MILLION SOLAR URJA LAMP (SoUL) PROGRAM

Right to Clean Light

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An Initiative of
Indian Institute of Technology Bombay

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Ministry of New and Renewable Energy, Government of India

Concurrent Evaluation Report of Million SoUL Program in Rajasthan

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About Million SoUL Program

Million SoUL Program (MSP) is an initiative of Indian Institute of Technology - Bombay (IIT-B). MSP headquarter is located in Mumbai within the campus of IIT-B. Its principle funders include Ministry of New and Renewable Energy (MNRE), Madhya Pradesh Govt., Sir Dorabji Tata Trust (SDTT), Larsen and Turbo (L&T) and Tata Motors.
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List of Acronyms

CEA	Central Electricity Authority
CRISIL	Credit Rating Information Services of India Limited
MDG	Millennium Development Goals
MNRE	Ministry of New and Renewable Energy
MSP	Million SoUL Program
NGO	Non Governmental Organization
IEA	International Energy Agency
IIT-B	Indian Institution of Technology, Bombay
PDS	Public Distribution System
RGGVY	Rajiv Gandhi Grameen Vidyutikaran Yojana
RVEP	Remote Village Electrification Program
SDG	Sustainable Development Goals
SE4ALL	Sustainable Energy for All
SKO	Superior Kerosene Oil
SoUL	Solar Urja Lamps
SRC	SoUL Repair Centre
SRCM	SoUL Repair Centre Manager
TERI	The Energy and Resource Institute

Executive Summary

The Million SoUL Program (MSP) an initiative by Indian Institute of Technology (IIT) Bombay aims to bring 'Right to Clean Light' to every child in India. With this vision, two year program is being implemented in 2014-15 across 4 states (Madhya Pradesh, Maharashtra, Rajasthan, and Odisha) with the help of NGO partners who act as implementers at the ground level. During two year program, one million solar study lamps called as Solar Urja Lamps (SoUL) are to be distributed in two phases (I & II). This report presents the results of the concurrent evaluation (Round I) of the MSP in the state of Rajasthan (RJ) in India. The objective of concurrent evaluation is to bring transparency in the MSP, make mid-course corrections and assess impact of the SoUL. The concurrent evaluation, which is made by conducting the household survey in sample blocks, is planned in two rounds: (a) after SoULs are distributed (so that mid-course corrections can be made) (b) 4-5 month prior to the end of Phase I in December 2015. In order to understand the impacts, a comparison between treatment sample (households of students who purchased SoUL) and control sample (households of students who didn't purchase SoUL) as well as electrified and non-electrified households in both the samples was made. The MSP team of IIT-B study conducted this study.

The main findings for Rajasthan are presented here. The cost or the beneficiary contribution of SoUL (Rs. 120) acted as a positive discrimination and was 'not the barrier' in purchasing or accessing the SoUL as there was not even a single household in both the sample groups stated expensiveness as the hurdle in purchasing the SoUL. The socio-economic profile of the treatment sample showed that SoUL has reached marginalised and poor households with 24% non-electrified, 56% scheduled tribes (STs), 26% other backward castes (OBCs), and 7% scheduled castes (SC) households, while 54% of the households were poor as they possessed either below poverty line (BPL) or Antyoday cards. The direct positive and significant impacts of SoUL such as elimination of one kerosene lamp specifically for study purpose, shift to SoUL's clean and better quality light resulting into complete cease of exposure of children to kerosene

