

SURVEY OF BATTERIES USED IN SOLAR HOME SYSTEMS IN SRI LANKA

Final Report

Submitted to

RERED Project, DFCC Bank

By

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**RENEWABLE ENERGY FOR RURAL ECONOMIC
DEVELOPMENT (RERED) PROJECT**

SURVEY OF BATTERIES USED IN SOLAR HOME SYSTEMS IN SRI LANKA

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CHAPTER 1

1.1 INTRODUCTION

The Government of Sri Lanka (GOSL), with the assistance of the World Bank and the Global Environment Facility (GEF) has established the Renewable Energy for Rural Economic Development (RERED) Project, which aims to foster rural economic development and improve the quality of life in rural areas by providing access to electricity, and expand the commercial provision by use of electricity generated from renewable sources.

One goal of the RERED project is to electrify 100,000 remote households mainly through solar home systems (SHS). These systems provide a convenient means of supplying power for small electrical loads such as fluorescent lights, black and white TV and radio/cassette players. Each SHS consists of one or more photovoltaic (PV) modules charging a 12 Volt lead-acid battery, along with light fixtures, related electronic and electrical components and mounting hardware.

About 21,000 certified SHS were installed under the earlier Energy Services Delivery (ESD) Project (1997-2002), and the cumulative figure under both ESD and RERED was over 50,000 systems by June 2004.

The Administrative Unit of the RERED project setup within the DFCC Bank has requested Sri Lanka Business Development Centre (SLBDC) to provide consultancy services to carry out a survey of batteries used in solar home systems in Sri Lanka.

As requested by the client Sri Lanka Business Development Centre carried out the survey of batteries used in solar home systems in Sri Lanka to find out statistically establish the life of batteries installed under ESD and RERED Projects

1.2 Objectives of the Assignment

The objective of this assignment is to carry out field survey using a standard questionnaire to statistically establish the life of a battery installed under the Energy Service Delivery (ESD) and RERED Projects, with the results further analysed under different operating conditions and configurations.

1.3 Methodology

Quantitative research method was applied to carry out a survey of batteries used in solar home systems in Sri Lanka covering a sample of 300 solar home systems installed under the ESD (1997-2002) and RERED (2002 - 2004) projects. Approximately 30 solar home systems in each of the following ten districts were surveyed: Nuwara Eliya, Polonnaruwa, Vavuniya, Ampara, Ratnapura, Matara, Badulla, Monaragala, Puttalam and Kurunegala.

Following steps were taken by the SLBDC to carry out the above survey:

- Initially the SLBDC reviewed the questionnaire developed by the Administrative Unit of the RERED project and agreed on the final format,
- Based on the sample provided by client, SLBDC carried out the pilot survey of ten household units in the district of Kurunegala to check and improve the approaches and methodologies if necessary,
- Initially, SLBDC and the Administrative Unit jointly listed a 450 number of Sample Solar Home Systems for the survey and SLBDC checked Solar Home Systems records with relevant solar companies and finalized the final sample size of 350 Solar Home Systems to be visited,
- Under the supervision of the project team of SLBDC, field staff carried out the field survey, which included the following activities:
 - Obtained information /data from the householders through discussion,
 - Validated the data through available documentations at site such as records of visits by solar company, battery warranty cards etc,
 - Visual inspection (battery water level, evidence of additional loads being added on etc)
 - Measurement of specific gravity of electrolyte using a hydrometer.

1.4 Data Validation

- More than 50% of the field data collected from solar home systems was validated with those available records with relevant solar companies and or relevant solar agents in the survey areas.

1.5 Data Processing and Analysis

The data/information gathered through the survey was computerized using a spreadsheet data entry format developed under Microsoft Excel environment and the statistical analysis package called SPSS was used to analyse the data.

1.6 Project Team

The team deployed for the project has extensive experience in designing and implementing surveys, studies and similar nature of work related to the above assignment. The team consisted of

Ms Rohanthi Perera, Executive Director SLBDC- Project Director
Mr. M.M.R. Pathmasiri, Technical Consultant – Team Member
Mr. Sarath Aberatne Pamunuwa, Technical Consultant – Team Member
Mr. S.L.P.Stambo, Technical Advisor- Team Member
Mr. Sanath Manage, Deputy Executive Director SLBDC – Team Member
Ms Harshini Wijekoon, Deputy Manager SLBDC – Team Member

In addition, we deployed two field investigators for each district to carry out a survey of batteries used in solar home systems in Sri Lanka. We have a pool of over 150 well-trained field investigators representing every administrative district in Sri Lanka except in the districts of Kilinochchi and Mullaitivu. These field investigators are, at least possessing their Advanced Level education qualifications, while some are graduates or those presently pursuing university education.

CHAPTER 2

2. ANALYSIS OF THE RESULTS OF THE SURVEY

Based on the sample provided by the Administrative Unit of the RERED project, the survey was carried out in ten administrative districts in Sri Lanka and 300 solar home systems were visited.

Table 1: Battery Survey Coverage By District

District	Number	%
Anuradhapura	30	10.0
Badulla	29	9.7
Kegalle	29	9.7
Kurunegala	42	14.0
Matara	28	9.3
Monaragala	28	9.3
Nuwara Eliya	22	7.3
Puttalam	34	11.3
Ratnapura	27	9.0
Trincomalee	31	10.3
Total	300	100.0

The above table shows the coverage of the battery survey by districts. Although we had planned to survey approximately 30 numbers of solar home systems in each district we were not able to achieve the target in Nuwara-Eliya district due to nonavailability of records with solar companies and difficulties in finding the locations of some households.

Table 2: Battery Survey Coverage By Solar Company

Solar Company	Number	%
Access Solar	72	24.0
Alpha Solar	21	7.0
EB Creasy	3	1.0
Selco Solar	74	24.7
Shell Solar	120	40.0
Softlogic	2	0.7
Suriyavahini	8	2.7
Total	300	100.0

Table 2 shows the coverage of the battery survey by solar companies. According to figures 40% of the solar home systems surveyed were installed by the Shell Solar Limited. In the final sample list, we have listed four solar home systems installed by a company called Solar Dynamics and we were not able to complete any forms due to difficulties in finding the locations of households.

Table 3: Battery Survey Coverage By Year of Installation

Year of Installation	Number	%	Age of the SHS (Years)
1998	12	4	7
1999	22	7.3	6
2000	32	10.7	5
2001	103	34.3	4
2002	81	27	3
2003	40	13.3	2
2004	10	3.3	1
Total	300	100	

Out of 300 systems surveyed, about 250 solar home systems were installed during the period of ESD project (1997 – 2001) and balance was installed during RERED project period.

