc.							**1,024**
1)	solar still		2	Set	80,000	Ky	160	320
2)	lead mould		2	Set	10,000	Ky	20	40
3)	lead nelting tool with compressor & nozzel		2	Set	50,000	Ky	100	200
4)	plates mounting jig set		2	Set	14,000	Ky	28	56
5)	water tank		1	Set	18,000	Ky	36	36
6)	acid soultion container		1	Set	12,000	Ky	24	24
7)	workshop table		1	Set	70,000	Ky	140	140
8)	plier,cutter & miscellaneous tools		1	Set	20,000	Ky	40	40
9)	tools and equipment shelf		1	Set	50,000	Ky	100	100
10)	hydrometer		1	Set	4,000	Ky	8	8
11)	thermometer		1	Set	1,500	Ky	3	3
12)	state of charge meter		1	Set	3,500	Ky	7	7
13)	multimeter/tester		1	Set	25,000	Ky	50	50
						Ky	0	0

Table A11.2 (2/2) Cost Estimate for Solar BCS (Sample for 50 Households Village)

No.	Items	Specification	nos.	Unit	Unit Price			Price
					Kyat or Yen		US$	US$
(2)	Provision of all parts and materials for recycling							**230**
1)	lead raw materials (50 sets)	16,000	1	Lot	9,200	Ky	18.4	18
2)	electrolite	9,000	1	Lot	5,200	Ky	10.4	10
3)	seperater	2,000	1	Lot	1,200	Ky	2.4	2
4)	standard lead plate	54,000	1	Lot	31,100	Ky	62.2	62
5)	empty battery	35,000	1	Lot	20,200		40.4	40
6)	battery cap & cover	3,500	1	Lot	2,100		4.2	4
7)	spare cabinet	75,000	1	Lot	43,100		86.2	86
8)	miscellaneous	5,000	1	Lot	2,900		5.8	6
(3)	Others for repairing							**0**
1)	Operator	10%				Ky	0	0
2)						Ky	0	0
	Total Summation for Item B							1,254
C	Shop with Stock Room							
(1)	Necessary utensils, tools, working tables., etc.					Ky		**200**
	Please specify here.		1	Set			0	0
							0	0
(2)	Provision of all FL lamps, electric/electronic parts and materials					Ky		122
1)	PV Module	54W =ROUNDUP(Calc_BCS!E3	2	set	30,000	Yen	60	120
2)	Terminal Box	=ROUNDUP(Calc_BCS!E3	1	set	40,000	Yen	80	80
3)	Arrester	=ROUNDUP(Calc_BCS!E39*N10*(1+N8	2	P's	400	Yen	0.8	2
	Charging Controller	1P/4P-12V, 20A Normal Ver.	1	set	80,000	Yen	160	160
	Charging Controller	1P/4P-Variable V, 20A	1	set	20,000	Yen	40	40
	Charging Controller	4P/4P-Variable V, 20A: Eco-Charge	1	set	200,000	Yen	400	400
	Mobile Battery	Recyclable 12V, 50Ah made-in-Mya	7	set	17,000	Ky	34	238
	Mobile Battery	Recyclable 12V, 75Ah	0		21,000	Ky	42	0
	Lighting Kit	FL-20W	4	set	6,500	Ky	13	52
	Lighting Kit	FL-10W	0		4,000	Ky		
	Lighting Kit	FL-8W	0	set	3,500	Ky	7	0
	Radio for Public Use	No inclusion for personal use	1	set	25,000	Ky	50	50
	Internal Wiring Set		4	set	9,000	Ky	18	72
(3)	Others						0	0
	Total Summation for Item C							322
D	Building	2 Rooms: one for Charging Room, another for BRSp Room						
(1)	Charging Room	36 m2	1		1,250,000	Ky	2500	2,500
		Total Area: 6x6m2	36		47	U$/m2		1,692
	Unit Cost 47	=ROUNDUP(61.43/(64/9.3)^0.2,0)					0	0
(2)	BRSp Room	36 m2	1		1,250,000	Ky	2500	2,500
		Total Area: 6x6m2	36		47	U$/m2		1,692
	Unit Cost 47	=ROUNDUP(61.43/(64/9.3)^0.2,0)					0	0
(3)	Shop with Stock Roon	18 m2 6x3m2	1		625,000	Ky	1250	1,250
		Total Area: 6x6m2	18		54	U$/m2		972
	Unit Cost 54	=ROUNDUP(61.43/(d113/9.3)^0.2,0)					0	0
	Total Summation for Item D							4,356
E	Management Work							
(1)	Consulting		60	M-D	35,000	Ky	70	4,200
(2)	Travelling Cost		3	set		Ky	300	900
(3)	Documetation		1	set	1,000,000	Ky	2000	2,000
(4)	On-site training work		1	set	1,500,000	Ky	3000	3,000
	Total Summation for Item D							10,100
	Grand Total for implementation of B CS, Type-1							39,067

