Chapter 6 Socio-Economic Situations and PV Potential in Botswana Rural Areas

Chapter 6 Socio-Economic Situations and PV Potential in Botswana Rural Areas

6.1 Definitions of Urban, Urban Villages, Rural Villages and Localities

(1) Administrative District

Botswana has ten (10) districts and seven (7) sub-districts in total.

Table 6.1-1 Administration Districts

Administrative District		Administrative Sub-District
Southern		
South East		
Kweneng		
Kgatleng		
Central		Serowe/Palapye
		Mahalapye
		Boboneng
		Boteti
		Tutume
North-East		
North West	Ngamiland	
	Chobe	
Ghanzi		
Kgalagadi		Kgalagadi South
		Kgalagandi North

Note: Ngamiland and Chobe Districts are jointly covered by the North West District Council

(Source: 2001 Population and Housing Census)

(2) Districts, Cities and Towns in Population and Housing Census

Central Statistic Office of Botswana Government conducts the Population and Housing Census in every 10 years. Previous one was in 1991 and latest one was in 2001. Census Districts and Census Sub-Districts are defined in Population and Housing census as follows.

Table 6.1-2 Census Districts

Census District	Census Sub-District
Southern	Ngwaketse
	Barolong
	Ngwakets West *
South East	
Kweneng	Kweneng East *
	Kweneng West *
Kgatleng	
Central	Serowe/Palapye
	Mahalapye
	Bobonong
	Boteti
	Tutume
North-East	
North West	Ngamiland East (inc-Delta)
	Ngamiland West
	Chobe
Ghanzi District	Ghanzi
	Central Kgalagadi Game Reserve
Kgalagadi	Kgalagadi South
	Kgalagandi North
City or Town	Gaborone
	Francistown
	Lobatse,
	Selibe-Phikwe
	Orapa
	Jwaneng
	Sowa

Note) * New Sub-District classified in 2001 Population and Housing Census

(Source: 2001 Population and Housing Census)

(3) Urban Village

The following nineteen (19) villages are classified as urban villages, which have more than 5,000 population and less than 25 percent of agricultural workforce within its population.

Table 6.1-3 Population of Urban Villages

Census District	Census Sub-District	Name of Urban Village	Population 1991	Population 2001
Southern	Ngwaketse	Kanye	31,354	40,628
		Moshupa	11,444	16,922
South East		Ramotswa	18,683	20,680
		Tlokweng	12,501	21,133
Kweneng		Molepolole	36,930	54,561
		Mogodishane	14,246	32,843
		Thamaga	13,026	18,117
		Gabane	5,975	10,399
Kgatleng		Mochudi	25,542	36,962
Central	Serowe/Palapye	Serowe	30,264	42,444
		Palapye	17,362	26,293
	Mahalapye	Mahalapye	28,078	39,719
	Bobonong	Bobonong	7,708	14,622
	Boteti	Letlhakane	8,583	14,962
	Tutume	Tonota	11,129	15,617
		Tutume	10,070	13,735
North West	Ngamiland South	Maun	26,768	43,776
	Chobe	Kasane	4,336	7,638
Ghanzi	Ghanzi	Ganzi	5,550	9,934
		Total	322,540	480,985

(Source: 1991 and 2001 Population and Housing Census)

(4) Definition of Villages

Although there is no official definition, the Census Office retained the status for all settlements officially designated as such jointly by the Tribal Administration, the District Administration, and the District Council. Population size alone is not sufficient criterion to classify a settlement as a village. However, a village is usually typified by the presence of a tribal authority (a Chief, a Tribal Authority, Chief's Representative or Headman) and availability of certain facilities such as schools, clinics or health centers, Tribal Administration offices, Botswana Police offices, water reticulations and so on.

(5) Definition of Localities

A locality is defined as any settlements with a name and identifiable boundaries. Any localities, whose residents pay allegiance (settlements of disputes, provision of social functions etc.) to a named village is regarded as an associated locality to the village. Localities are categorized in the following settlements.

Land Area: A settlement for a base of ploughing and weeding seasons

Cattle Post: A settlement for a base of grazing cattle
Freehold Farm

(6) Population in Botswana

According to the quick report for 2001 Population and Housing Census issued in April 2002, population of Census Districts, Sub-Districts and City/Towns in 1991 and 2001 are shown in the Table 6.1-4. This table also indicates population of Localities (small settlements) administratively under villages.

Table 6.1-4 Population in Botswana

Census District	Census Sub-District	Villages				Localities (Small settlements)				Total (Villages + Localities)	
		1991		2001		1991		2001			
		Nos	Population	Nos	Population	Nos	Population	Nos	Population	1991	2001
Southern		70	98174	88	137,040	645	49,215	424	34,612	147,389	171,652
South East		5	37,744	5	51,610	134	5,840	139	9,013	43,584	60,623
Kweneng		36	106,072	45	173,771	618	64,365	775	56,564	170,437	230,335
Kgatleng		19	44,442	22	65,452	229	13,328	215	8,055	57,770	73,507
Central	Serowe/Palapye	41	81,887	43	125,675	735	46,584	859	27,360	128,471	153,035
	Mahalapye	33	62,654	36	92,538	519	32,779	498	17,273	95,433	109,811
	Bobonong	14	26,669	17	47,298	338	26,889	408	19,666	53,558	66,964
	Boteti	12	19,176	15	33,874	338	16,283	431	14,183	35,459	48,057
	Tutume	35	66,085	40	94,093	345	33,964	492	29,421	100,049	123,514
North-East		32	34,846	42	45,476	139	8,508	163	3,923	43,354	49,399
North West	Ngamiland East	18	34,375	24	54,280	293	23,436	395	20,790	57,811	75,070
	Ngamiland West	21	14,071	24	30,537	164	22,652	180	19,105	36,723	49,642
	Chobe	9	9,427	9	14,890	84	4,699	91	3,368	14,126	18,258
Ghanzi	Ghanzi	15	13320	17	22,230	217	11,399	399	10,940	24,719	33,170
Kgalagadi	Kgalagadi South	20	14,105	21	20,589	79	5,689	121	5,349	19,794	25,938
	Kgalagandi North	15	10,024	14	14,525	26	1,316	70	1,586	11,340	16,111
Sub Total		395	673,071	462	1,012,878	4,903	366,946	5,660	281,208	1,040,017	1,305,086
City or Town	Gaborone		133,468		186,007					133,468	186,007
	Francistown		65,244		83,023					65,244	83,023
	Lobatse,		26,052		29,689					26,052	29,689
	Selibe-Phikwe		39,772		49,849					39,772	49,849
	Orapa		8,827		9,151					8,827	9,151
	Jwaneng		11,188		15,179					11,188	15,179
	Sowa		2,228		2,879					2,228	2,879
Sub Total			286,779		375,777					286,779	375,777
Grand Total										1,326,796	1,680,863

(Source: 1991 and 2001 Population and Housing Census)

Population movement for Towns, Villages and Localities in recent 10 years (1991 t0 2001) is investigated through a study of Population and Housing Census in 1991 and 2001 as shown in Table 6.1-5. Localities are divided

into two groups, one is localities having population 200 or more and the other is localities having population less than 200.
67 Localities have promoted to Villages during 10 years since the number of villages was 395 in Population and Housing Census in 1991 while that was 462 in Population and Housing Census in 2001.

Population of Villages (692,207) in Table 6.1-5 includes that of settlements which promoted to the Village from the Locality during 10 years. Therefore, this does not coincide with the population in 1991 (673,071) shown in Table 6.1-4. The detail of population movement for Sub-District and Town is referred to Appendix Table 6.1-2.

Table 6.1-5 Population Movement of Towns, Villages, Localities

	Population (1991) ①	2001 Population and Housing Census		Incremental ratio ②/①	Average No. of Family ②/③
		Population ②	No. of HHs ③		
Village	692,207	1,023,878		1.48	
Locality (Population 200 or more)	116,352	106,706		0.92	
Locality (Population less than 200)	231,458	174,502		0.75	
Sub-Total	1,040,017	1,305,086	291,087	1.25	4.48
Town	286,779	375,777	113,619	1.31	3.31
Grand Total	1,326,796	1,680,863	404,706	1.27	4.15

(Source: Derived from 1991 and 2001 Population and Housing Census)
(The localities which has population 200 or more in the above Table includes both localities which recorded population 200 or more in either in the year of 1991 or 2001, namely the above includes the locality which had population 200 or more in 1991 but less than 200 in 2001 and also includes the opposite case.

According to the Table 6.1-5, the following movements of the population are investigated.

- Population incremental ratio of entire Botswana in recent 10years is 27%.
- That of towns is 31%, which is rather higher than average value of entire Botswana.
- That of villages is 48%, especially that of large villages shown in Table 6.1-6 reaches 51%, which is much higher than average value of entire Botswana.

- On the contrary that of localities having population 200 or more and less than 200 indicates minus 8% and minus 25% respectively.

The tendency of the population concentration towards urban areas, especially towards urban villages is clearly found in these ten years in Botswana
We have to take this movement into consideration when we establish the Mater Plan for PV Rural Electrification in Botswana.

Table 6.1-6 Population Movement of Large Village

No.	Village Name	Population		Incremental Ratio
		1991	2001	1991 – 2001
1	Molepolole	36,930	54,561	1.48
2	Maun	26,768	43,776	1.64
3	Serowe	30264	42,444	1.40
4	Kanye	31,354	40,628	1.30
5	Mahalapye	28,078	39,719	1.41
6	Mochudi	25,542	36,962	1.45
7	Mogoditshane	14,246	32,843	2.31
8	Palapye	17,362	26,293	1.51
9	Tlokweng	12,501	21,133	1.69
10	Ramotswa	18,683	20,680	1.11
11	Thamaga	13,026	18,117	1.39
12	Moshupa	11,444	16,922	1.48
13	Tonota	11,129	15,617	1.40
14	Letlhakane	8,583	14,962	1.74
15	Bobonong	7,708	14,622	1.90
16	Tutume	10,070	13,735	1.36
17	Mmadinare	6,890	10,918	1.58
18	Gabane	5,975	10,399	1.74
19	Ghanzi	5,550	9,934	1.79
20	Kasane	4,336	7,638	1.76
21	Shoshong	5,592	7,490	1.34
22	Tsabong	3,352	6,591	1.97
23	Gumare	3,539	6,067	1.71
24	Letlhakeng	4,379	6,032	1.38
25	Lerala	3,779	5,747	1.52
26	Kopong	3,122	5,571	1.78
27	Maitengwe	4,866	5,302	1.09
28	Otse	3,106	5,192	1.67
29	Mmankgodi	4,093	4,997	1.22
30	Molapowabojang	2,000	4,869	2.43
31	Tsienyane/Rakops	3,122	4,555	1.46
32	Mmathethe	2,868	4,415	1.54
33	Shakawe	2,198	4,389	2.00
34	Tati Siding	2,402	4,375	1.82
35	Tumasera/Seleka	2,734	4,305	1.57
36	Lotlhakane	2,339	4,227	1.81
37	Sefhare	2,776	4,195	1.51
38	Nata	2,786	4,150	1.49
39	Metsimotlhaba	1,586	4,056	2.56
40	Gweta	2,715	4,055	1.49
41	Lentsweletau	2,245	4,025	1.79
42	Hukuntsi	2,562	3,807	1.49
	Total	394,600	600,315	1.52

(Source: 1991 and 2001 Population and Housing Census)

6.2 Socio-Economic Survey

Central Statistics Office of Botswana Government issued "Household Income and Expenditure 1993/1994", which mentioned actual situations and conditions of the household income and expenditure of Botswana people living in Urban areas, Urban Villages and Rural areas in 1993/1994. The Study team carried out the Socio-Economic Survey in order to investigate the socio-economic conditions in the rural Botswana, to estimate electric power demand and to evaluate the potential for photovoltaic electrification, referring the Survey Report and to obtain base data for evaluation and selection of villages where the Dissemination Project would be implemented.