Table 4: Panel Capacity By Solar System

Capacity (Wp)	Number	%
20 - 40	127	42.3
>40 -60	118	39.3
>60 - 80	42	14
>80 - 100	7	2.3
>100	2	0.7
Total Respond	296	98.7
Not Respond	4	1.3
Total	300	100

The above table shows the capacity of panels by solar systems, according to the figures 42% of the systems surveyed had a range of 20 to 40 Wp capacities of solar panels and 39% of the systems had range of 41 to 60 Wp capacities of panels. Only two systems were found having more than 100 Wp capacity panels.

Table 5: Total Energy(Estimated) Used Per Day By House Holders

Energy Used Per Day (Wh/day)	Number	%
12 – 50	28	9.3
>50 - 100	88	29.3
>100 - 150	97	32.3
>150 - 200	44	14.7
>200 - 250	31	10.3
>250	12	4
Total	300	100

The above table shows the total energy (estimated) used per day by households, according to the estimated figures about 32% of the households used between 101 to 150 Wh of energy per day generated by the solar systems while 29% of households used 51 to 100 Wh of energy per day.

Table 6 : Type of First Battery Installed

Type	Number	%
ABM	39	13.0
Ecosolar	3	1.0
Exide	62	20.7
Incoe	111	37.0
Lucas	71	23.7
Nico	3	1.0
Sandya	11	3.7
Total	300	100.0

Reference to the Table 6, Exide, Incoe and Lucas batteries are installed in 81% of the solar systems surveyed. According to the data, Incoe batteries are installed in 37% of the solar systems and Lucas batteries are installed in 24% of the systems.

Table 7: Types of Batteries(First Battery) installed by Solar Companies

Solar Company		Battery Type							Total
		ABM	Ecosolar	Exide	Incoe	Lucas	Nico	Sandya	
Access Solar	Count	9		2	5	55		1	72
	% within Solar Company	12.5%		2.8%	6.9%	76.4%		1.4%	100.0%
Alpha Solar	Count			18		3			21
	% within Solar Company			85.7%		14.3%			100.0%
EB Creasy	Count		3						3
	% within Solar Company		100.0%						100.0%
Selco Solar	Count	25		15	19	5		10	74
	% within Solar Company	33.8%		20.3%	25.7%	6.8%		13.5%	100.0%
Shell Solar	Count	3		19	87	8	3		120
	% within Solar Company	2.5%		15.8%	72.5%	6.7%	2.5%		100.0%
Softlogic	Count			2					2
	% within Solar Company			100.0%					100.0%
Suriyavahini	Count	2		6					8
	% within Solar Company	25.0%		75.0%					100.0%
Total	Count	39	3	62	111	71	3	11	300
	% within Solar Company	13.0%	1.0%	20.7%	37.0%	23.7%	1.0%	3.7%	100.0%

The above table shows the types of batteries installed by solar companies. Out of 300 solar home systems surveyed, 72 systems were installed by the Access Solar and 76% of the batteries they had installed in the solar systems were brand of Lucas. Out of 120 systems installed by the Shell Solar, 73% of the batteries installed were Incoe brand. 74 solar home systems installed by the company of Selco Solar were surveyed and more than 70% of the batteries they had installed in the systems are mix of ABM, Exide and Incoe.

Table 8 : Capacity of Panel By Capacity of Battery (First Battery)

Panel Capacity (Wp)		Battery Capacity(First Battery)(Ah)									Total
		40	50	60	70	80	90	100	120	140	
20 - 40	Count	2	6	7	49	1	53	6	3		127
	% within Panel Capacity	1.6%	4.7%	5.5%	38.6%	.8%	41.7%	4.7%	2.4%		100.0%
>40 - 60	Count			1	24		28	54	13	1	121
	% within Panel Capacity			.8%	19.8%		23.1%	44.6%	10.7%	.8%	100.0%
>60 - 80	Count				6		8	20	8	1	43
	% within Panel Capacity				14.0%		18.6%	46.5%	18.6%	2.3%	100.0%
>80	Count				2		1	4	1	1	9
	% within Panel Capacity				22.2%		11.1%	44.4%	11.1%	11.1%	100.0%
Total	Count	2	6	8	81	1	90	84	25	3	300
	% within Panel Capacity	0.7%	2.0%	2.7%	27.0%	.3%	30.0%	28.0%	8.3%	1.0%	100.0%

The above table shows the capacity of panel and capacity of first battery installed in each system surveyed. Out of 300 systems surveyed, 30% of the batteries installed are 90 Ah capacity while 28% of batteries are 100 Ah capacity. 27% of batteries installed had capacity of 70 A. As per the figures, 127 of the systems surveyed had capacity of 20 to 40 Wp solar panels of which 40% of batteries installed had capacity of 90 A. 121 systems surveyed had capacity of 41 to 60 Wp range of panels of which 45% of the batteries installed had capacity of 100 Ah.

Table 9 : Energy Used Per Day By Battery Capacity(First Battery) and Panel Capacity

Battery Capacity (Ah)	Panel Capacity (Wp)	Energy Used Per Day(Wh)						Total
		12- 50	>50 - 100	>100 - 150	>150 - 200	>200 - 250	>250	
40	20 - 40		1			1		2
	Total		1			1		2
50	20 - 40		3	1		2		6
	Total		3	1		2		6
60	20 - 40		4	1	2			7
	>40 - 60	1						1
	Total	1	4	1	2			8
70	20 - 40	5	18	15	8	3		49
	>40 - 60	3	7	7	3	1	3	24
	>60 - 80			2	2	1	1	6
	>80			1	1			2
	Total	8	25	25	14	5	4	81
80	20 - 40	1						1
	Total	1						1
90	20 - 40	1	18	17	9	4	4	53
	>40 - 60	4	8	10	3	3		28
	>60 - 80		2	5		1		8
	>80			1				1
	Total	5	28	33	12	8	4	90
100	20 - 40		3	1	1		1	6
	>40 - 60	7	16	14	9	7	1	54
	>60 - 80	4	5	4	3	3	1	20
	>80		1	3				4
	Total	11	25	22	13	10	3	84
120	20 - 40			2		1		3
	>40 - 60	1	2	6	1	3		13
	>60 - 80	1		4	2	1		8
	>80			1				1
	Total	2	2	13	3	5		25
140	>40 - 60			1				1
	>60 - 80						1	1
	>80			1				1
	Total			2			1	3
Total		28	88	97	44	31	12	300