fumes while studying during night, significant decline in kerosene expenditure for lighting due to saving from one kerosene lamp was observed. The usage of SoUL in other activities reaffirmed its utility merit and emphasises the requirement of home lighting system in order to fulfil domestic lighting needs. It was an aid in performing various domestic activities, in irrigating farms, and as a torch providing increased mobility during night. Other impacts though not significant but they showed positive direction such as reduction in total expenditure on lighting as well as expenditure on electricity bill, and more and increased night study hours for children using no other device than SoUL as compared to control group. It needs to be acknowledged that complete elimination of kerosene cannot be possible with SoUL or a small solar study lamp as it would have limited impact. According to Census 2011 data for rural Rajasthan 96% of the households reside in a dwelling having more than 1 room and will apparently require the illumination solution that caters the need for all the rooms. This reflects in continued dependence on kerosene purchase from PDS and its consumption primarily for illumination purpose. Therefore, unless the need for lighting for entire house gets fulfilled through solar home lighting the significant impact in terms of elimination of kerosene consumption for lighting and its expenditure cannot be expected. The high percentage of non-functional SoULs (16.87%) in the sample called for stringent quality control and SRC awareness campaign on a priority basis to ensure that people avail the SRC facility and all SoULs are in working condition till the end of phase 1. Other mid course corrections required were regular monitoring of SRC operations for timely identification and resolution of issues, better quality switches, goose neck. The need assessment of solar technology related needs demonstrated the needs at the domestic level. However, the expressed capacity to pay for these needs revealed it quite low and can be a hindrance in converting the need into the purchase and hence, requires some financial model to facilitate this.

Chapter 1. Introduction

Energy access is important issue to be addressed at international, national and sub-national level to stimulate accelerate development of low income communities. As the development discussion has progressed from Millennium Development Goals (MDGs) to Sustainable Development Goals (SDGs), energy access became one of its central goals. UN General Assembly declared year 2012 as Sustainable Energy for All (SE4ALL) and 2014-2024 a decade for the same (UNDP 2011). While the focus on improving the energy access has grown in last decade, there are still billion plus population across the developing and under-developed countries lack access to modern source of energy (IEA 2013). Lack of modern energy such as electricity undermines the key development indicators such education, health and livelihoods. It is clear through understanding of literature that without access to modern energy, achieving social and economic development of countries will remain distant dream. While the energy access is multidimensional which includes cooking and lighting needs, this report is specially focused upon the lighting needs by presenting arguments and results of assessment of solar lighting project 'Million SoUL Program' (MSP) introduced by Indian Institute of Technology – Bombay (IIT-B).

1.1. Need for the solar technology based solution

India has one of the youngest populations in the world, with 350 million children less than 14 years of age. School education is thus essential for the better future and development of the country. However according to Census (2011), for 7.8 Crore families kerosene is still the primary source of lighting. Many young children going to schools either do not have access to alternate clean light source or those having access to grid electricity suffer from erratic electricity supply, both of which affect their study during evening hours. Hence, alongside 'Right to Education' it is desirable to provide the 'Right to Clean Light' as well.

The light level required for study purposes is about 150 Lux[1] at the reading area. Thus, to provide light for 4 hours every evening for study purposes requires only 0.7 kWh (Note: 1 unit = 1 kWh) of electricity per year. Now, a 0.5 Watt LED provides up to 250 Lux of light. A solar power lamp with LED light can hence provide 150 Lux of light at the table in low intensity, and up to 250 Lux of light in high intensity mode using a 1 Watt solar panel, at a cost of Rs.400-Rs.600 per lamp. The Ni-MH batteries can be used for 700 cycles.

A clear mismatch between the requirements and the scope of past solar lamp Programs acted as hindrance for sustainable adoption of solar energy products in India. Solar PV technology that could be decentralised is typically required in remote, rural areas inclusive of some 'must' features like low-affordable cost, availability in local market with distribution mechanism, and access to timely and low cost after sales service. However, concentration of the solar technology production in urban areas at present results in high cost of lamp (due to higher overheads), minimal availability at local level (due to absence of distribution channels), and time consuming, unreliable, and expensive after sale service. Hence, to remove the bottlenecks, the solar lamp Program must involve and train local people in all aspects of assembly, distribution and after sales service at the local level. This will ensure sustainable adoption of the solar technology in rural areas. Given the magnitude of children being deprived of right to clean light there is an urgency to address this need. For this a countrywide large-scale solar lamp Program simultaneously addressing the issues of *Scale*, *Speed* and *Skill* is needed.