6.2.1 Object Areas of This Study

The objective of this Study is to formulate a Master Plan for PV Rural Electrification. Accordingly object areas of this Study are all villages in the rural areas in Botswana, excluding to the following cities and towns.
Gaborone, Francistown, Lobatse, Selibe-Phikwe, Orapa, Jwaneng, Sowa

6.2.2 Surveyed Items and Methods

The Study team and MMEWR-EAD selected typical 10 villages to be surveyed, which could represent rural Botswana, making use of the selection criteria referred to Appendix 6.2.1. A local consultant, EECG Consultants (Pty) Ltd., was awarded among 4 local consultant candidates for the socio-economic study.
Local consultant company EECG formed two teams, which were composed of one supervisor and four enumerators each. EECG had carried out survey works for 10 villages during month of November, 2000 and issued the Survey Report at the end of January, 2001 after analyzing and evaluating all data collected in the Survey.
Term of Reference for the socio-economic survey is shown in Appendix Document 6.2-1. Locations of 10 villages are shown in Figure 6.2-1. Approximately 50 samples were gathered in each village.

Number of respondents interviewed in this survey was as follows.

Non-PV electrified households:	520
PV electrified households:	42
Non-PV electrified public facilities:	32
PV electrified public facilities:	9
Informal survey to Council authority etc.:	20

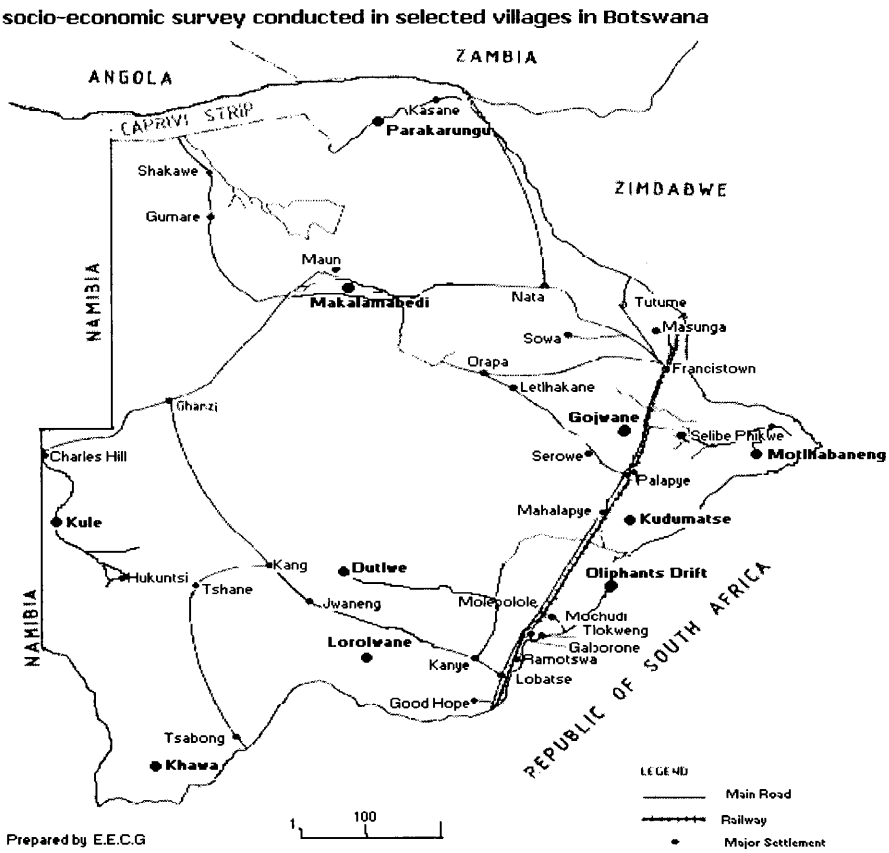

Figure 6.2-1 Location of 10 Villages to be Surveyed

Table 6.2-1 10 Villages for Socio-economic Survey

District	Sub-district	Villages	(1) Pop. (1991)	(2) Est. Pop. (2001)	(3) Pop. (2001)	(4) Est. H/Hs (2001)	(5) HHs (2001)
Southern	Ngwaketse	Lorolwana	574	679	952	136	190
South East		(not selected)					
Kweneng		Dutlwe	767	877	1,017	175	203
Kgatleng		Oliphant's Drift	378	429	758	91	152
Central	Serowe/Palapye	Gojwane	618	1,011	1,041	202	208
	Mahalapye	Kudumatse	905	1,150	1,339	230	268
	Bobonong	Motlhabaneng	622	892	1,276	178	255
	Boteti	Makalamabedi	883	1,313	1,117	263	223
	Tutume	(not selected)					
North East		(not selected)					
Ngamiland	South	(not selected)					
	North	(not selected)					
Chobe		Parakarungu	594	862	806	172	161
Ghanzi		Kule	656	773	741	155	148
Kgalagadi	South	Khawe	424	643	517	129	103
	North	(not selected)					

(1) Population of Housing Census 1991

(2) Estimated of figures based on the data of 1991 census and Population Projection 1991-2021 Medium Variant

(3) Population of Housing Census 2001

(4) Estimated number of Households in 2001 based on the data (2) (average family size: 5)

(5) Estimated number of Households in 2001 based on the data (3) (average family size: 5)

Questionnaire

The Study team prepared questionnaire paper with the assistance of MMEWR-EAD for non- electrified households and PV electrified households. EECG, awarded local consultant, finally completed the questionnaire paper for such two households, non- electrified public facilities and informal interviews to village authorities on aspects of appropriate institutional framework and village social security. The socio-economic information on 10 villages was collected from the questionnaire, with which enumerators interviewed the villagers.

Questionnaire structures are as follows and copies of these questionnaire papers are attached in Appendix Document 6.2-2.

(1) Non-electrified households:

- Household head's particulars (Sex, age, education levels, marital status and occupation)
- Housing information (Ownership of property, type of dwellings, household size and number of rooms)
- Household economic status (Livestock, agricultural outputs, sources of income and income levels, regularity of income, number of employed household members, expenditure structure, disposable/saved income)
- Owned appliances (Radio, television, refrigerator, lighting appliances and others)
- Energy fuels and expenditure (Fuel used, duration of use, time of daily use, monthly expenditure for energy fuels)
- Awareness on PV systems and how respondents got to know of PV systems
- Decision making in the household
- The willingness and ability to pay for PV systems
- Preference either to buy and own the PV system or to pay for solar-based electricity services on fee-for-service basis
- Perceptions on how households expect to benefit from PV systems and what is presently hindering them from procuring the systems

- Willingness to participate in the Dissemination Project

(2) PV electrified households:

The questionnaire survey for this category sought similar information as for the non-PV electrified households.

In addition to the above question items the followings were asked to respondents;

Types/designs/sizes of systems owned, how and when they were purchased, the repayment arrangements, what influenced households to buy the system, systems performance, problems and related costs of maintenance, what benefits have been realized since using PV systems, the measure of satisfaction or dissatisfaction with the systems and payment arrangements.

(3) Non-PV electrified public facilities

- Particulars of public facilities (Type, Facility head, ownership of the facility, scale of the facility)
- Financial status
- Expenditure status
- Energy fuels and expenditure (Fuel used, duration of use, time of daily use, monthly expenditure for energy fuels)
- Owned appliances (Radio, television, refrigerator, lighting appliances and others)
- Awareness on PV systems and how respondents got to know of PV systems
- The willingness and ability to pay for PV systems
- Preference either to buy and own the PV system or to pay for solar-based electricity services on fee-for-service basis.
- Perceptions on how households expect to benefit from PV systems and what is presently hindering them from procuring the systems.
- Willingness to participate in the Dissemination Project.

6.2.3 Socio-Economic Status

6.2.3.1 Non-PV Electrified Households

(1) Households status

Although there are certain differences in the households status among 10 villages, the following results shows the average figures in 10 villages to be surveyed, which also seems to represent average figures for typical households status in rural villages in Botswana.

Occupation

Unemployed:	39%
Employed:	25.8%
Self-employed:	18.7%
Pensioned :	15.2%
Others:	1.2%

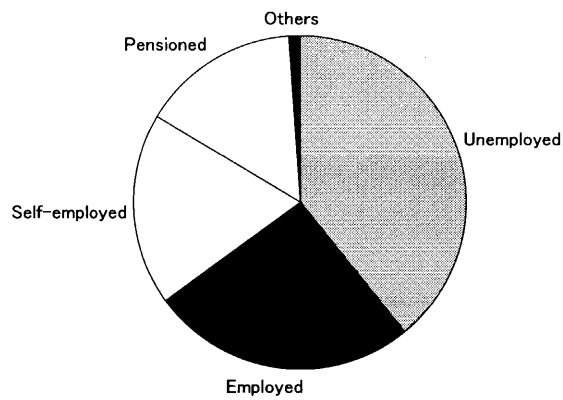

Figure 6.2-2 Occupation

Ownership of premises

Owning:	94.6%
Renting:	2.9%

Housing structure

Lolwapa:	91.5%
Decent/Detached house:	8.5%

Family size

Average: 6.17

Number of required lighting points

1～4 rooms:	86.9%
5～6 rooms:	11.2%

(2) Cash income (not including any income in kind)

Among all households surveyed, 97.5% said that they had one or more income sources and 52.7% have two or more incomes which should improve their affordability.

* Salary/Wage (92% of this category is main income)
* Remittance
* Self employment
* Rentals
* Livestock sales
* Agricultural products sales
* Pensions (as low as level P200/m, however it is monthly regular income.)

Table 6.2-2
Number of Income Source of Households

No. of income source	No. of households	Percent
0	13	2.5
1	233	44.8
2	200	38.5
3	73	14.0
4	1	0.2
Total	520	100

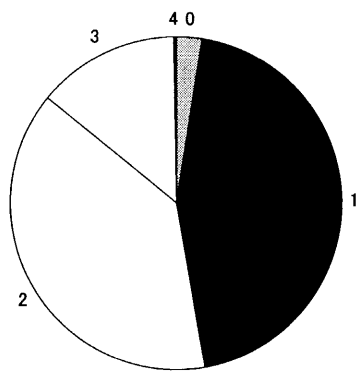

Figure 6.2-3
Number of Income Source of Households

Cash income distribution by each income source and ratio that the said income is to be main source of income are indicated in Table 6.2-3. 92.9% of salary earners consider salary/wage income is their main source of income. 89.2% of pension earners consider pension income is their main source of income. On the contrary, only about 30% of households getting cash income from livestock sales and agricultural product sales consider these are their main source of income, which means these incomes turn out to be supplemental incomes for household budgets. These cash income distribution (cumulative value) is illustrated in Figure 6.2-4.