Note : Each cell represent number of batteries

Table 10 : Batteries Replaced From Solar Home Systems

Type	No.	%
Not Replaced	154	51.33
Replaced only one Battery	119	39.67
Replaced Two Batteries	18	6.00
Replaced Three batteries	5	1.67
Not respond	4	1.33
Total	300	100.00

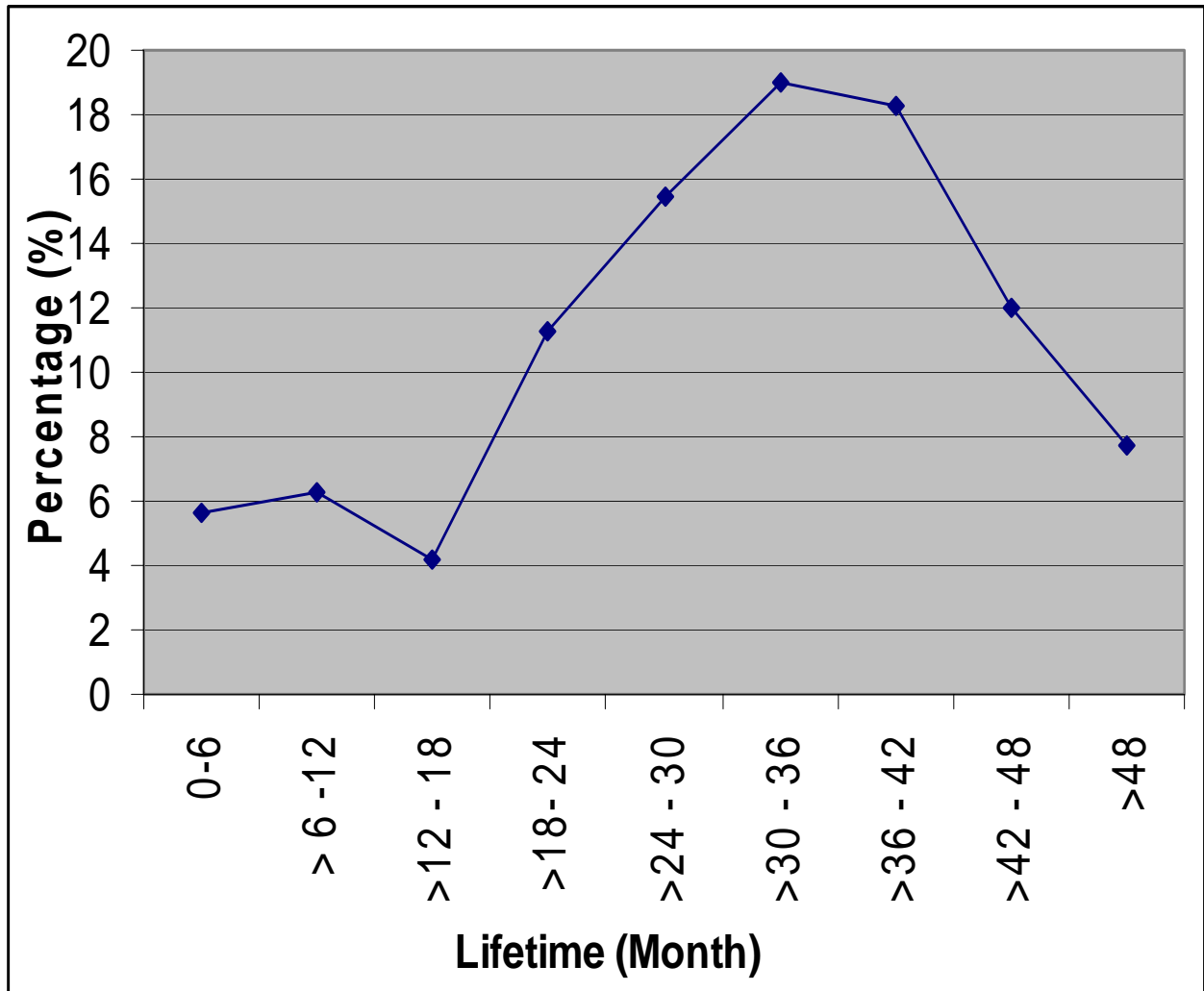
Table 10 indicates the number of households that replaced batteries of their solar system. Out of 300 households surveyed, about 142 households replaced batteries of their solar systems. According to the figures of the above table 40% of the households had replaced only the first battery of the solar system while 6% of households replaced batteries of their solar system twice. Only five households were found using the fourth battery by replacing batteries thrice from their systems.

Table 11: Analysis of Replaced Batteries: Lifetime of First Battery

Lifetime (Month)	Number	%
0-6	8	5.6
> 6 -12	9	6.3
>12 - 18	6	4.2
>18- 24	16	11.3
>24 - 30	22	15.5
>30 - 36	27	19
>36 - 42	26	18.3
>42 - 48	17	12
>48	11	7.7
Total	142	100

The above table shows the Lifetime of first batteries replaced from the solar home system. Based on the figures of the above table, weighted average lifetime of first battery was calculated and it is 30.4 months.

Graph 1: Analysis of Replaced Batteries: Lifetime of First Battery



The above graph clearly indicates that most of the batteries replaced from the solar systems had a lifetime of 24 to 42 month period.

2.1 Analysis of the Minimum Lifetime of First Batteries By Battery Capacity in Different SHS Installation Age

Minimum life time of first batteries installed to the SHSs were analysed according to the age of the Solar Systems and the following tables highlighted the results of the above analysis in different SHS installation age groups. In this analysis, we have included both replaced and existing batteries(first battery) to calculate the cumulative figures of the lifetime.