Appendix-12 Planning Sheets for RE by Wind Power BCS

Table A12.1 Mean Wind Speed and Required Number of Wind Turbine-Generator

1)	Type of Wind PG		**Whisper 3000 (IWANAKA, Japan)**										
2)	Monthly Mean W.V.		2.7m/s	3.1m/s	3.6m/s	4.0m/s	4.5m/s	4.9m/s	5.4m/s	5.8m/s	6.3m/s	6.7m/s	7.2m/s
3)	Monthly Power Output	kWh/M	56	102	162	233	316	408	507	611	715	818	916
4.	Calculation of Wind PGS												
a)	Calculated Power Demand		600 kWh/Month										
b)	Calc of W/T PG		10.7	5.9	3.7	2.6	1.9	1.5	1.2	1	0.8	0.7	0.7
c)	Nos of W/T PG	Set	**11**	**6**	**4**	**3**	**2**	**2**	**2**	**1**	**1**	**1**	**1**

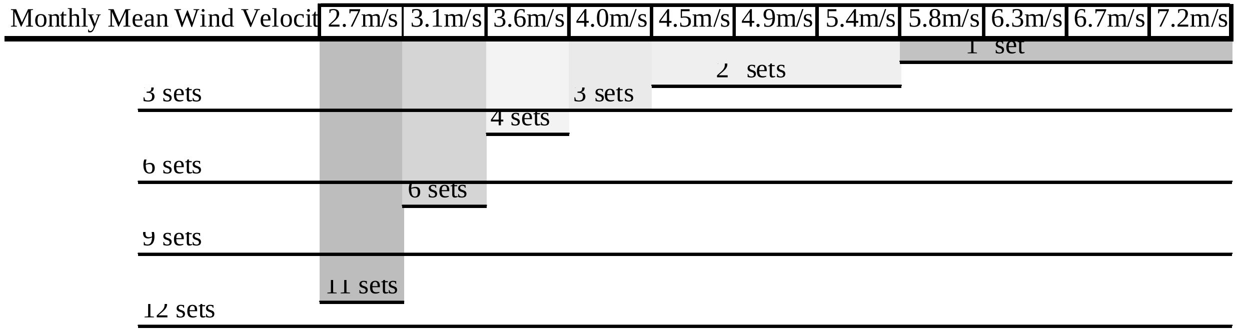


Table A12.2 Examples of Estimated Power Outputs from Small Wind Turbines

(Unit: kWh/Month)

No	Type of Wind Turbine	Monthly Mean Wind Velocity										
		2.7m/s	3.1m/s	3.6m/s	4.0m/s	4.5m/s	4.9m/s	5.4m/s	5.8m/s	6.3m/s	6.7m/s	7.2m/s
1.	Whisper 600	11	20	32	47	63	82	102	122	143	164	183
2.	Whisper H900	11	20	32	47	65	86	109	134	160	187	214
3.	Whisper 1000	19	34	54	78	105	136	156	204	238	273	305
4.	Whisper H1500	18	34	54	79	108	143	181	223	265	312	357
5.	Whisper 3000	56	102	162	233	316	408	507	611	715	818	916
6.	Whisper H4500	54	100	161	236	325	428	543	668	800	936	1070

Data Source: Iwanaka Denki Seisakusyo, Sagamihara city, Japan

Note: Use Table A10.2 for planning of battery.

Appendix-13 Suppliers and Contractors in Construction Industry in Myanmar Market

No.	Resources	Consultants/Maker/Supplier
1.	Topo-survey	Concordia International, Yangon, Tel. (1)544 824
2.	Geological investigations, assessment	U Sann Lwin, Consulting Engineering Geologist, Professor Emeritus, Yangon University
3.	Investigation, planning, and design of small hydro Construction Pico turbine/ generator	U Khun Kyaw, REAM Aung Pyi Tun Construction Ltd., Yangon, Tel. (1)663 608 National Engineering & Planning Services (NEPS), Yangon, Tel. (1) 705 197 Emerald Green Co-op Ltd., Tel. 662 417, 546 174 ECODEV, Yangon, Tel. (1) 222 048
4.	Planning of rice husk gas engine, solar and wind power	Renewable Energy Association Myanmar (REAM), Yangon, Tel. (1) 292 012 Karamosia International, Yangon, Tel. (1) 662 777
5.	Supply of materials (cement, reinforcing bars, concrete pipes, timbers, etc.)	Shaheen Co.,Ltd (Yangon), Tel. - (95 - 1) 590199 Madina (Mandalay), Tel. - (95 - 2) 25453, 35085 Ko Myo Win (Shwe Innwa), Tel. - (95 - 2) 28113, 31640
6.	Gates, screens, penstock pipes	Triangle Link Engineering Co., Ltd., Yangon, Tel. (1) 558 176 U Khun Kyaw, REAM Sein Pann Industrial Production Co-op Ltd., Mandalay, Tel. (2) 88423 Taing Kyaw Engineering & Construction Co., Ltd., Tel. (2) 88627
7.	Transformers	Soe Electric & Machinery Co., Ltd., Yangon, Tel. (1) 590 255 Yangon Transformer and Electrical Co.,Ltd, Tel. - (95 - 1) 511765, 514305
8.	Concrete poles for distribution lines	Sin Phyu Taw Co.,Ltd. (Mandalay), Tel. (95 - 2) 88529, Fax. (95 - 2) 53416 There are many factories in Yangon.
9.	Construction equipment	Myanmar Tractors, Yangon, Tel. (1) 541 717
10.	Fuel oil, lubricant oil	Olympic Co., Ltd., Yangon, Tel. (1) 211 430
11.	Erection of distribution lines	Myanma Electric Light Co-operative Society Ltd. (MELC), Yangon, Tel. (1) 227 678, There are many private companies. U Ye Neing, Lashio, Tel. 082-21344
12.	Manufacturing of rice husk gas engine	Myanmar Inventors Cooperative Ltd., Yangon, Tel. (1) 666 763