Table 6.2-3 Cash Income Distribution by Income Source (Percent)

Income source	No. of respondents Main income/Total	Main source income(%)	P1-200	P201-500	P501-1000	P1001-1500	>P1500
Salary Wage	158/170	92.9%	19%	30%	31%	9%	11%
Remittance	65/149	43.6%	63%	26%	9%		3%
Self Employment	81/132	61.4%	55%	20%	26%		
Rentals	2/4	50.0%	75%	25%			
Pensions	116/130	89.2%	87%	12%	1%		
Livestock sales	30/99	30.3%	16%	15%	69%		
Agricultural products	25/80	31.3%	30%	38%	33%		
Others	34/63	54.0%	70%	14%	16%		
Total	511/827		48%	22%	25%	2%	3%

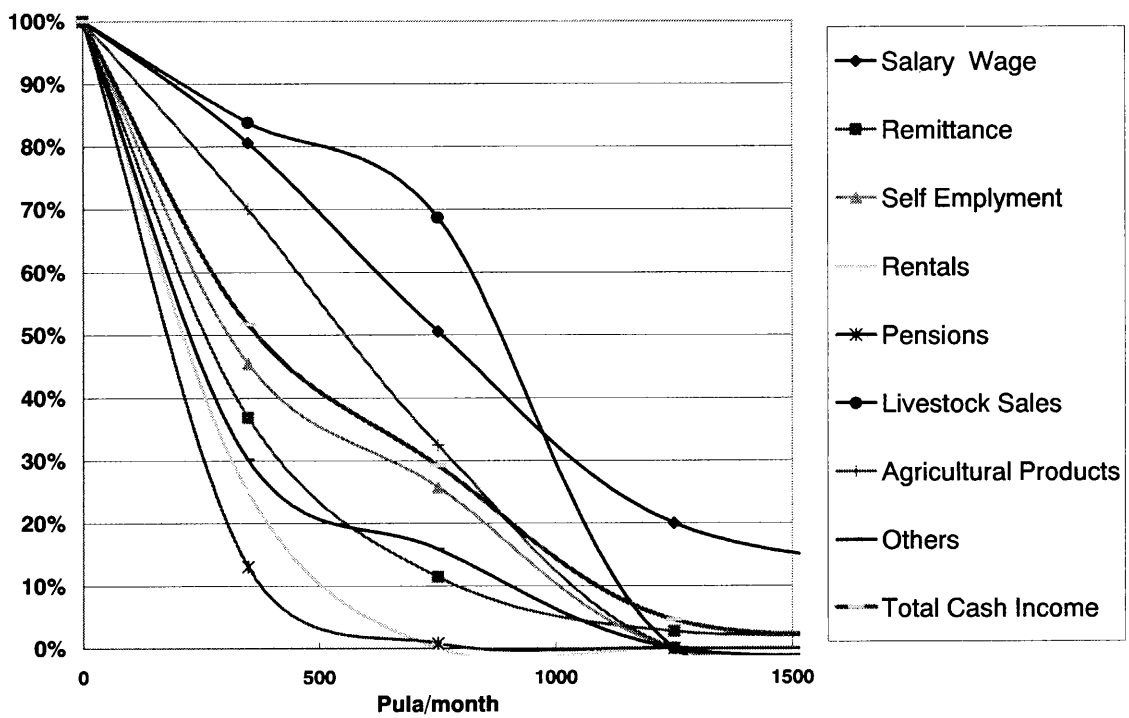

Figure 6.2-4 Cash Income Distribution by Income Source (Percent)

Figure 6.2-5 shows that how many percents the said income source is considered to be the main source in total households. Share No.1 is Salary/wage as the main source of income in 30.9%, following is pensions in 22.7%. Livestock sales are very low as much as only 5.9%. Salary and pension as a cash income source are very stable income, however other income sources are considered to be rather unstable and irregular income sources.

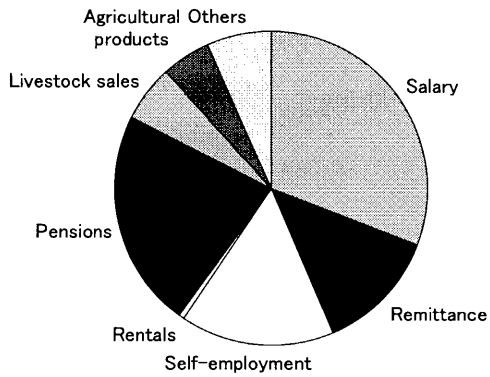

Figure 6.2-5 Ratio of Said Income as a Main Income

Households total cash income

Table 6.2-4 and Figure 6.2-6 shows cash income (per month) distribution curves (cumulative) by village summing up all households cash incomes. This income does not include income in kind. Villages with higher cash income distribution are Oliphant's Drift, Dutlwe, and those with lower distribution are Lorolwana, Khawa, Parakarungu.

Table 6.2-4 Total Cash Income Distribution (P/m)

(Unit: %)

Village	P1-25	P26-50	P51-100	P101-150	P151-200	P201-300	P300-500	P501-1000	P1000+	Group Total
Dutlwe	12.5	6.3	10.4	14.6	10.4	14.6	4.2	10.4	16.7	100
Gojwane	15.7	5.9	11.8	17.6	7.8	15.7	7.8	9.8	7.8	100
Kudumatse	10.9	5.5	12.7	5.5	5.5	10.9	20	16.4	12.7	100
Khawa	31.8	2.3	2.3	20.5	11.4	6.8	2.3	18.2	4.5	100
Kule	11.1	13.3	6.7	24.4	4.4	8.9	8.9	22.2		100
Lorolwana	31.5	11.1	9.3	20.4	13	1.9	9.3	1.9	1.9	100
Makalamabedi	2	8.2	8.2	14.3	10.2	16.3	8.2	20.4	12.2	100
Motlhabaneng	4	10	6	8	4	4	28	26	10	100
Parakarungu	4	8	14	10	10	22	20	10	2	100
Oliphant's Drift	3.5	7	8.8	8.8	10.5	7	8.8	24.6	21.1	100
Total	12.5	7.8	9.1	14.1	8.7	10.7	11.9	15.9	9.1	100

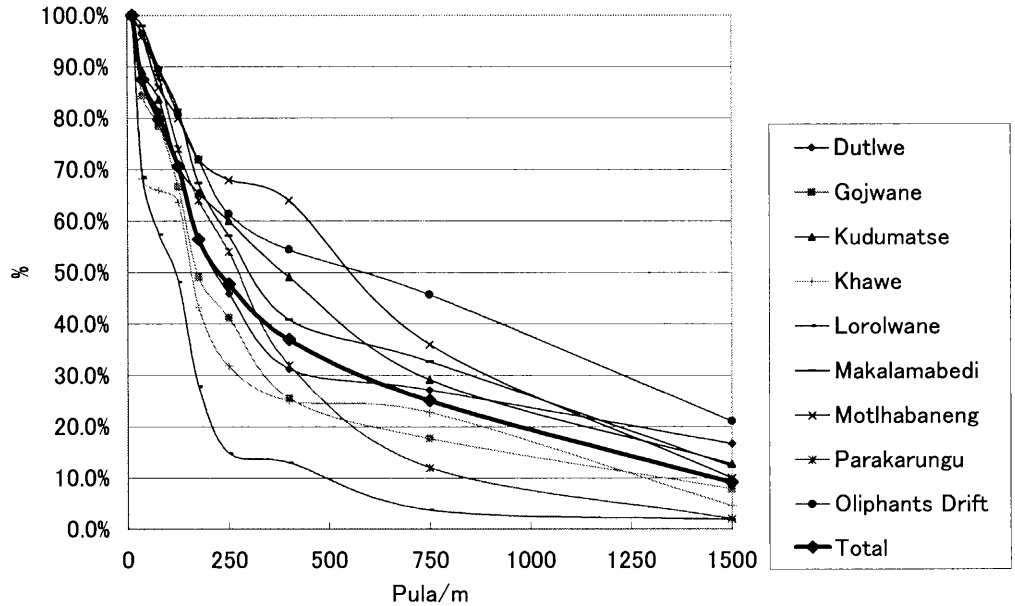

Figure 6.2-6 Cash Income Distribution by Village

(3) Households expenditure

Households expenditure is shown in Table 6.2-5. The majority of rural households (93% or 483 out of 520) spend their incomes on buying food followed by those who buy energy, clothes, education and health. Expenditure on entertainment, rent and other are not significant. About 43% of those buying food spend up to P100/m and 33% spend between P100 and P200/m, 15% between P200 and P300/m and the rest above P300/m. In the case of energy, education, health and entertainment, 85%, 83%, 94% and 84% of the households surveyed respectively spend P50 or below. About 53% of those who are saving money in month are saving less than P100 and 38% are saving more than P200.

Table 6.2-5 Households Expenditure in Month

Expenditure	Total sample	0-50P	50-100P	100-150P	150-200P	200-300P	300P-
Food	**483**	19%	24%	19%	14%	15%	9%
Rent	**17**	29%	71%				
Education	**323**	83%	10%	3%	3%	0	1%
Clothes	**352**	55%	16%	9%	7%	6%	7%
Energy	**471**	85%	8%	3%	1%	3%	1%
Entertainment	**101**	84%	4%	4%	3%		5
Health	**261**	94%	2%	1%	1%	1%	2%
Others	**66**	32%	8%	18%	12%	17%	14%
Savings	294	38%	15%		17%	13%	18%

The fuels used for lighting in rural households and the levels of expenditure per month are given in Table 6.2-6. Eighty-eight percent (88% or 448 out of 520) of the households use paraffin and 90% (402 out of 448) of them consider it their main lighting fuel. Candles are also used by 67% (346 out of 520) of the households but only 19% (67 out of 346) consider candles as their main source of lighting fuel. This implies that candles are mostly used as a backup lighting energy source. Paraffin is the main lighting fuel and candles the second main lighting in all the villages.

Expenditure levels on paraffin and candles mainly fall within P10/m category in 44% of total households, 56% of households using paraffin and 85% of households using candles respectively. The expenditures on paraffin and candles less than P20/m for 77% of total households, 89% of households using paraffin and 91% of households respectively.

Table 6.2-6 Fuel for Lighting Expenditure

Type of Fuel	TOTAL Sample	Main fuel	0-10P	10-20P	20-30P	30-50P
Firewood	**86**	39	7	4	4	2
Paraffin	**448**	402	229	170	22	22
Candle	**346**	67	293	23	4	10
LPG	**9**	3	1	1	2	1
Generator	**6**	2	1			5
Battery	**5**	2		3	1	1
Other	**6**	2	5			

Table 6.2-7 shows the energy used for appliances and the expenditure levels. Expenditure for radio and TV (combined) is in the P20 category account for 54% of the households using these appliances.

Table 6.2-7 Energy for Appliances and Expenditure Levels

Appliance	Total users	Main energy source	Users of main energy source	0-20P	20-50P	50P-
Radio	311	Dry battery	258	175	98	17
TV	33	Liquid battery	18	11	7	7
Refrigerator	56	LPG	50	4	6	41

Basing on current energy expenditure for lighting, radio and television, it would appear that the majority of rural households would afford monthly repayments of P30-P50.

(4) Awareness on PV system

Solar PV systems are generally known by 73.5% of all households surveyed. The problem is probably the extent of knowledge to be able to decide to invest in it. The majority (80%) of the 382 who know of solar PV have seen but not operated the system. They often see the systems at rural government/local authority institutions. A few have heard (13%) of the system and 5% have previously used the system. The rest have either read or have known through other means.

(5) Willingness to pay

Willingness to use PV system was indicated through this socio-economic survey as follows. Villages with the largest numbers of households willing to pay are Oliphant's Drift (94.8%), Dutlwe (91.8%) and Kudumatse (85.5%) while Kule (29.8%) and Khawa (36%) had the least number of households willing to pay for PV system use.

Table 6.2-8 Willingness to Pay by Village

Village	Sample no.	Willingness to pay (Sample No.)	Ratio
Dutlwe	49	45	91.8%
Gojwane	51	37	72.5%
Kudumatse	55	47	85.5%
Khawa	50	18	36.0%
Kule	48	14	29.8%
Lorolwana	54	37	68.5%
Makalamabedi	52	30	58.8%
Motlhabaneng	51	34	66.7%
Parakarungu	51	29	58.0%
Oliphant's Drift	59	55	94.8%
Total	520	346	66.5%

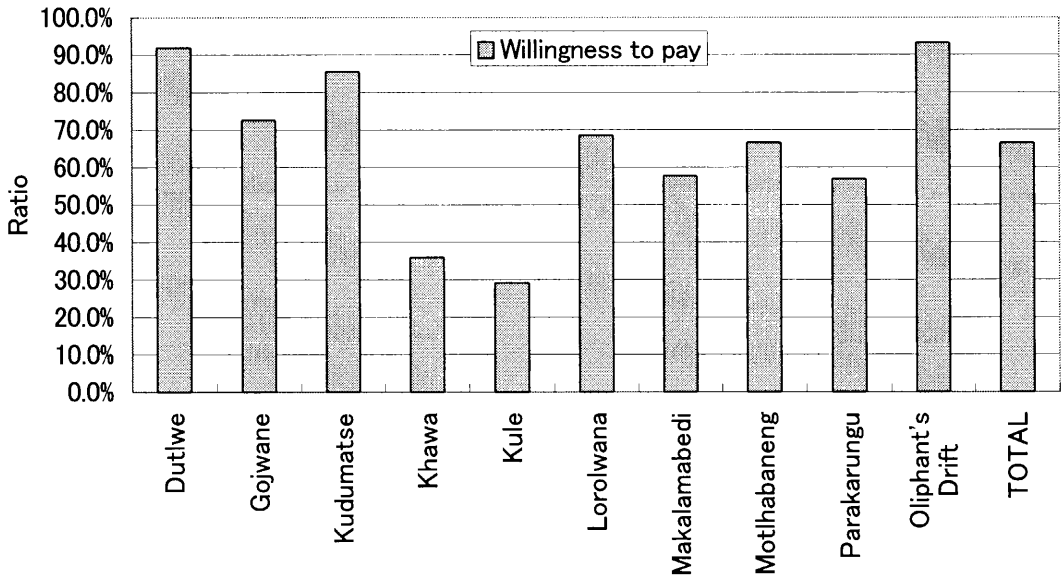

Figure 6.2-7 Willingness to Pay

Reason why do not want to use PV system

① High up-front cost 64%
② Lack of knowledge/information 17%
③ Preference to use current fuels 10%
④ Vulnerable/fragile 9%
⑤ Less powerful, Performance is 4%
affected by the weather

Above ②, ③ results from lack of information to end users and could be potential customers through appropriate propaganda.