Table 12: Minimum Lifetime of First Battery By SHS Installation Age >36 months to 42 months

Battery Capacity (Ah)	Lifetime of First Battery (Month) (%)							Total-SHS replaced First Battery (%)	Total SHS Covered (Number)
	< 6	≥ 6	≥12	≥18	≥24	≥30	≥ 36		
140									
120	0.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	10
100	0.0	100.0	100.0	100.0	81.0	76.2	61.9	47.6	21
90	0.0	100.0	100.0	100.0	100.0	89.3	82.1	21.4	28
70	5.0	95.0	95.0	95.0	95.0	80.0	80.0	30.0	20
60									
50	0.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	1
40									
Total	1.2	98.7	98.7	98.7	93.7	85.0	78.7	27.5	80

Table 13: Minimum Lifetime of First Battery By SHS Installation Age > 42 months to 48 months

Battery Capacity (Ah)	Lifetime of First Battery (Month) (%)								Total-SHS replaced First Battery (%)	Total SHS Covered (Number)
	< 6	≥ 6	≥12	≥18	≥24	≥30	≥ 36	≥ 42		
140	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	1
120	0.0	100.0	80.0	80.0	80.0	80.0	60.0	40.0	60.0	5
100	0.0	100.0	85.2	81.5	81.5	70.4	51.9	37.0	70.3	27
90	5.0	95.0	90.0	85.0	85.0	80.0	65.0	40.0	60.0	20
70	0.0	100.0	100.0	88.2	88.2	76.5	52.9	47.1	52.9	17
60	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	1
50										
40										
Total	1.4	98.6	90.1	84.5	84.5	76.1	57.8	42.3	61.8	71

Table 14: Minimum Lifetime of First Battery By Battery Capacity - SHS Installation Age > 48 months to 54 months

Battery Capacity (Ah)	Lifetime of First Battery (Month) (%)									Total-SHS replaced First Battery (%)	Total SHS Covered (Number)
	< 6	≥ 6	≥12	≥18	≥24	≥30	≥ 36	≥ 42	≥ 48		
140	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	100.0	1
120	0.0	100.0	100.0	100.0	100.0	100.0	100.0	75.0	75.0	25.0	4
100	0.0	100.0	100.0	100.0	100.0	100.0	91.7	50.0	25.0	75.0	12
90	0.0	100.0	83.3	83.3	66.7	66.7	66.7	66.7	50.0	66.7	6
70	0.0	100.0	100.0	100.0	80.0	80.0	80.0	80.0	80.0	20.0	5
60	0.0	100.0	100.0	100.0	50.0	50.0	50.0	50.0	50.0	50.0	2
50											
40											
Total	3.3	96.7	93.3	93.3	83.3	83.3	80.0	60.0	46.67	56.7	30

Table 15: Minimum Lifetime of First Battery By Battery Capacity - SHS Installation Age > 54 months to 60 months

Battery Capacity (Ah)	Lifetime of First Battery (Month) (%)										Total-SHS replaced First Battery (%)	Total SHS Covered (Number)
	< 6	≥ 6	≥12	≥18	≥24	≥30	≥ 36	≥42	≥ 48	≥ 54		
140												
120												
100	0.0	100.0	100.0	100.0	100.0	83.3	66.7	33.3	33.3	33.3	83.3	6
90	0.0	100.0	100.0	100.0	83.3	83.3	83.3	50.0	50.0	33.3	66.7	6
70	0.0	100.0	100.0	100.0	100.0	100.0	100.0	40.0	0.0	0.0	100.0	5
60	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	1
50	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	1
40												
Total	5.3	94.7	94.7	94.7	89.5	84.2	79.0	42.1	31.6	26.3	79.0	19

Table 16: Minimum Lifetime of First Battery by Battery Capacity - SHS Installation Age > 60 months

Battery Capacity (Ah)	Lifetime of First Battery (Month) (%)										Total-SHS replaced First Battery (%)	Total SHS Covered (Number)
	< 6	≥ 6	≥12	≥18	≥24	≥30	≥ 36	≥42	≥ 48	≥ 54		
140	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	0.0	100.0	1
120	0.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	0.0	0.0	100.0	1
100	0.0	100.0	100.0	100.0	100.0	100.0	66.7	66.7	33.3	16.7	83.3	6
90	0.0	100.0	100.0	100.0	90.0	75.0	70.0	60.0	40.0	25.0	85.0	20
70	0.0	100.0	100.0	100.0	88.9	66.7	55.6	44.4	22.2	11.1	100.0	9
60	0.0	100.0	100.0	100.0	75.0	75.0	50.0	50.0	50.0	25.0	100.0	4
50												
40	0.0	100.0	100.0	100.0	100.0	0.0	0.0	0.0	0.0	0.0	100.0	2
Total	0.0	100.0	100.0	100.0	90.7	74.4	62.8	53.5	32.6	18.6	90.7	43

According to the above tables(12 to 16), capacities of 100Ah, 90Ah and 70Ah batteries were installed in 85% of Solar Home Systems. When compared to installation age of solar systems, more than 50% of the batteries installed in solar systems over a 60 month period had a lifetime of more than 42 months. In general, the above tables highlighted that over 75% of the batteries had a lifetime of more than 30 months and 54% of the batteries had a lifetime of more than 54 months.

2.2 Analysis of the Minimum Lifetime of First Batteries By Battery Capacity and Brand in Different SHS Installation Age

The following tables highlight the results of the analysis of minimum life time of first batteries by battery capacity and brand . The age of the Solar Home Systems were also considered during the analysis. This analysis is limited to only three major brands namely Exide, Lucas and Incoe due to the limited sample size representation of other brands. In this analysis, we have included both replaced and existing batteries(first battery) to calculate the cumulative figures of the lifetime.

Table 17: Minimum Lifetime of First Battery By Battery Capacity - Exide Brand - SHS Installation Age >36 months to 42 months

Battery Capacity (Ah)	Lifetime of First Battery (Month) (%)							Total SHS replaced First Battery (%)	Total SHS Covered (Number)
	< 6	≥ 6	≥12	≥18	≥24	≥30	≥ 36		
140									
120									
100	0.0	100.0	100.0	100.0	33.3	33.3	-	100.0	3.0
90	0.0	100.0	100.0	100.0	100.0	100.0	90.0	20.0	10.0
70									
60	0.0	100.0	100.0	100.0	100.0	100.0	100.0	-	1.0
50									
40									
Total	0.0	100.0	100.0	100.0	85.7	85.7	71.4	35.7	14.0

Table 18: Minimum Lifetime of First Battery By Battery Capacity - Exide Brand- SHS Installation Age > 42 months to 48 months

Battery Capacity (Ah)	Lifetime of First Battery (Month)								Total- SHS replaced First Battery (%)	Total SHS Covered (Number)
	< 6	≥ 6	≥12	≥18	≥24	≥30	≥ 36	≥42		
140										
120										
100	0.0	100.0	75.0	75.0	75.0	75.0	25.0	0.0	100.0	4
90	0.0	100.0	100.0	83.3	83.3	83.3	66.7	16.7	83.3	6
70										
60	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	1
50										
40										
Total	0.0	100.0	90.9	81.8	81.8	81.8	54.5	18.2	90.9	11

**Table 19: Minimum Lifetime of First Battery By Battery Capacity - Exide Brand - SHS Installation
Age > 48 months to 54 months**