1.2. Literature Review

Literatures are available in context of impacts of off-grid solar interventions in India. This impact assessment report adds to the growing literature on impact of small scale technologies like solar lamps and lanterns on improvement in lives and livelihoods of the rural communities. A study on impact of solar lantern Program named LaBL[2] by TISS (2013), have outlined positive impact across education, health and livelihoods

[1] Lux is unit of illuminance and luminous emittance, measuring luminous flux per unit area.

[2] LaBL is Lighting a Billion Lives. More details about the Program can be found at the Program website http://labl.teriin.org/

through increased studying hours, lesser exposure to sooth from the kerosene lamps and aiding livelihood activities. This confirms potential of off-grid solar intervention to offer benefits at household level. A research by Agoramoorthy and Hsu (2009) on 100 households in tribal areas of rural India also confirms increased study duration of children by hour and half as a result of provisioning solar lamps. Similarly, their study also reports of decreased expenditure on kerosene and electricity bill expenditure of these households post purchasing the solar lanterns. Their result were important in context as the rural areas where study was conducted observed to have not receiving power between 3 to 6 am in the morning and 6 to 9 pm in the evening, which are eventually dark hours. Similar insights are provided by Garg (2014) on the solar lantern Programs introduced by Government of India for school going girls in rural areas. Study of solar PV electrification Program in India by Chakrabarti and Chakrabarti (2002) reveal higher willingness to pay by the sample households for the monthly fee. The study also highlights the overall change in behavior as communities are willing to move towards adoption of cleaner technology. The authors state (pp. 41), ' *… (communities) have expressed their willingness to continue the use of solar power, even if diesel power is available at low cost, to avoid the air and noise pollution caused by a diesel generator'*. There are also literatures available on impact of off-grid solar Programs, however systems disseminated in such cases are of larger capacity (like in case of Solar Home Systems under RVEP in India or IDCOL Program in Bangladesh) which can fulfill higher needs of the households and the impacts literature cannot be contextualized within the scope of MSP.

1.3. The Million SoUL Program

IIT Bombay has developed the 'localisation of solar energy model' through its Million SoUL Program (henceforth MSP). In this model the assembly, distribution and maintenance of the solar lamp are done by the local people. In order to achieve *scale*, the model is designed such that it can be replicated in parallel in multiple blocks, across districts and states. To achieve *Speed*, the assembly and distribution for any block is designed to be completed in 90 working days. In order to target *skill development*, rural

people are trained in the assembling, distribution and repair of these lamps in their local areas.

The goal of the MSP is to fulfil 'right to clean light to every child' in rural areas for the study purpose during dark hours in the fastest possible way, thus reducing dependency on kerosene lamp and contribute to build a better future. The specific objectives are:

- Provide one SoUL to every student to increase their study hours
- Involve local people and develop their capabilities to assemble, sale, provide repair and maintenance service for solar products
- Generate sustainable employment in rural areas

The model is based on the solar PV technology with its inherent feature of providing off-grid decentralised energy at an individual or household level. It integrates three critical elements of speed and reach at wider scale (access) through saturation, cost effectiveness (affordability), and sustainability. The model has three core concepts of 'partnership approach', 'capacity building' and 'financial viability'. These concepts in the model are interrelated and interdependent and they converge in to realisation of localisation of solar energy.