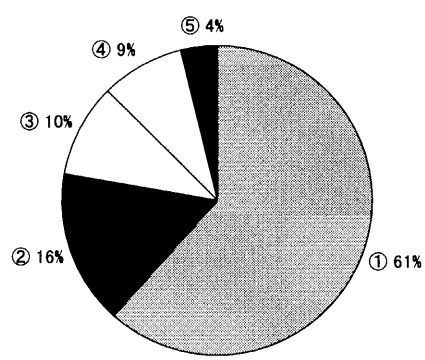

Figure 6.2-8 Reason why do not want to use PV System

(6) Time frame to introduce PV system

How soon the decision can be made would give the time for the estimated demands (on short term, middle term and long term basis) for PV system. These data are shown in Table 6.2-9 and Figure 6.2-9.

Table 6.2-9 Time Frame for PV Demands by Village

Village	H/Hs	Immediately		Need to consider		Later/ next year		Don't know	
		H/Hs	%	H/Hs	%	H/Hs	%	H/Hs	%
Dutlwe	49	11	22.4	3	6.1	30	61.2	1	2.0
Gojwane	51	6	11.8	4	7.8	21	41.2	5	9.8
Kudumatse	55	7	12.7	7	12.7	29	52.7	3	5.5
Khawa	50	6	12.0	0	0.0	5	10.0	6	12.0
Kule	48	4	8.3	0	0.0	8	16.7	2	4.2
Lorolwana	54	6	11.1	5	9.3	19	35.2	5	9.3
Makalamabedi	52	9	17.3	0	0.0	14	26.9	7	13.5
Motlhabaneng	51	12	23.5	0	0.0	11	21.6	10	19.6
Parakarungu	51	9	17.6	1	2.0	11	21.6	8	15.7
Oliphant's Drift	59	12	20.3	3	5.1	23	39.0	16	27.1
Total	520	82	15.8	23	4.4	171	32.9	63	12.1

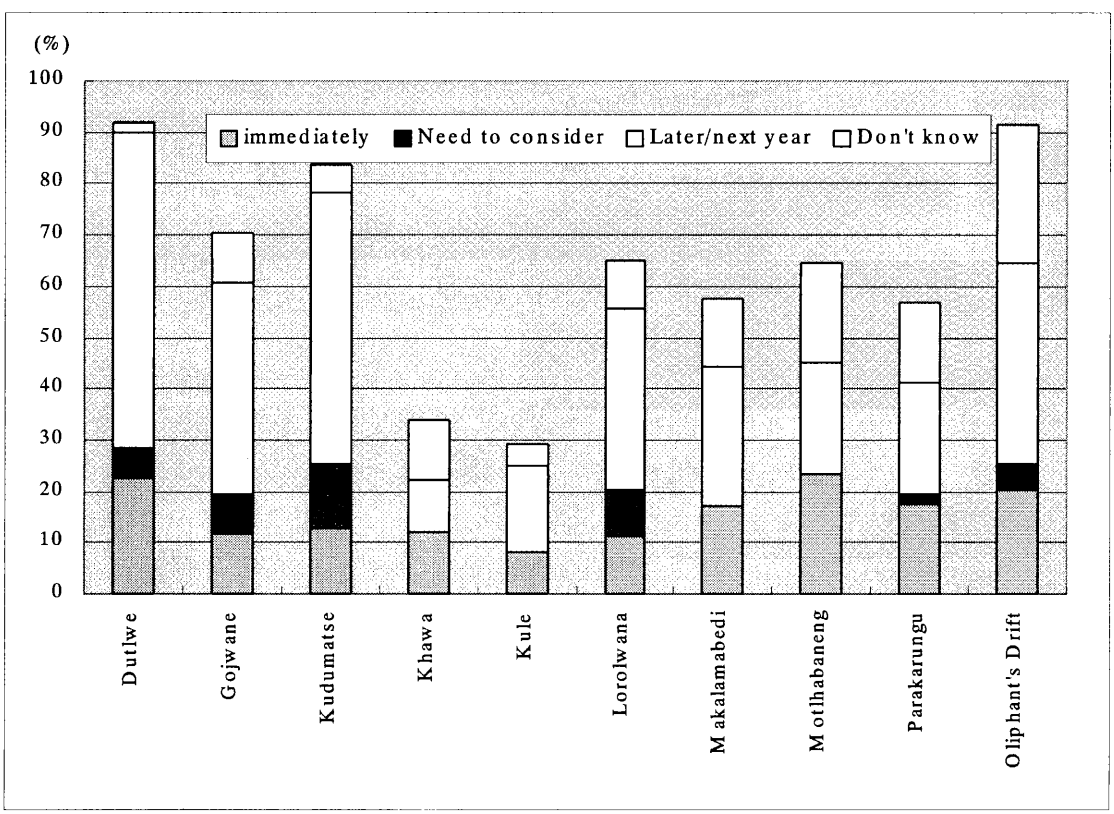

Figure 6.2-9 Time Frame for PV Demands by Village

(7) Ability to pay

PV systems for which households able to pay are shown in Table 6.2-10 and maximum deposit and monthly repayment that respondents could pay are shown in Table 6.2-11. 332 households out of 520 and 96% of those who showed willingness to pay showed ability to pay.

Table 6.2-10 System Size for which Households are Able to Pay

System size	Households	Ratio of able to pay (%)	Ratio against No. of total H/Hs(%)	Ration of those willing to pay(%)	Payable (P/m)
2-Light system	166	50.0	31.9	48.0	30 – 50
3 to 4 lights	73	22.0	14.0	21.1	51 – 100
6lights + radio	27	8.1	5.2	7.8	101 – 150
3to 4 lights + B&W TV	3	0.9	0.6	0.9	151 – 200
3 to 4 lights + Color TV	19	5.7	3.7	5.5	201 – 250
3 to 4 lights + small refrigerator	44	13.3	8.3	12.7	251 –
Total	332	100	63.7	96.0	–

Table 6.2-11 Max. Deposit and Max. Monthly Payment (unit : P)

Max. Deposit	H/Hs	Ratio against 332 H/Hs(%)	Max. Monthly payment	H/Hs	Ratio against 332 H/Hs(%)
200-300	143	43.1	30-50	146	44.0
301-500	57	17.2	51-100	56	16.9
501-800	25	7.5	101-150	23	6.9
801-1,000	5	1.5	151-200	9	2.7
1,001-1,500	16	4.8	201-250	14	4.2
1,501-2,000	17	5.1	251-300	16	4.8
2,001-2,500	8	2.4	301-400	8	2.4
2,501-3,000	5	1.5	401-600	7	2.1
Sub-Total	276	83.1		279	84.0
N/A	56	16.9	N/A	87	19.4
Total	332	100	Total	332	100

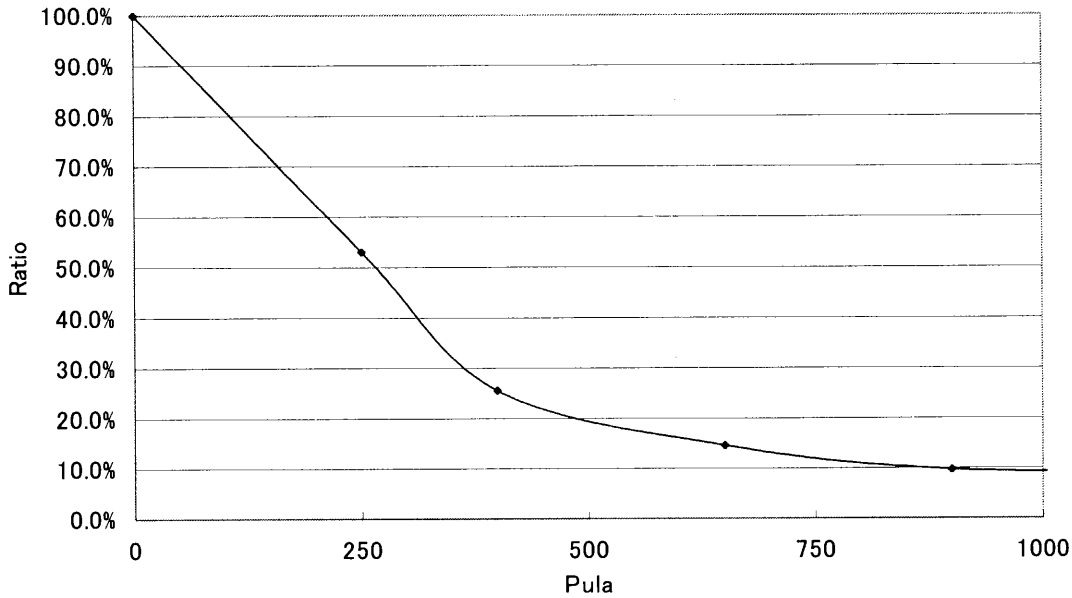

Figure 6.2-10 Max. Payable Deposit (10Villages)

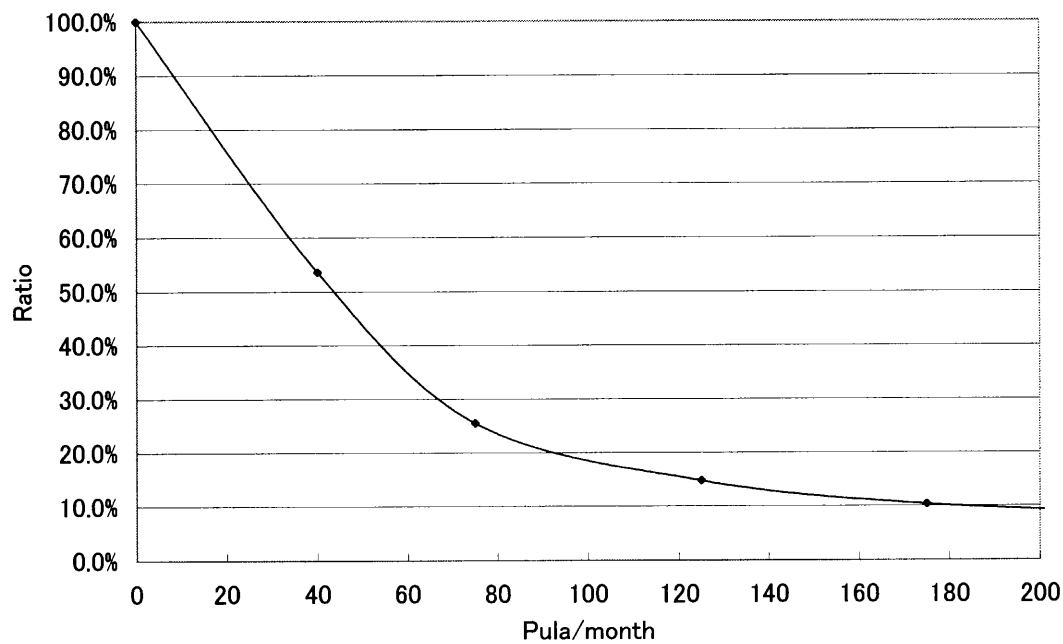

Figure 6.2-11 Max. Payable Monthly Payment (10Villages)

According to Table 6.2-11 nearly half (43%) of surveyed households can afford a deposit of P200-P300 and a similar proportion can afford a monthly payment of P30-P50 (44%).