Battery Capacity (Ah)	Lifetime of First Battery (Month) (%)									Total-SHS replaced First Battery (%)	Total SHS Covered (Number)	
	< 6	≥ 6	≥12	≥18	≥24	≥30	≥ 36	≥42	≥ 48			
140												
120	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	-	1
100	0.0	100.0	100.0	100.0	100.0	100.0	100.0				100.0	2
90	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	-	1
70												
60	0.0	100.0	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	1
50												
40												
Total	0.0	100.0	100.0	100.0	80.0	80.0	80.0	40.0	40.0	60.0	60.0	5

**Table 20: Minimum Lifetime of First Battery By Battery Capacity - Exide Brand - SHS Installation
Age > 54 months to 60 months**

Battery Capacity (Ah)	Lifetime of First Battery (Month) (%)										Total-SHS replaced First Battery (%)	Total SHS Covered (Number)	
	< 6	≥ 6	≥12	≥18	≥24	≥30	≥ 36	≥42	≥ 48	≥ 54			
140													
120													
100	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	-	1	
90	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	-	100.0	1	
70	0.0	100.0	100.0	100.0	100.0	100.0	100.0	-	-	-	100.0	2	
60	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		1	
50													
40													
Total	0.0	100.0	100.0	100.0	100.0	100.0	100.0	60.0	60.0	40.0	60.0	5	

**Table 21: Minimum Lifetime of First Battery By Battery Capacity - Exide Brand-SHS Installation
Age > 60 months**

Battery Capacity (Ah)	Lifetime of First Battery (Month) (%)										Total-SHS replaced First Battery (%)	Total SHS Covered (Number)
	< 6	≥ 6	≥12	≥18	≥24	≥30	≥ 36	≥42	≥ 48	≥ 54		
140												
120	0.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	0.0	0.0	100.0	1
100	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	0.0	100.0	1
90	0.0	100.0	100.0	90.0	80.0	60.0	50.0	50.0	30.0	20.0	90.0	10
70	0.0	100.0	100.0	100.0	100.0	75.0	75.0	50.0	50.0	25.0	100.0	4
60	0.0	100.0	100.0	100.0	50.0	50.0	50.0	50.0	50.0	50.0	100.0	2
50												
40												
Total	0.0	100.0	100.0	94.4	83.3	66.7	61.1	50.0	33.3	22.2	94.4	18

**Table 22: Minimum Lifetime of First Battery By Battery Capacity – Lucas Brand- SHS Installation
Age >36 months to 42 months**

Battery Capacity (Ah)	Lifetime of First Battery (Month) (%)							Total-SHS replaced First Battery (%)	Total SHS Covered (Number)
	< 6	≥ 6	≥12	≥18	≥24	≥30	≥ 36		
140									
120	0.0	100.0	100.0	100.0	100.0	100.0	100.0		7
100									
90	0.0	100.0	100.0	100.0	100.0	82.4	76.5	23.5	17
70	0.0	100.0	100.0	100.0	100.0	100.0	100.0		1
60									
50									
40									
Total	0.0	100.0	100.0	100.0	100.0	88.0	84.0	16.0	25

**Table 23 : Minimum Lifetime of First Battery By Battery Capacity – Lucas Brand- SHS Installation
Age > 42 months to 48 months**

Battery Capacity (Ah)	Lifetime of First Battery (Month)								Total SHS replaced First Battery (%)	Total SHS Covered (Number)
	< 6	≥ 6	≥12	≥18	≥24	≥30	≥ 36	≥42		
140	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		1
120	0.0	100.0	100.0	100.0	100.0	100.0	100.0	50.0	50.0	2
100	0.0	100.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	2
90	10.0	90.0	90.0	90.0	90.0	80.0	60.0	40.0	60.0	10
70	0.0	100.0	100.0	100.0	100.0	100.0	66.7	66.7	33.3	3
60										
50										
40										
Total	5.6	94.4	88.9	88.9	88.9	83.3	66.7	50.0	50.0	18

**Table 24 : Minimum Lifetime of First Battery By Battery Capacity – Lucas Brand- SHS Installation
Age > 48 months to 54 months**

Battery Capacity (Ah)	Lifetime of First Battery (Month)								Total SHS replaced First Battery (%)	Total SHS Covered (Number)	
	< 6	≥ 6	≥12	≥18	≥24	≥30	≥ 36	≥42			≥ 48
140	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	1
120	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		1
100											
90	0.0	100.0	80.0	80.0	60.0	60.0	60.0	40.0	20.0	80.0	5
70	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		1
60	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		1
50											
40											
Total	11.1	88.9	77.8	77.8	66.7	66.7	66.7	55.6	44.4	55.6	9

**Table 25 : Minimum Lifetime of First Battery By Battery Capacity – Lucas Brand- SHS Installation
Age > 54 months to 60 months**

Battery Capacity (Ah)	Lifetime of First Battery (Month)										Total-SHS replaced First Battery (%)	Total SHS Covered (Number)
	< 6	≥ 6	≥12	≥18	≥24	≥30	≥ 36	≥42	≥ 48	≥ 54		
140												
120												
100												
90	0.0	100.0	100.0	100.0	100.0	100.0	100.0	50.0	50.0	50.0	50.0	4
70												
60												
50												
40												
Total	0.0	100.0	100.0	100.0	100.0	100.0	100.0	50.0	50.0	50.0	50.0	4

**Table 26 : Minimum Lifetime of First Battery By Battery Capacity – Lucas Brand- SHS Installation
Age > 60 months**

Battery Capacity (Ah)	Lifetime of First Battery (Month)										Total-SHS replaced First Battery (%)	Total SHS Covered (Number)
	< 6	≥ 6	≥12	≥18	≥24	≥30	≥ 36	≥42	≥ 48	≥ 54		
140	0.0	100.0	100.0	0.0	100.0	100.0	100.0	100.0	0.0	0.0	100.0	1
120												
100												
90	0.0	100.0	100.0	100.0	100.0	100.0	100.0	50.0	50.0	50.0	50.0	2
70	0.0	100.0	100.0	100.0	100.0	50.0	0.0	0.0	0.0	0.0	100.0	2
60	0.0	100.0	100.0	100.0	100.0	100.0	50.0	50.0	50.0	0.0	100.0	2
50												
40												
Total	0.0	100.0	100.0	100.0	100.0	85.7	57.1	42.9	28.6	14.3	85.7	7

**Table 27 : Minimum Lifetime of First Battery By Battery Capacity – Incoe Brand- SHS Installation
Age >36 months to 42 months**