Source: JICA Study Team

Appendix-14 LIST of Myanmar Laws Relating To Environment

Administrative Sector

1. The Territorial Sea and Maritime Zones Law, 1977
2. The Emergency Provisions Act, 1950
3. The Essential Supplies and Services Act, 1947
4. The Police Act, 1945
5. The Poisons Act, 1919
6. The Explosive Substances Act, 1908
7. The Towns Act, 1907
8. The Village Act, 1907
9. The Yangon Police Act, 1899
10. The Explosives Act, 1887
11. The Penal Code, 1861 of Offences Affecting the Public Health, Safety, Convenience, Decency and Morals.

Agriculture and Irrigation Sector

12. The Plant Pest Quarantine Law, 1993
13. The Pesticide Law, 1990
14. The Embankment Act, 1909

Culture Sector

15. The Protection and Preservation of Cultural Heritage Region Law, 1998

City Development Sector

16. The Development Committees Law, 1993
17. The Mandalay City Development Law, 1992
18. The City of Yangon Development Law, 1990
19. (Amended in 1995 and again in 1996)
20. The Underground Water Act, 1930
21. The Water Power Act, 1927
22. The City of Yangon Municipal Act, 1922
23. (The Law Amending the City of Yangon Municipal Act, 1991)
24. The Yangon Water-works Act, 1885

Finance & Revenue Sector

25. The Myanmar Insurance Law, 1993

Forestry Sector

26. The Protection of Wild Life and Wild Plants and Conservation of Natural Areas Law, 1994
27. The Forest Law, 1992

Health Sector

28. The National Food Law, 1997
29. The Traditional Drug Law, 1996
30. The Prevention and Control of Communicable Diseases Law, 1995
31. The National Drug Law, 1992
32. The Union of Myanmar Public Health Law, 1972

Hotels and Tourism Sector

33. The Myanmar Hotel and Tourism Law, 1993

Industrial Sector

34. The Private Industrial Enterprise Law, 1990
35. The Factories Act, 1951
36. The Oilfield (Workers and Welfare) Act, 1951
37. The Petroleum Act, 1934
38. The Oilfields Act, 1918

Livestock and Fisheries Sector

39. The Animal Health and Development Law, 1993
40. The Freshwater Fisheries Law, 1992
41. The Myanma Marine Fisheries Law, 1990
42. (The Law Amending the Myanma Marine Fisheries Law, 1993)
43. The Law Relating to Aquaculture, 1989
44. The Law Relating to the Fishing Rights of Foreign Fishing Vessels, 1989
45. (The Law Amending the Law Relating to the Fishing Rights of Foreign Fishing Vessels, 1993)

Mining Sector

46. The Myanmar Gemstone Law, 1995
47. The Myanmar Pearl Law, 1995
48. The Myanmar Mines Law, 1994
49. The Salt Enterprise Law, 1992
50. The Land Acquisition (Mines) Act, 1885

Science and Technology Sector

51. The Science and Technology Development Law, 1994

Transportation Sector

52. The Highways Law, 2000
53. The Motor Vehicles Law, 1964
54. (The Law Amending the Motor Vehicles Law of 1964 enacted in 1989)
55. The Myanmar Aircraft Act, 1934
56. The Inland Steam Vessels Act, 1917
57. The Ports Act, 1908
58. The Defile Traffic act, 1907
59. The Yangon Port Act, 1905
60. The Canal Act, 1905
61. The Obstruction in Fairways Act, 1881

Source: Compiled by JICA Study Team

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ii Reports of U Aung, U Kyaw Min Htun, and Professor U Myat Thein in “Industrial Development in Myanmar: Prospects and Challenges” edited by T. Kudo, Institute of Developing Economics and Japan External Trade Organization, 2001

iii T. Kudo, “Myanmar”, (Overseas Vocational Training Association, 1998, in Japanese)

iv A. Takahashi, “Agricultural Economy in Modern Myanmar” (Tokyo University Press, 2000, in Japanese)

v **“**Myanmar Facts and Figures” (Ministry of Information, 2000) and field survey by the Study Team

vi Field survey by the Study Team, and Y. Yamaguchi (Former Japanese Ambassador in Myanmar), “Real Myanmar” (Keisou-Shobou, 1998, in Japanese)

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