Based on the above survey results, maximum payable deposit and maximum payable monthly payment are illustrated in Figure 6.2-10 and 6.2-11. Maximum payable monthly payment surveyed is net repayment cost for PV investment and does not include a maintenance cost (replacement of a battery at least every three years) and other relevant costs.

According to Figure 6.2-10 and 6.2-11, about 55 % of households can pay more than P40 per month and P250 as a deposit.

According to Table 6.2-9 and Figure 6.2-9, those who responds "immediately" is about 16% of total households, and "later/next year" is about 33% of total households. The former group may be placed in the most potential PV users on the short term basis and the latter group may be placed in the potential PV users on the middle term basis. The rest part of group may be placed in the potential PV users on the long term basis. Accordingly Figure 6.2-11 indicates ability to pay on the long term basis for the potential PV users. Those who have willingness and ability to pay within the short or middle term might decrease from the results of Figure 6.2-11.

6.2.3.2 Non-PV Electrified Public Facilities

(1) Public facilities surveyed

Public facilities surveyed are listed as below Table 6.2-12.

Table 6.2-12 Public Facilities Surveyed

Type	No. of public facilities	Ratio (%)
Clinic	6	18.8
Primary School	5	15.6
Kgotla	5	15.6
Police	7	21.9
VDC	3	9.4
Veterinary Office	3	9.4
Other	3	9.4
TOTAL	32	100

Schools have enrollments ranging from 168 to 482 with teacher to student ratios of 1 to 20 up to 30 and classrooms ranging from 4 to 12. PV systems would be required in schools for the power source of radios, TV and videos

and for lighting staff quarters, offices and classrooms if the village pupils can use the classrooms for studying at night.

Clinics have capacity to treat patients up to 200 but all as out-patients. Staff is generally below 10. All clinics have one consultation room, sometimes an office and staff quarters. Solar PV would mostly be required for lighting the consultation rooms, staff quarters and refrigerating the drugs.

In the other public facilities like the police, VDC and Kgotla, PV systems would be for lighting the premises and staff quarters.

(2) Financing and procurement for PV system

The public facilities are allocated a budget that is managed by the central Government or the District Councils. Council facilities in particular do not handle funds except where they charge for fees/rents, conduct fund raising or receive donations.

About 40% of the facilities interviewed receive such additional incomes ranging from P200 up to P10,000 annually.

A small number of the public facilities (3 facilities) indicated their savings save up to P500/year and the other 2 facilities between P3000 and P5000/year.

On energy consumption, 37.5% do not require energy for lighting and another 37.5% use only one fuel while the remaining 25% use two to four energy fuels for lighting.

Half of the institutions (50%) indicated that they consume up to P100/m of energy for lighting. The facility using generator indicated a consumption of over P300/m on energy for lighting. The rest do not even know their expenditure on this energy as government or Council provides the energy.

For appliances as well, about 60% of the facilities are provided with energy by government and Council and only 4 institutions indicated their monthly energy requirements for appliances to be between P100 and P200/m.

(3) Awareness on PV system

The level of awareness on the PV system is as high as 90.6% knew about solar PV systems. Of these 18.8% have previously used the systems, 62.5% have seen the systems in use and 9.4% have heard about the systems.

(4) Willingness to use PV system

Nearly all (94% or 30 out of 32) the public facilities interviewed indicated willingness to use PV systems. Previously PV has been mainly for lighting in the government institutions but 97% of those willing to use the PV system would want to power both lighting and appliances.

In the case of lighting, a significant number (65.6%) wants to be able to power more than 6 lights. With respect to time of use, only 24.1% want to power lights for 4 or less hours and 42.1% want the lights for 5 to 12 hours and the rest for longer periods. This is because facilities may require lights during the day as well as for the night.

Table 6.2-13 PV Lighting Requirements in Public Facilities

No. of lights desired	No. of public facilities	Ratio (%)
Up to 2	1	3.1
3	1	3.1
4	4	12.5
6	2	6.3
>6	21	65.6
NR/NA	3	9.4
Total	32	100

Public facilities which want to power electric appliances such as radios, color TV, refrigerators are shown in Table 6.2-14

Table 6.2-14 Appliance PV Requirements for Public Facilities

Appliance	No. of public facilities	Ratio (%)
Radio	26	81.3
B&W TV	13	40.6
Color TV	18	56.3
Refrigerator	24	75.0
Others	14	43.8

Public facilities also want to engage in income generating activities like charging batteries, lighting chicken runs, cooling drinks for sale, sewing,

water pumping for irrigation and charging for video programs. Clinics also want to cool some of their medicines which require refrigeration.

Table 6.2-15 Economic Activities for which PV can be used as Energy Source

Activity	No. of public facilities	Ratio (%)
Charging batteries	20	62.5
Lighting chicken runs	21	65.6
Cooling medicines	21	65.6
Cooling drinks	22	68.8
Sewing machine	20	62.5
Other- water pumping & video charges	2	6.3

The reasons why public facilities like to shift to PV are given in Table 6.2-16 and the main reason is that PV is a better and cleaner energy source for lighting (87.5% of respondents) than the fuels they are using currently. Lack of conventional fuels (75%) and ability to use entertainment appliances (65.6%) are also significant reasons followed by the notion of reducing expenditure on fuels (59.4%).

Table 6.2-16 Reasons Given by Public Facilities for Willing to Use PV System

Reason	No. of public facilities	Ratio (%)
better and clean fuel	28	87.5
entertainment from appliances	21	65.6
lack of conventional fuels	24	75
saves money	19	59.4
Other	1	3.1

(5) Ability to pay

Decisions to procure PV will lie with the facility owner which in 56.3% cases could be the Council, government or private owner. Only in 21.9% cases would the public facility-head make such a decision. A combined decision of facility-head and Council/government/owner and donor is required in 12.5 % cases of public facilities. It is for this reason that, in terms

of when decision to procure PV system can be taken, 65.6% of the facilities can only make the decision after consultation with the responsible financier/owner e.g. council and another 9.4% can only make the decision in the coming year. This pattern is true of all types of public facilities. A similar proportion (9.4%) does not even know when they can procure the system. Only 6.3% (or two facilities) indicated they could make a decision immediately.

Eighty-four (84.4% or 27 out of 32) percent of the public facilities expressed ability to pay for the various PV system sizes and the majority (78.1% of total facilities) would like to buy the system which can power 3 to 4 lights and a refrigerator (>200Wp). Thirty seven (37.5%) percent of the facilities who indicated ability to pay deposits can pay P2000 to P3000. An even higher proportion (68.7% of total facilities) indicated they could pay P300 to P600 monthly installments. The main source of income to pay for the PV in public facilities was obviously given as the budget in 65.6% of the facilities and 9.4% will use other means (e.g. profit for private) and only 3.1% will use donations.

Table 6.2-17 System Size Preferred by Public Facilities

Type of institution	2-light	3-4light +refrigerator	Total sample
Clinics		6	6
Primary schools		4	4
Kgotla		5	5
Police	2	3	7
VDC		3	3
Veterinary Office		2	3
Other		2	3
Total	2	30	

6.2.3.3 PV Electrified Households

(1) Households status

Occupation

Unemployed : 6%

Employed : 45%

Self-employed : 22%

Pensioned : 8%
Others : 4%

Ownership of premises
Owning : 56%
Renting : 28%

Housing structure
Lolwapa : 58%
Decent/Detached house : 8%
Others : 34%

Family size
4～8 : 55.4%
Adults 1～3 : 70%
School going children 0 : 46%
School going children less than 2 : 79%

(2) Cash income

The majority of those who own the PV systems had household heads who are on salary or wage (36%) followed by those on self employment who get their salary monthly (24%) and then those on pensions (14%). Table 6.2-18 shows that most of those with PV systems have income ranges between P500 and P1000 per month and they are in the salary/wage and self employed groups. It is therefore important to consider the potential market by considering these two income sources for household heads.

Table 6.2-18 Main Income Source of PV System Owners

Main Income source	No. of H/Hs	Ratio (%)
Salary/wage	18	36
Remittance	6	12
Self employment	12	24
Rentals	1	2
Pensions	7	14
Sale of livestock	1	2
Sale of agricultural produce	1	2
Other	2	4

Table 6.2-19 Income Ranges by Income Source

	P100-300		P501-1000		P1001-1500		>P1500	
Main Income source	H/Hs	Ratio (%)	H/Hs	Ratio (%)	H/Hs	Ratio (%)	H/Hs	Ratio (%)
Salary/wage	1	2	17	34	0	0	1	2
Remittance	4	8	2	4				
Self employment	4	8	8	16	1	2	3	6
Rentals	1							
Pensions	7	14						
Sale of livestock	1	2	14	28				
Sale of agricultural produce	4	8	4	8				
Other	3	6	4	8				

Other possessions which are an indicator of affordability in the case of interviewed households were cars for 32% of households followed by bicycles (24%), scotch carts (18%) and other (14%), the latter consisting of wheelbarrows.

(3) Household expenditure

Those spending more than P300 per month for energy expenditure were 11%, 200～P300 were 7 %, P150～200 were 7%, P100～150 were 14%, P50～100 were 20%, P0～50 were 23%, no expense were18% (Refer to Figure 6.2-12).

The majority (46%) of the PV electrified households were found to be saving over P300/m and those saving between P200 and P300 were only 4%. Those saving up to P100 were 18% and 20% claimed not to save anything (Refer to Figure 6.2.13).

PV electrified households/premises use up to 4 types of fuels for lighting but the majority use 2 fuels (38%) followed by those using just one (36%) fuel and those using 3 fuels (18%). PV was ranked the main energy source used by 68% of the electrified households/premises for lighting. Another 16%, 8% and 4% still use paraffin, candles and generators respectively as their main lighting energy sources.

The majority of solar users have used PV in the last two years (38%) followed by those who have used solar for 2 to 5 years (22%) and then over 5 years (20%). The rest did not indicate period of use.

On the appliances side, 38%, 30% and 10% were using their PV systems to power radio, televisions and refrigerators respectively. Most

households/premises are using all these appliances for more than 4 hours and may thus use a combination of energy sources.