Battery Capacity (Ah)	Lifetime of First Battery (Month)							Total-SHS replaced First Battery (%)	Total SHS Covered (Number)
	< 6	≥ 6	≥12	≥18	≥24	≥30	≥ 36		
140									
120	0.0	100.0	100.0	100.0	100.0	100.0	100.0	-	2
100	0.0	100.0	92.3	92.3	84.6	84.6	69.2	46.1	13
90		100.0	100.0	100.0	100.0	100.0	100.0		1
70	10.0	90.0	90.0	90.0	80.0	60.0	60.0	50.0	10
60									
50	0.0	100.0	100.0	100.0	100.0	100.0	100.0	-	1
40									
Total	3.7	96.2	92.5	92.5	85.1	77.8	70.3	40.7	27

**Table 28 : Minimum Lifetime of First Battery By Battery Capacity – Incoe Brand -SHS Installation
Age > 42 months to 48 months**

Battery Capacity (Ah)	Lifetime of First Battery (Month)								Total-SHS replaced First Battery (50%)	Total SHS Covered (Number)
	< 6	≥ 6	≥12	≥18	≥24	≥30	≥ 36	≥42		
140										
120	0.0	100.0	50.0	50.0	50.0	50.0	0.0	0.0	100.0	2
100	0.0	100.0	89.5	84.2	84.2	68.4	52.6	36.8	73.7	19
90		100.0	100.0	100.0	100.0	100.0	100.0	100.0		1
70	0.0	100.0	100.0	84.6	84.6	69.2	46.2	38.5	61.5	13
60										
50										
40										
Total	0.0	100.0	91.4	82.9	82.9	68.6	48.5	37.1	68.6	35

**Table 29 : Minimum Lifetime of First Battery By Battery Capacity – Incoe Brand- SHS Installation
Age > 48 months to 54 months**

Battery Capacity (Ah)	Lifetime of First Battery (Month)									Total-SHS replaced First Battery (50%)	Total SHS Covered (Number)
	< 6	≥ 6	≥12	≥18	≥24	≥30	≥ 36	≥42	≥ 48		
140											
120	0.0	100.0	100.0	100.0	100.0	100.0	100.0	50.0	50.0	50.0	2
100	0.0	100.0	100.0	100.0	100.0	100.0	90.0	60.0	30.0	70.0	10
90											
70	0.0	100.0	100.0	100.0	75.0	75.0	75.0	75.0	75.0	25.0	4
60											
50											
40											
Total	0.0	100.0	100.0	100.0	93.8	93.8	87.5	62.5	43.8	56.2	16

**Table 30 : Minimum Lifetime of First Battery By Battery Capacity – Incoe Brand -SHS Installation
Age > 54 months to 60 months**

Battery Capacity (Ah)	Lifetime of First Battery (Month)										Total-SHS replaced First Battery (50%)	Total SHS Covered (Number)
	< 6	≥ 6	≥12	≥18	≥24	≥30	≥ 36	≥42	≥ 48	≥ 54		
140												
120												
100	0.0	100.0	100.0	100.0	100.0	80.0	60.0	20.0	20.0	20.0	100.0	5
90	0.0	100.0	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	1
70	0.0	100.0	100.0	100.0	100.0	100.0	100.0	66.7	0.0	0.0	100.0	3
60												
50	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	1
40												
Total	10.0	90.0	90.0	90.0	80.0	70.0	60.0	30.0	10.0	10.0	100.0	10

Table 31 : Minimum Lifetime of First Battery By Battery Capacity – Incoe Brand -SHS Installation Age > 60 months

Battery Capacity (Ah)	Lifetime of First Battery (Month)										Total-SHS replaced First Battery	Total SHS Covered (Number)
	< 6	≥ 6	≥12	≥18	≥24	≥30	≥ 36	≥42	≥ 48	≥ 54		
140												
120												
100	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		1
90	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	50.0	2
70												
60												
50												
40												
Total	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	33.3	3

When comparing installation age of Solar Systems and brand of the batteries 50% of the Lucas batteries installed in 42 to 48 months old systems had a life time of more than 42 months, while 34% of the Incoe batteries had the same life time in same system age.

Only 18% of the Exide batteries had a life time of more than 42 months in same system age.

Table 32 : Percentage of First Batteries Lasting More Than 30 Months By SHS Age

Type	SHS Age			
	> 42	> 48	> 54	> 60
% of First Batteries Lasting More Than 30 Months	62.6	71.8	72.2	69.2

Table 33: Minimum Lifetime of First Battery By Battery Capacity by Panel Capacity -SHS Installation Age > 36 months to 54 months

Battery Capacity (Ah)	Panel Capacity (Wp)	Lifetime of First Battery (Month) (%)									Total-SHS replaced First Battery (%)	Total SHS Covered (No.)	
		< 6	≥ 6	≥12	≥18	≥24	≥30	≥ 36	≥42	≥ 48			
140	20 - 40	-	-	-	-	-	-	-	-	-	-	-	
	>40 - 60	-	-	-	-	-	-	-	-	-	-	-	
	>60 - 80	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	1	
	> 80	0.00	100.00	100.00	100.00	100.00	100.00	100.00	0.00	0.00	0.00	1	
Sub Total(140)		50.00	50.00	50.00	50.00	50.00	50.00	50.00	0.00	0.00	0.00	50.00	2
120	20 - 40	0.00	100.00	100.00	100.00	100.00	100.00	50.00	50.00	50.00	50.00	2	
	>40 - 60	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	0.00	8	
	>60 - 80	0.00	100.00	85.71	85.71	85.71	85.71	71.43	57.14	57.14	42.86	7	
	>80	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	0.00	1	
Sub Total(120)		0.00	100.00	94.44	94.44	94.44	94.44	83.33	77.78	77.78	22.22	18	
100	20 - 40	0.00	100.00	100.00	100.00	33.33	33.33	33.33	0.00	0.00	33.33	3	
	>40 - 60	0.00	100.00	92.11	86.84	84.21	78.95	60.53	47.37	34.21	65.79	38	
	>60 - 80	0.00	100.00	93.33	93.33	93.33	80.00	73.33	40.00	40.00	60.00	15	
	>80	0.00	100.00	75.00	75.00	50.00	50.00	25.00	25.00	25.00	75.00	4	
Sub Total(100)		0.00	100.00	91.67	88.33	81.67	75.00	60.00	41.67	33.33	63.33	60	
90	20 - 40	0.00	100.00	93.94	90.91	87.88	81.82	75.76	75.76	57.58	42.42	33	
	>40 - 60	9.09	90.91	90.91	90.91	90.91	81.82	63.64	54.55	54.55	45.45	11	
	>60 - 80	0.00	100.00	100.00	100.00	100.00	87.50	75.00	62.50	62.50	37.50	8	
	> 80	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	0.00	1	
Sub Total(90)		1.89	98.11	94.34	92.45	90.57	83.02	73.58	69.81	58.49	41.51	53	
70	20 - 40	0.00	100.00	100.00	88.00	88.00	80.00	68.00	60.00	60.00	44.00	25	
	>40 - 60	8.33	91.67	91.67	91.67	91.67	75.00	66.67	58.33	58.33	41.67	12	
	>60 - 80	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	0.00	3	
	> 80	0.00	100.00	100.00	100.00	100.00	100.00	50.00	50.00	50.00	50.00	2	
Sub Total(70)		2.38	97.62	97.62	90.48	90.48	80.95	69.05	61.90	61.90	40.48	42	
60	20 - 40	0.00	100.00	100.00	66.67	66.67	66.67	33.33	33.33	33.33	66.67	3	
	>40 - 60	-	-	-	-	-	-	-	-	-	-	-	
	>60 - 80	-	-	-	-	-	-	-	-	-	-	-	
	>80	-	-	-	-	-	-	-	-	-	-	-	
Sub Total(60)		0.00	100.00	100.00	66.67	66.67	66.67	33.33	33.33	33.33	66.67	3	
50	20 - 40	-	-	-	-	-	-	-	-	-	-	-	
	>40 - 60	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	0.00	1	
	>60 - 80	-	-	-	-	-	-	-	-	-	-	-	
	>80	-	-	-	-	-	-	-	-	-	-	-	
Sub Total(50)		0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	0.00	1	
Grant Total		1.68	98.32	93.85	89.94	87.15	80.45	67.60	58.10	51.96	46.93	179	