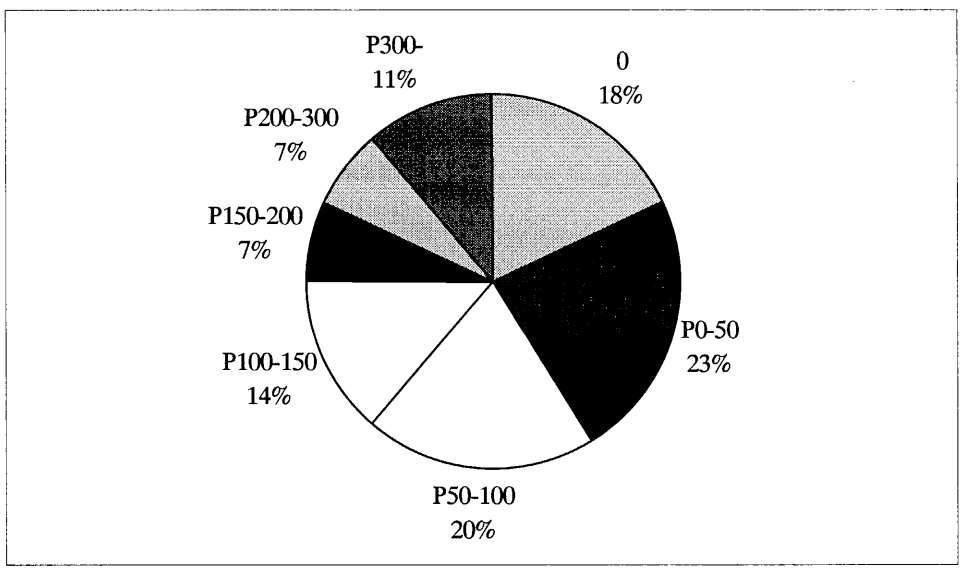

Figure 6.2-12 Monthly Energy Expenditure

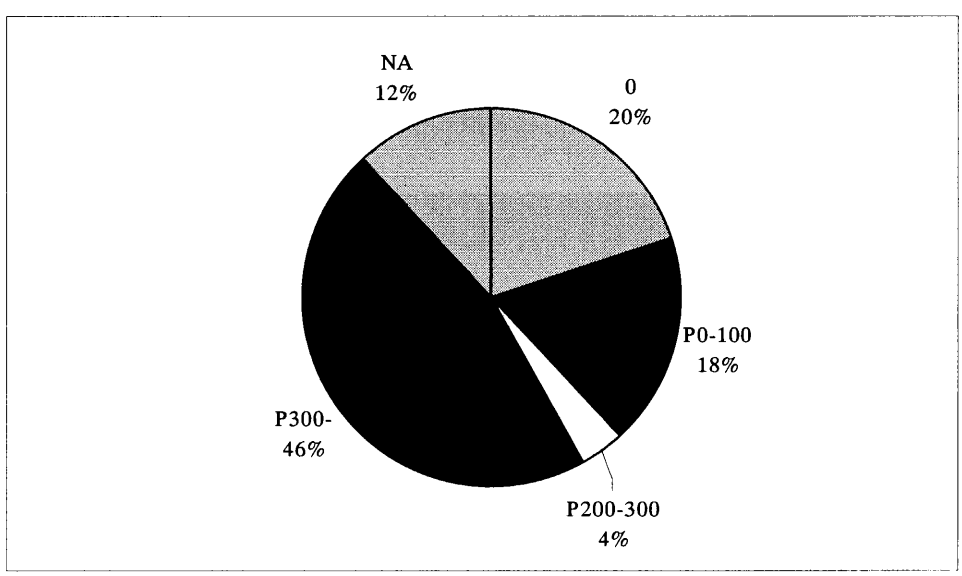

Figure 6.2-13 Monthly Saving Amount

6.3 Survey on Localities

There are 5,660 localities in the country of which total population is estimated to reach approximately 280,000 in 2001. They were not covered by the Socio-economic survey described in Section 6.2 and their actual living and other conditions are not known in detail. While the extension of the grid reduces the number of non-electrified villages at a rapid rate, most localities will likely remain unserved while a small percentage will benefit from the project.

The Study team decided to conduct field surveys for selected localities to understand their current conditions. The study team visited two localities (Dipotsana and Southern District) as well as localities around Kudumatse where the Dissemination Project projects were planned. Then, the survey results were analyzed to identify local conditions peculiar to the localities.

Table 6.3-1 The Localities Surveyed

Name of Locality	Principal village	Population		No. of dwell		Category of Locality
		1981	1991	1981	1991	
Dipotsana	Kanye	212	176	29	33	Land Area
Rapitse	Kudumatse	17	4	5	2	Land Area
Kudumatse Land 1	〃	112	35	233	10	Land Area
Kudumatse Land 2	〃	5	5	1	1	Land Area
Dikgatlhong 1	〃	142	147	19	15	Cattle Post
Dikgatlhong 2	〃	24	21	4	6	Cattle Post
Seditsane	〃	12	23	5	4	Cattle Post
Tlakadibe 1	〃	67	86	15	14	Cattle Post
Tlakadibe 2	〃	34	33	6	6	Cattle Post
Kudumatse Cattle Post	〃	10	10	3	6	Cattle Post

Dipotsana has public facilities, such as an elemental school, a health post and a VDC, and thus the central part looks similar to a village except for the absence of the chief or police. As one moves away from the center, houses used as cattle raising depots are sparsely distributed (each house is as much as 1km apart from the nearest one) and there is no evidence of human settlement. Under this setting, it is likely that the demand for PV electrification mainly exists for public facilities and houses located in the central area, while there is little demand among surrounding households.

Similarly, localities in the vicinity of Kudumatse have 150 or less population each (30 houses or less if the average number of persons is assumed to be five per household)

and do not have a center containing public facilities. Again, there seems to be no immediate demand for PV electrification.

Therefore it is reasonable to assume that only localities that have relatively large population and function as an established settlement need PV electrification, whereas those that virtually serve as a cattle post or a land firm have little needs.

6.4 Socio-Economic Survey for Participants in the Dissemination Project

A socio-economic survey was followed for participants in the Dissemination Project in Motlhabaneng, Kudumatse, Lorolwana by the same survey method carried out in the first year in order to investigate the actual situation of the entire Botswana villages.

(1) Number of Samples and Survey Method

The questionnaire paper used in the Socio-economic survey in the first year was utilized in this survey. Number of samples is shown as follows.

Table 6.4-1 Number of Samples

	Motlhabaneng		Kudumatse		Lorolwana		Total	
	No. of partici-pants	No. of respon-dents	No. of partici-pants	No. of respon-dents	No. of partici-pants	No. of respon-dents	No. of partici-pants	No. of respon-dents
SHS user								
50Wp	23	4	30	22	35	18	88	44
100Wp	7	1	7	2	4	2	18	5
150Wp	1		2	1	1		4	1
200Wp			1				1	
250Wp	3						3	
Total	34	5	40	25	40	20	114	50
BCS user					34	20	34	20
Grand Total	34	5	40	25	74	40	148	70

Note) SHS: (Solar Home System)
BCS: (Battery Charging Station)
SHS: 50 respondents in 114 participants (43.9%)
Respondent's average age: 46.7

BCS: 20 respondents in 34 participants (59%)
Respondent's average age: 42

(2) Households Status

1) Occupation

The distribution of SHS users shows the similar results as the Socio-economic Survey, while "Unemployed" of BCS user is prominent.

Table 6.4-2 Occupation

	Socio-economic Survey (Average of 10 villages)	SHS user	BCS user
Unemployed	39%	42%	90%
Employed	25.8%	34%	0%
Self-employed	18.7%	20%	5%
Pensioned	15.2%	2%	5%
Others	1.2%	2%	0%

2) Ownership of premises

No significant difference exists in three groups.

Table 6.4-3 Ownership of Premises

	Socio-economic Survey (Average of 10 villages)	SHS user	BCS user
Owning	94.6%	96%	90%
Renting	2.9%	4%	10%

3) Housing structure

No significant difference exists in three groups.

Table 6.4-4 Housing Structure

	Socio-economic Survey (Average of 10 villages)	SHS user	BCS user
Lolwapa	91.5%	84%	95%
Decent/Detached house	8.5%	6%	5%
Others		10%	

4) Family size, No. of rooms, No. of lighting points

The distribution of SHS users shows the similar results as the Socio-economic Survey. However, both " No of rooms" and "No. of lighting points" are low in spite of a large family size in BCS users. 2 lights and 1 light were provided for 50Wp SHS users and BCS users respectively. This coincides with the results below.

Table 6.4-5 Family Size, No. of Rooms, No. of Lighting Points

	Socio-economic Survey (Average of 10 villages)	SHS user	BCS user
Family size (average)	6.17	6.48	7.40
No. of rooms (average)	about 4	3.4	2.5
No. of lighting points (average)	About 3	3.0	1.25

(3) Cash income situation (not including any income in kind)

1) Number of income source

The distribution of SHS user shows the similar results as the Socio-economic Survey. BCS user who has 3 or 4 income sources is nil. As there is a tendency that those who have more cash income sources have higher income, the below results of BCS users suggest that they are rather classified in the low income brackets

Table 6.4-6 Number of Income Source

No. of cash income source	Socio-economic Survey (Average of 10 villages)	SHS user	BCS user
0	2.5%	0%	5%
1	44.8%	54%	50%
2	38.5%	30%	45%
3	14.0%	14%	
4	0.2%	2%	

2) Cash income distribution by income source

40 percent of SHS users are salary earners and its income level is higher than that of the results of Socio-economic survey (average of 10 villages). Only 5 percent of BCS users are getting salary income as small as P150 per month. There is not big difference in the income level by "Remittance" in three groups (Less than P200/m, Average P50-P150/m). The income level of SHS users who gain an income from "Self-Employment", is about three times higher than the average of 10 villages. There is no earner from "Self-Employment" in BCS users. Villagers who gain incomes from "Rentals" are negligible small in any group. Those who gain incomes from "Pensions" reach about 22% in total respondents of Socio-economic survey, however, only 8%-5% is counted in SHS/BCS users. This means that rather younger villagers (average age: about 45) participate in the Dissemination Project in SHS/ BCS users. Regarding to "Livestock sales", average income of SHS users, is about P200. The average income of 10 villages and BCS users are about P70. Income level of "Agricultural products" is very small in any group, but the average value is increased by few villagers having very high income from this category in SHS users.

Table 6.4-7 Cash Income Distribution by Income Source

Cash income source		No. of respondents /total		P1-200	P201-500	P501-1000	P1001-1500	Over P1500	Average (P)	Median (P)	Max. (P)
Salary Wage	A	158/520	30%	19%	30%	31%	9%	11%	652.5	750	1750
	B	19/50	38%	0%	16%	53%	0%	32%	1089	750	2000
	C	1/20	5%	100%					150	150	150
Remittance	A	65/520	13%	63%	26%	9%		3%	152	50	750
	B	8/50	16%	75%					50	50	50
	C	7/20	35%	86%	14%				85	50	400
Self Employment	A	81/520	16%	55%	20%	26%			195	50	250
	B	11/50	22%	36%	9%	27%	18%	9%	653	500	2000
	C	0/20	0%						0	0	0
Rentals	A	2/520	0%	75%	25%				125	100	750
	B	0/50	0%						0	0	0
	C	0/20	0%						0	0	0
Pensions	A	116/520	22%	87%	12%	1%			156	150	750
	B	4/50	8%	75%				25%	613	150	2000
	C	1/20	5%	100%					150	150	150
Livestock sales	A	30/520	6%	16%	15%	69%			74	62	750
	B	11/50	22%	64%	27%	9%			201	188	500
	C	3/20	15%	100%					74	104	104
Agricultural products	A	25/520	5%	30%	38%	33%			55	33	750
	B	12/50	24%	75%				8%	202	12.5	2000
	C	6/20	30%	100%					10	4	33
Others	A	34/520	7%	70%	14%	16%			102	17	750
	B	17/50	34%	35%	6%	6%	24%	6%	485	67	2000
	C	10/20	50%	50%	30%	20%			261	167	750

Note) A: Socio-economic survey result (Average of 10 villages)
B: Results for Questionnaire to SHS users
C: Results for Questionnaire to BCS users

3) Cash income distribution

Total cash income in households for SHS users and BCS users are shown in the below table as well as that of Socio-economic survey results (average of 10 villages). The income of SHS users in 3 villages remarkably exceeds the average income of respective villages. The income of BCS users in Lorolwana slightly exceeds the average income of Lorolwana, however, is less than that of the average of 10 villages.

Thus, it is understandable that BCS users are relatively composed of low income brackets and BCS is considered as the facility for the poor.

Table 6.4-8 Cash Income Distribution

VILLAGE	P1-25	P26-50	P51-100	P101-150	P151-200	P201-300	P300-500	P501-100	P1000+	Group Total
	12.5	37.5	77.5	125	175	250	400	750	1500	
Kudumatse	6	3	7	3	3	6	11	9	7	55
Percent	10.9%	5.5%	12.7%	5.5%	5.5%	10.9%	20.0%	16.4%	12.7%	100.0%
Cumulative	100.0%	89.1%	83.6%	70.9%	65.5%	60.0%	49.1%	29.1%	12.7%	
SHS Participants	1	2	2		3		4	5	8	25
Percent	4.0%	8.0%	8.0%	0.0%	12.0%	0.0%	16.0%	20.0%	32.0%	
Cumulative	100.0%	96.0%	88.0%	80.0%	80.0%	68.0%	68.0%	52.0%	32.0%	
Lorolwane	17	6	5	11	7	1	5	1	1	54
Percent	31.5%	11.1%	9.3%	20.4%	13.0%	1.9%	9.3%	1.9%	1.9%	100.0%
Cumulative	100.0%	68.5%	57.4%	48.1%	27.8%	14.8%	13.0%	3.7%	1.9%	
SHS Participants	3	1	3	1	2	2	1	3	4	20
Percent	15.0%	5.0%	15.0%	5.0%	10.0%	10.0%	5.0%	15.0%	20.0%	100.0%
Cumulative	100.0%	85.0%	80.0%	65.0%	60.0%	50.0%	40.0%	35.0%	20.0%	
BCS Participants	3	1	6	2	2	2	2	2	0	20
Percent	15.0%	5.0%	30.0%	10.0%	10.0%	10.0%	10.0%	10.0%	0.0%	100.0%
Cumulative	100.0%	85.0%	80.0%	50.0%	40.0%	30.0%	20.0%	10.0%	0.0%	
Motlhabaneng	2	5	3	4	2	2	14	13	5	50
Percent	4.0%	10.0%	6.0%	8.0%	4.0%	4.0%	28.0%	26.0%	10.0%	100.0%
Cumulative	100.0%	96.0%	86.0%	80.0%	72.0%	68.0%	64.0%	36.0%	10.0%	
SHS Participants							1	1	3	5
Percent	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	20.0%	20.0%	60.0%	100.0%
Cumulative	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	80.0%	60.0%	
Total(Average)	63	39	46	71	44	54	60	80	46	503
Percent	12.5%	7.8%	9.1%	14.1%	8.7%	10.7%	11.9%	15.9%	9.1%	100.0%
Cumulative	100.0%	87.5%	79.7%	70.6%	56.5%	47.7%	37.0%	25.0%	9.1%	

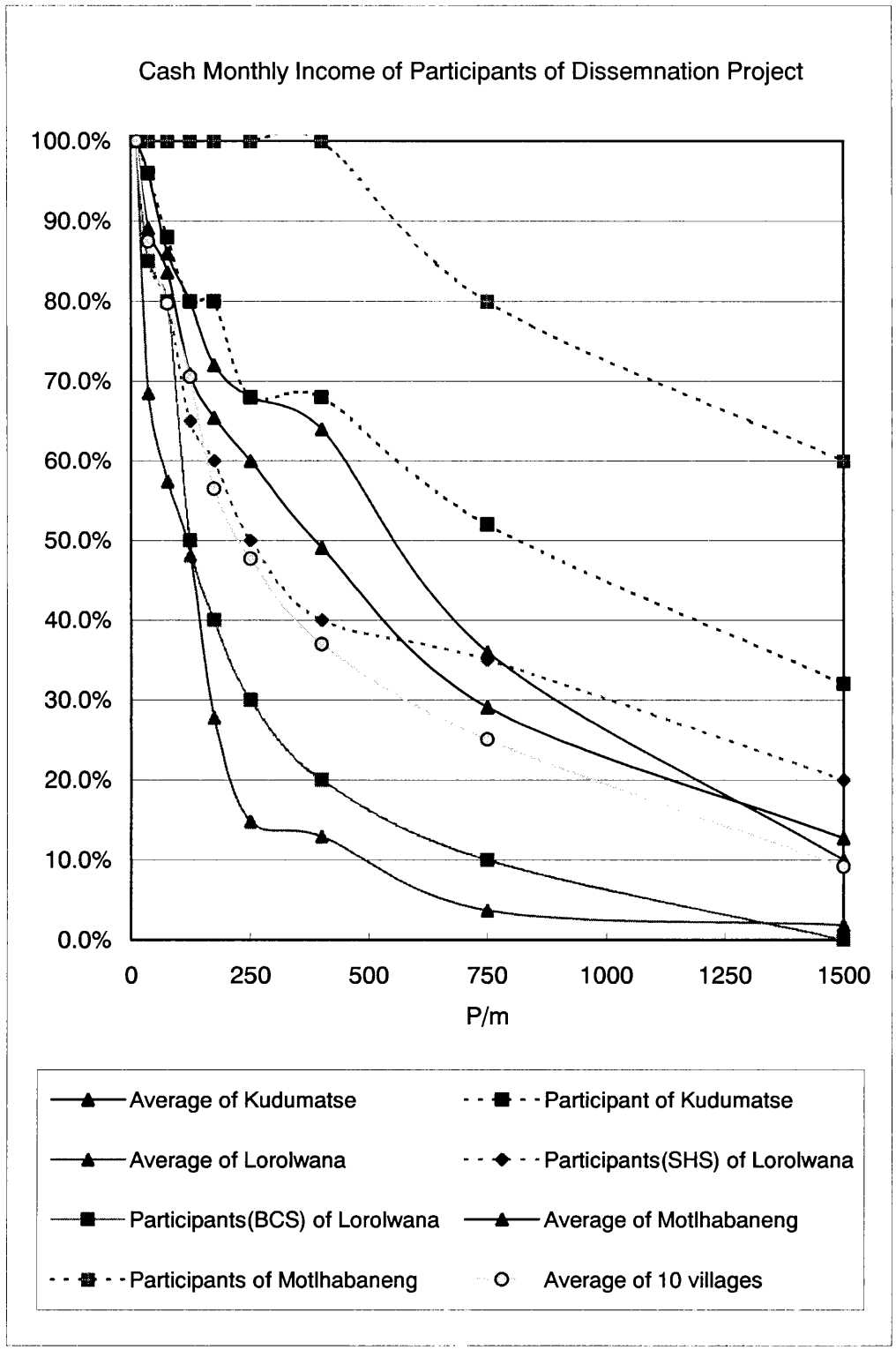

Figure 6.4-1 Cash Monthly Income of Participants of Dissemination Project

4) Household expenditure in a month

The distribution of SHS users shows the similar results as the Socio-economic Survey in any expenditure item. However, BCS users mainly spend for necessities of life such as "food", "Education" and "Energy" and what is more, expenditure levels are as low as P1-P50/m.

Table 6.4-9 Household Expenditure in a Month

Expenditure		No. of Respondents/ Total		0-50P	50-100P	100-150P	150-200P	200-300P	300P-
Food	A	483/520	93%	19%	24%	19%	14%	15%	9%
	B	46/50	92%	15%	9%	28%	26%	17%	4%
	C	20/20	100%	75%	25%				
Rent	A	17/520	3%	29%	71%				
	B	4/50	8%	75%	25%				
	C	0/20	0%						
Education	A	323/520	62%	83%	10%	3%	3%	0	1%
	B	30/50	60%	93%	3%	3%			
	C	16/20	80%	100%					
Clothes	A	352/520	68%	55%	16%	9%	7%	6%	7%
	B	18/50	36%	39%	22%	17%	11%	6%	6%
	C	4/20	20%	100%					
Energy	A	471/520	91%	85%	8%	3%	1%	3%	1%
	B	44/50	88%	75%	14%	5%		7%	
	C	18/20	90%	83%	17%				
Entertainment	A	101/520	19%	84%	4%	4%	3%		5
	B	4/50	8%	100%					
	C	0/20	0%						
Health	A	261/520	50%	94%	2%	1%	1%	1%	2%
	B	11/50	22%	91%					9%
	C	3/20	15%	100%					
Others	A	66/520	13%	32%	8%	18%	12%	17%	14%
	B	5/50	10%	60%			20%	20%	
	C	0/20	0%						
Savings	A	294/520	6%	38%	15%		17%	13%	18%
	B	38/50	76%	29%	18%	18%	8%	16%	11%
	C	10/20	50%	30%	40%	10%		20%	

Note) A: Socio-economic survey result (Average of 10 villages)
B: Results for Questionnaire to SHS users
C: Results for Questionnaire to BCS users

5) Expenditure for fuels

Although almost all households use firewood as a main fuel for cooking, it does not cost so much because firewood is collected by themselves. Paraffin and Candle are main fuel sources for lighting both for SHS users and BCS users.

Table 6.4-10 Expenditure for Fuels

(Unit: No. of samples)

Type of Fuel		No. of Respondents /Total		Main Fuel	0-10P	10-20P	20-30P	30-50P
Firewood	A	86/520	17%	39	7	4	4	2
	B	17/50	34%	14	16	1		
	C	6/20	30%	2	6			
Paraffin	A	448/520	86%	402	229	170	22	22
	B	41/50	82%	29	16	9	6	10
	C	12/20	60%	10	1	4	1	6
Candle	A	346/520	67%	67	293	23	4	10
	B	25/50	25%	5	13	6	3	4
	C	16/20	80%	8	4	3	2	7
LPG	A	9/520	2%	3	1	1	2	1
	B	6/50	12%	1		2		
	C	1/20	5%			1		
Generator	A	6/520	1%	2	1			5
	B	2/50	4%	1				2
	C	0/20	0%					
Battery	A	5/520	1%	2		3	1	1
	B	0/50	0%					
	C	0/20	0%					
Others	A	6/520	1%	2	5			
	B	1/50	2%		1			
	C	0/20	0%					

Note) A: Socio-economic survey result (Average of 10 villages)
B: Results for Questionnaire to SHS users
C: Results for Questionnaire to BCS users

6) Expenditure level for electric appliance

Table 6.4-11 Expenditure Level for Electric Appliance

Appliance		No. of Respondents /Total		Main energy source	User of main energy source	0-20P	20-50P	50P-
Radio	A	311/520	60%	Dry battery	258	175	98	17
	B	33/50	66%		22	29		
	C	7/20	35%		7	6	1	
TV	A	33/520	6%	Liquid battery	18	11	7	7
	B	8/50	16%		5	3	3	
	C	0/20	0%					
Refrige rator	A	56/520	11%	LPG	50	4	6	41
	B	7/50	14%		6	0	7	
	C	0/20	0%					

Note) A: Socio-economic survey result (Average of 10 villages)
B: Results for Questionnaire to SHS users
C: Results for Questionnaire to BCS user

7) Awareness on PV system

Awareness on PV system in BCS users is 25%, which is much smaller than that in SHS users (64%) and of the average of 10 villages (73.5%).

Table 6.4-12 Awareness on PV System

		YES		NO	
	No. of samples	**Count**	(%)	**Count**	(%)
Socio-economic Survey (Average of 10 villages)	520	382	73.5	130	25.0
SHS user	50	32	64	18	36
BCS user	20	5	25	14	70

8) Willingness to pay

As both SHS users and BCS users recognize to pay the necessary payment to participate in the Dissemination Project, a willingness to pay of those respondents shows high ratio.

Table 6.4-13 Willingness to Pay

	No. of Samples	Willingness t pay (count)	Ratio
Socio-economic Survey (Average of 10 villages)	520	346	66.5%
SHS user	50	48	96%
BCS user	20	18	90%

9) PV potential Demand by PV size

PV potential demand by PV size was estimated based on the results of "PV size and Ratio of potential PV users in Socio-economic survey. Actual PV size distribution in the Dissemination Project is summarized in the below table, which shows a big difference in the larger size of PV systems.