According to table 33 above, batteries with a capacity of 120Ah had a longer lifetime in comparison to the others. The main reason for this being the systems installed were with a panel capacity of less than 100Wp.

When comparing the sample, 18 batteries of 120Ah have been installed to the systems with an age limit between 36 to 54 months of which only 22% of the batteries were replaced.

Table 34: Battery Water Level of Current Battery

Battery Water Level	Number	%
Low	87	29.0
Correct	171	57.0
High	24	8.0
Incomplete	18	6.0
Total	300	100.0

The above table shows the water level of current batteries maintained by households. Accordingly, 57% of batteries surveyed were maintained at correct levels of water while 29% of the batteries were reported to be at low water level.

Table 35: Distilled Water Available at Household

Type	Number	%
Yes	215	71.7
No	72	24.0
Incomplete	13	4.3
Total	300	100.0

According to the above table, 72% of the households surveyed had distilled water to top up the batteries.

Table 36 : Battery Used For Any Other Purpose

Type	Number	%
Yes	55	18.3
No	233	77.7
Not Respond	12	4.0
Total	300	100.0

The above table shows the details of batteries used by householders for any other purpose. According to the values, 18% of the household surveyed were found to use batteries for others purposes. According to the enumerators most of them used the battery to re-charge mobile phones.

CHAPTER 3

FINDINGS

3.1 FINDINGS

- Out of 300 solar home systems surveyed, a total of 142 batteries were replaced from solar home systems of which 40% of the households had replaced only the first battery from the solar system and 6% of the households had replaced two batteries. Only five households were found using the fourth battery by replacing three batteries,
- Exide, Incoe and Lucas batteries are installed in most of the solar home systems surveyed,
- Weighted average life time of replaced first battery was calculated and it is 30.4 months,
- Range of 20 Wp to 120 Wp capacity of solar panels installed to the solar home systems surveyed from which more than 80% of the panels are range of 20 Wp to 60 Wp capacity,
- Capacities of 100Ah, 90Ah and 70Ah batteries were installed in 85% of the solar home systems surveyed,
- Estimated energy usage per day was calculated according to the use of lights and other equipment. According to the results, more than 60% of the households used 50 Wh to 150 Wh of energy per day,
- 57% of the current batteries surveyed were maintained at correct levels of water while 29% of the batteries were reported to be low in water level. Furthermore 72% of households had distilled water in their homes,

ANNEX 1

Table A1 : Analysis of Replaced Batteries : Lifetime of First Battery by Model

Model		Battery Lifetime(month)									Total
		1 - 6	>6 - 12	>12 - 18	>18 - 24	>24 - 30	>30 - 36	>36 - 42	>42 - 48	>48	
ABM	Number		1			1	1	1		2	6
	%		16.7%			16.7%	16.7%	16.7%		33.3%	100.0%
Exide	Number	1	3	2	5	5	5	9	4	5	39
	%	2.6%	7.7%	5.1%	12.8%	12.8%	12.8%	23.1%	10.3%	12.8%	100.0%
Incoe	Number	3	5	3	8	7	14	11	5	2	58
	%	5.2%	8.6%	5.2%	13.8%	12.1%	24.1%	19.0%	8.6%	3.4%	100.0%
Lucas	Number	4			2	7	4	5	3	1	26
	%	15.4%			7.7%	26.9%	15.4%	19.2%	11.5%	3.8%	100.0%
Nico	Number					1	1		1		3
	%					33.3%	33.3%		33.3%		100.0%
Sandya	Number			1	1	1	2		4	1	10
	%			10.0%	10.0%	10.0%	20.0%		40.0%	10.0%	100.0%
Total	Number	8	9	6	16	22	27	26	17	11	142
	%	5.6%	6.3%	4.2%	11.3%	15.5%	19.0%	18.3%	12.0%	7.7%	100.0%

The above table describes the Lifetime of first battery by model. Compared to the total number of batteries replaced by each model , 28% of the Exide batteries and 33% of the Incoe batteries had less than two years of life. According to the figures , most of batteries in above models had more than 24 months of Lifetime.