Table 6.4-14 PV Demand by Size in the Dissemination Project

	Socio-economic survey	Motlhabaneng	Kudumatse	Lorolwana	Total
50Wp SHS	55.0%	67.6%	75.0%	87.5%	77.1%
100Wp SHS	22.0%	20.6%	17.5%	10.0%	15.8%
150Wp SHS	8.1%	2.9%	5.0%	2.5%	3.5%
200Wp SHS	0.9%	0.0%	2.5%	0.0%	0.9%
250Wp SHS	5.7%	8.8%	0.0%	0.0%	2.6%
350Wp SHS	13.3%	0.0%	0.0%	0.0%	0.0%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

A higher income bracket in each village participates in the Dissemination Project as evaluated in Section 6.4 "Cash income distribution". There cannot be a case to use 250Wp or more size except very high income households. However, only 2.6% of participants use 250Wp of PV system

as shown in the above table. There was no 350 Wp PV system in the menu of the Dissemination Project. But even though this size was included in the menu, it seems there is no applicant who wish to use 350Wp PV system, considering functional limitation of PV systems that it is not suitable for the large size of refrigerator.

6.5 PV Market Potential

6.5.1 PV Demand by Size in Households

It was clarified through the Socio-economic survey that there would be a certain needs by a PV system size in conjunction with user's income status, affordability and housing status etc. (Referred to Table 6.2-10).

As described in Section 6.4 12), it was found that the actual distribution by PV size in participants in the Dissemination Project was far from the results of the Socio-economic survey. The actual results are adopted to assess a potential PV demand by a PV size.

Table 6.5-1 PV Demand by PV size

PV system	PV size adopted by the Study team	PV demand by PV size	
		*1 Result of Socio-economic survey	*2Adoption based on the actual results of the Dissemination Project
2-Light	50Wp	50.0%	77.1%
3-4Light	100Wp	22.0%	15.8%
6 Light + radio	150Wp	8.1%	3.5%
3-4 Light + B&W TV	200Wp	0.9%	0.9%
3-4 Light + Color TV	250Wp	5.7%	2.6%
3-4 Light + small Refrigerator	350Wp	13.3%	0.0%
Total		100%	100%
Average PV size per household		122Wp	68Wp

*1 Refer to Table 6.2-10

*2 Refer to Section 6.4 12)

6.5.2 PV Demand by Size in Public Facilities

In order to assess the potential demands for the public facilities the following public facilities are listed up, of which clinic (or Health post), Primary school, Kgotla and VDC are very common in a standard village. Therefore demands for such four facilities are named as "Minimum demand in public facilities" and total demands for all facilities below are names as "Maximum demands in public facilities".

Table 6.5-2 Min. and Max. Demands for Public Facilities per One Village

No.		Demand of 4 Light + Fridge (corresponding to 350Wp)	PV demand (Wp)
1	Clinic (Health Post)	100%	350
2	Primary school	80%	280
3	Kgotla	100%	350
4	VDC	100%	350
5	Police	43%	150
6	Veterinary office	67%	235
7	Others	67%	235
Min. demands/village (Sum of 1 to 4)			1,330
Max. demands/village (Sum of 1 to 7)			1,950

Note) the above % indicates willingness to pay in surveyed public facilities.

The above results derive the average demands per one village, which is adopted to assess potential demands for public facilities in PV electrified villages.
Average demands: 1,650Wp per one PV electrified village

As for public facilities in localities, the PV demand is assumed to be 350Wp based on the assumption that a locality has either an elementary school or a health post in average.

As a result, potential demands of public facilities in villages and localities are summarized in the Table 6.5-3.

Table 6.5-3 PV Demands of Public Facilities

Category	Wp
Villages	1,650
Localities	350

6.5.3 Willingness/Ability to Pay Curve Adopted

The ability to pay curve obtained in Socio-economic survey (Figure 6-2-11) has been assessed and reviewed though the Dissemination Project.

(1) Ratio of Participants in the Dissemination Project

The number of participants in the Dissemination Project, the number of households in each village and other related data are summarized in Table 6.5-4. The number of participants, who signed the contract with the Implementation Body and paid the deposit money and for whom PV systems were installed, was 114 in total at the beginning of the Project, however eleven participants had not paid monthly charges for more than 3 months due to their absences, the lack of money, etc. Accordingly, the number of substantial participants decreased to 103 as of December, 2002.

It is necessary to obtain the accurate number of households in the villages for the evaluation of the ratio of participants in the Project to the total number of households in the villages. Information on the population of 3 villages in 2001 was updated in accordance with the Population and Housing Census 2001, which was issued in April, 2002. According to the Census 2001, it is found that the population growth of 3 villages was more than predicted value as shown in Table 6.2-1. The number of households in the villages was obtained on the assumption that the average family size in the villages was five.

The ratio of the number of participants to the number of households in 3 villages was 16.0% at the beginning of the Project and decreased to 14.4% in December 2002. The detail of payment status of the participants in the Dissemination Project is referred to Appendix Table 15.9-1.

Table 6.5-4 Dissemination Project: Monitoring Results Summary

		Motl.	Kud.	Lorol.	Total	
①	Total No. of HHs (year of 2001)	255	268	190	713	Ratio of Willingness/ Ability to Pay
②	Original Participants in Mar. 2002 (SHS)	34	40	40	114	
③	Ratio (②/①)	13.3%	14.9%	21.1%	16.0%	
④	No. of Repossesion (for 10months)	3	2	6	11	
⑤	Net Participants in Dec, 2002 SHS)	31	38	34	103	
⑤-1	50Wp SHS	(21)	(29)	(30)	(80)	14.4%
⑤-2	100Wp SHS	(6)	(7)	(3)	(16)	3.2%
⑤-3	150Wp SHS	(1)	(2)	(1)	(4)	1.0%
⑤-4	200Wp SHS	(0)	(0)	(0)	(0)	0.4%
⑤-5	250Wp SHS	(3)	(0)	(0)	(3)	0.4%
⑥	Ratio (⑤/①)	12.2%	14.2%	17.9%	14.4%	
⑦	No. of BCS Users	-	-	34	-	
⑧	Ratio (⑦/①)	-	-	17.9%	-	

(2) Willingness/Ability to Pay in the Dissemination Project

Based on data in Table 6.5-4, the willingness/ability to pay in the Project is estimated as follows;

P40/month, corresponding to the monthly tariff of 50Wp SHS: 14.4%
P80/month, corresponding to the monthly tariff of 100Wp SHS: 3.2%
P120/month, corresponding to the monthly tariff of 100Wp SHS: 1.0%
P160/month, corresponding to the monthly tariff of 100Wp SHS: 0.4%
P200/month, corresponding to the monthly tariff of 100Wp SHS: 0.4%

The above percentage is calculated on the assumption that the willingness/ability to pay, which is represented by monthly charges paid by the participants, correspond to that for average villagers in the villages.
The willingness/ability curve in the Project is drawn in Figure 6.5-1 as a title "Nation-wide Project in the first year (Result of the Dissemination Project at the first year)".

(3) Willingness/Ability to Pay Curve in the Nationwide Project

According to the time frame to introduce PV system surveyed in the Socio-economic survey which is referred in Table 6.2-9 and Figure 6.2-9, those who wished to introduce PV systems reached 65% of total villagers. About 16% of showed "immediately", about 33% of respondents showed "Later/next year" and about 16% of respondents showed "Need to consider/Don't know". The evaluation had been done in the Socio-economic survey that "Immediately", "Later/next year" and "Need to consider/Don't know" represented an urgent demand, a middle term demand and a long term demand respectively.

Actual results, i.e., the ratio of participants of 16% or 14.4%, in the Dissemination Project, almost coincide with the results of the Socio-economic survey for the immediate demand.

The group who answered "Later/next year", which is considered to be the candidate customers who will join the Dissemination Project if the Project still continues to solicit villagers for the participation. However, this prediction is not able to be validated because new applicants for the Project will not be planned. If we follow the result of the Socio-economic survey, 235 households, which is 33% of total number of households in 3 villages, might wish to participate in the Project for coming 2-3 years. There exists a certain number of villagers who wish to have PV systems if the Implementation Body resumes applications in the Project. Number of households in waiting list would be, according to the System Monitoring Agents assigned in the villages, about 30 villagers in Motlhabaneng, about 30 in Kudumatse and 10 in Lorolwana, which is not as many as the prediction of the Socio-economic survey. The Study team also does not feel that there would be almost twice of potential waiting villagers as the actual number of participants n the Dissemination Project in the villages for coming 2 to 3 years, considering the difficulties that the Implementation Body and the Study Team experienced in the Project in collecting deposit money and continuous monthly charges from the participants.

Target PV electrification rate is set up at 40% in rural Botswana as mentioned in Section 7.1 and the willingness/ability to pay for PV systems is

considered to be P40/m correspond to 40% in rural Botswana. Therefore it is set up that the willingness/ability to pay will be 14% in the first year, 16% in the second year and 10% for the years afterwards and finally reach 40% in the future as shown in Table 6.5-5.

The willingness/ability to pay-curve adopted in the Nationwide Project is shown in Figure 6.5-1 based on aforementioned discussions. The figure includes the curve in the first year, in the second year and in the future as well as the result of the Socio-economic survey for the reference.

Table 6.5-5 Willingness/Ability to pay (yearly movement)

	Result of the Dissemination Project	Nation-wide Project	Socio-economic survey	
1st year	14.4%	14%	"Immediately"	16%
2nd year	-	16%	"Later/next year"	33%
3rd year onward	-	10%	"Need to consider/Don't know"	16%
Total	-	40%		65%

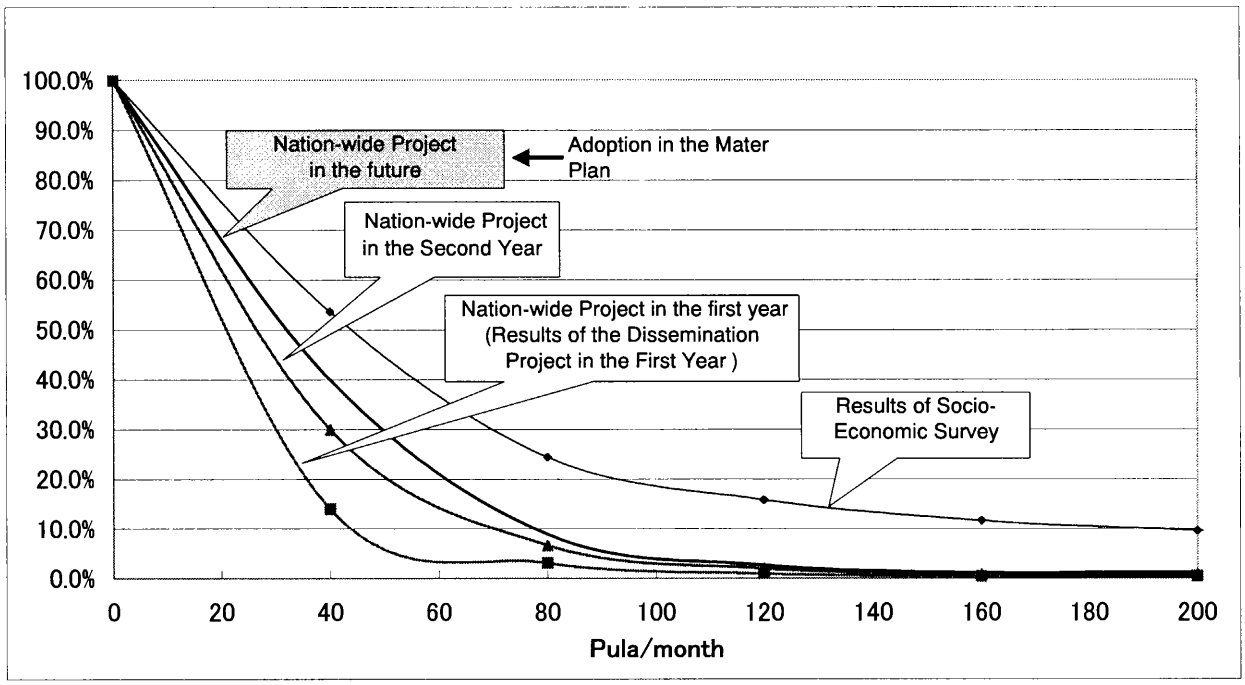

Figure 6.5-1 Willingness/Ability to Pay for the Monthly Charge Adopted in Master Plan

Refer to the Appendix 6 for the detailed studies on the subjects related to Chapter 6.