Table A2 : Analysis of Replaced Batteries : Lifetime of First Battery by Battery Capacity

Battery Capacity (Ah)		Battery Lifetime(month)									Total
		1 - 6	>6 - 12	>12 - 18	>18 - 24	>24 - 30	>30 - 36	>36 - 42	>42 - 48	>48	
40	Number				1	1					2
	%				50.0%	50.0%					100.0%
50	Number	1				1					2
	%	50.0%				50.0%					100.0%
60	Number		1		1		1		2	1	6
	%		16.7%		16.7%		16.7%		33.3%	16.7%	100.0%
70	Number	2	1	3	2	8	3	8	3	2	32
	%	6.3%	3.1%	9.4%	6.3%	25.0%	9.4%	25.0%	9.4%	6.3%	100.0%
90	Number	3	2	1	6	7	8	6	5	6	44
	%	6.8%	4.5%	2.3%	13.6%	15.9%	18.2%	13.6%	11.4%	13.6%	100.0%
100	Number	1	4	2	6	5	13	10	6	2	49
	%	2.0%	8.2%	4.1%	12.2%	10.2%	26.5%	20.4%	12.2%	4.1%	100.0%
120			1				2	2			5
			20.0%				40.0%	40.0%			100.0%
140		1							1		2
		50.0%							50.0%		100.0%
Total	Number	8	9	6	16	22	27	26	17	11	142
	%	5.6%	6.3%	4.2%	11.3%	15.5%	19.0%	18.3%	12.0%	7.7%	100.0%

The above table describes the lifetime of first battery by battery capacity. Accordingly, capacities of 100 Ah, 90 Ah and 70 Ah batteries installed in most of the systems were surveyed. Furthermore 40% of 70 Ah batteries installed and 38% of the 90 Ah batteries installed had more than three years of Lifetime. 36 % of the 100 Ah batteries installed in the solar home systems also had more than three years of lifetime.

Table A3 : Analysis of Replaced Batteries : Lifetime of First Battery By Panel Capacity

Panel Capacity		Battery Lifetime(month)									Total
		1 - 6	>6 - 12	>12 - 18	>18 - 24	>24 - 30	>30 - 36	>36 - 42	>42 - 48	>48	
20 - 40	Count	3	4	3	7	12	9	12	10	5	65
	% within Panel Capacity	4.6%	6.2%	4.6%	10.8%	18.5%	13.8%	18.5%	15.4%	7.7%	100.0%
40> - 60	Count	3	3	2	5	8	12	8	6	5	52
	% within Panel Capacity	5.8%	5.8%	3.8%	9.6%	15.4%	23.1%	15.4%	11.5%	9.6%	100.0%
60> - 80	Count	1	2	1	2	2	5	6	1	1	21
	% within Panel Capacity	4.8%	9.5%	4.8%	9.5%	9.5%	23.8%	28.6%	4.8%	4.8%	100.0%
80>	Count	1			2		1				4
	% within Panel Capacity	25.0%			50.0%		25.0%				100.0%
Total	Count	8	9	6	16	22	27	26	17	11	142
	% within Panel Capacity	5.6%	6.3%	4.2%	11.3%	15.5%	19.0%	18.3%	12.0%	7.7%	100.0%

The above table describes the lifetime of first battery by panel capacity. Most of the systems surveyed had capacities of 20 to 40 Wp, 41 to 60 Wp and 61 to 80 Wp panels. As the figures of the above table, indicate 42% of the batteries installed in the systems of 20 to 40 Wp capacity of panels and 38% of the batteries installed in the system range of 41 to 60 Wp capacity of panels had more than three years of life.

Table A4 : Analysis of Replaced Batteries : Lifetime of First Battery By Battery Capacity and Panel Capacity

Battery Capacity (Ah)	Panel Capacity (Wp)	Battery Lifetime(month)									Total
		1 - 6	>6 - 12	>12 - 18	>18 - 24	>24 - 30	>30 - 36	>36 - 42	>42 - 48	>48	
40	20 - 40				1	1					2
	Total				1	1					2
50	20 - 40	1				1					2
	Total	1				1					2
60	20 - 40		1		1		1		2	1	6
	Total		1		1		1		2	1	6
70	20 - 40	1	1	2	1	5	3	7	2	1	23
	>40 - 60	1				3		1	1	1	7
	>60 - 80			1							1
	>80				1						1
	Total	2	1	3	2	8	3	8	3	2	32
90	20 - 40	1	2	1	4	5	4	3	5	2	27
	>40 - 60	2			1	1	4	2		4	14
	>60 - 80				1	1		1			3
	Total	3	2	1	6	7	8	6	5	6	44
100	20 - 40							1	1	1	3
	>40 - 60		3	2	4	4	8	5	4		30
	>60 - 80		1		1	1	4	4	1	1	13
	>80	1			1		1				3
	Total	1	4	2	6	5	13	10	6	2	49
120	20 - 40						1	1			2
	>60 - 80		1				1	1			3
	Total		1				2	2			5
140	>40 - 60								1		1
	>60 - 80	1									1
	Total	1							1		2
Total		8	9	6	16	22	27	26	17	11	142

Table A5 : Analysis of Replaced Batteries : Lifetime of First Battery By Battery Capacity By Energy Usage

Battery Capacity (Ah)	Total Energy Used Per Day (Wp/day)	Battery Lifetime(month)									Total
		1 - 6	>6 - 12	>12 - 18	>18 - 24	>24 - 30	>30 - 36	>36 - 42	>42 - 48	>48	
40	>50 - 100				1						1
	>200 - 250					1					1
	Sub Total				1	1					2
50	>50 - 100	1									1
	>200 - 250					1					1
	Sub Total	1				1					2
60	>50 - 100		1		1		1		1		4
	>100 - 150									1	1
	>150 - 200								1		1
	Sub Total		1		1		1		2	1	6
70	12- 50			1		2		1			4
	>50 - 100	2				2	3	3	2		12
	>100 - 150		1	2	1	2			1	1	8
	>150 - 200				1	2		1			4
	>200 - 250							2			2
	>250							1		1	2
	Sub Total	2	1	3	2	8	3	8	3	2	32
90	12- 50						1				1
	>50 - 100	2			2	4		2	2	2	14
	>100 - 150			1	3	2	5	2	1	1	15
	>150 - 200	1							1	2	4
	>200 - 250		1		1	1	1	1	1	1	7
	>250		1				1	1			3
	Sub Total	3	2	1	6	7	8	6	5	6	44
100	12- 50			1			5	1	1		8
	>50 - 100	1	1		2		4	4			12
	>100 - 150		2		4	1	2	4	4		17
	>150 - 200					2	1		1		4
	>200 - 250		1	1		2	1	1		1	7
	>250									1	1
	Sub Total	1	4	2	6	5	13	10	6	2	49
120	>100 - 150						2	1			3
	>150 - 200		1								1
	>200 - 250							1			1
	Sub Total		1				2	2			5
140	>100 - 150								1		1
	>250	1									1
	Sub Total	1							1		2
Total		8	9	6	16	22	27	26	17	11	142

Note : Each cell represent number of batteries