During two year MSP, one million solar study lamps called as Solar Urja Lamps (SoUL) were targeted to be distributed in two phases (I & II). During phase I, 7,50,000 SoUL are distributed, while in phase II rest 2,50,000 will be distributed. Phase I is implemented across 72 blocks in four Indian states of Madhya Pradesh, Maharashtra, Rajasthan, and Odisha states covering more than 7900 villages. Funding from central and state governments as well as philanthropic partners contributed towards keeping the beneficiary contribution low. The actual cost per solar urja lamp (SoUL) is Rs. 500, however at the subsidised cost the beneficiary contribution is Rs. 120 per lamp. Any child enrolled in the school and studying between Class V to Class XII is eligible to purchase one SoUL and they can avail free servicing facility provided in their vicinity till end of the phase I, i.e. December 2015. For localisation and ground level implementation partnership is formed with the NGOs. The capacity building of the local

people has resulted into development of 260 solar entrepreneurs (called as SoUL repair centres managers – SRCM). This report presents the results of the concurrent evaluation (Round I) of the MSP during phase I in the state of Rajasthan in India.

Chapter 2. Scope and Objectives of the Study

The phase 1 of the MSP has influenced the sizeable number stakeholders in rural areas of four Indian states in a short span which needs to be studied in depth to gain insights about the efficacy of the MSP. This can further contribute to up-scaling, replication, and the policy recommendations related to solar technology. Hence, the research component formed an integral part of the MSP and accordingly the concurrent evaluation of the MSP was conducted.

The objectives of the concurrent evaluation are to:

1. Assess performance of SoUL and SoUL Repair Centres (SRC)
2. Assess socio-economic impact of the Million SoUL Program
3. Assess market potential for solar PV products in rural areas
4. Bring transparency in the program and make mid-course corrections
5. Assess localisation model for scalability and replicability

The objectives of the research guided to take the mixed methods approach. The research objectives consist of both qualitative as well as quantitative dimensions, so it was appropriate to employ quantitative and qualitative research methods. In the quantitative data the survey method was applied by collecting the data at the household level, whereas for qualitative data collection the focus group discussion and interview methods were used. The main focus of qualitative method is to assess the objective of localisation model and its scalability, whereas the household survey primarily focuses on the objective of assessing the impact of the MSP.

The concurrent evaluation covered both stakeholders as well as non-stakeholders of the MSP. The qualitative method covered NGO partners and the staff involved in the MSP, solar entrepreneurs (i.e. SRCM), parents of SoUL recipients' children, school teachers, knowledgeable person in the village, and IIT B's field officer posted with the NGO Partner. The quantitative method studied the households of the SoUL recipients (treatment sample) and SoUL non-recipients (control sample) who despite being eligible

had not purchased SoUL. The household survey is planned to be conducted in two rounds in 20 representative sample blocks. The round one is after SoULs are distributed and round two is 4-5 months prior to the end of Phase 1 in December 2015. In survey the same household will be surveyed twice at two intervals. This report presents the results of the household survey for the state of Rajasthan and the mid-course corrections that are required for improvement of the Program.

2.1. Sample for the household survey

The sampling method employed for selecting the sample was "stratified random sampling". The sampling size and plan was as follows:

- Two samples were drawn, viz. Treatment Sample and Control Sample. Treatment sample was defined as the recipients of SoUL (who have purchased SoUL from the school) studying in class V-XII. While control sample defined as the children studying in classes V- XII who have not purchased SoUL from the school.
- 1.2% of the total population (i.e. one million students who have purchased the SoUL) was taken as the "treatment sample".
- The control sample was considered as 10% of the treatment sample, with the 2% of the control sample as the error while surveying, making a total of 12% of the Treatment Sample.
- Stratified Random Sampling was used for the evaluation. The sampling involved dividing the population into two strata, viz. electrification status of house and caste category of the household. The castes were divided into three categories, namely, Scheduled Castes (SC), Scheduled Tribes (ST) and others comprising general and Other Backward Castes (OBC). Thus, the sample (number of households to be surveyed) was arrived at by referring to Census 2011 block level data which determined the proportionate percentage of electrified and non electrified households and caste composition.
- The blocks where the MSP has been implemented were clustered and then a representative block was chosen for the survey. This clustering was based on homogeneity of geographical and social characteristics of the population in each

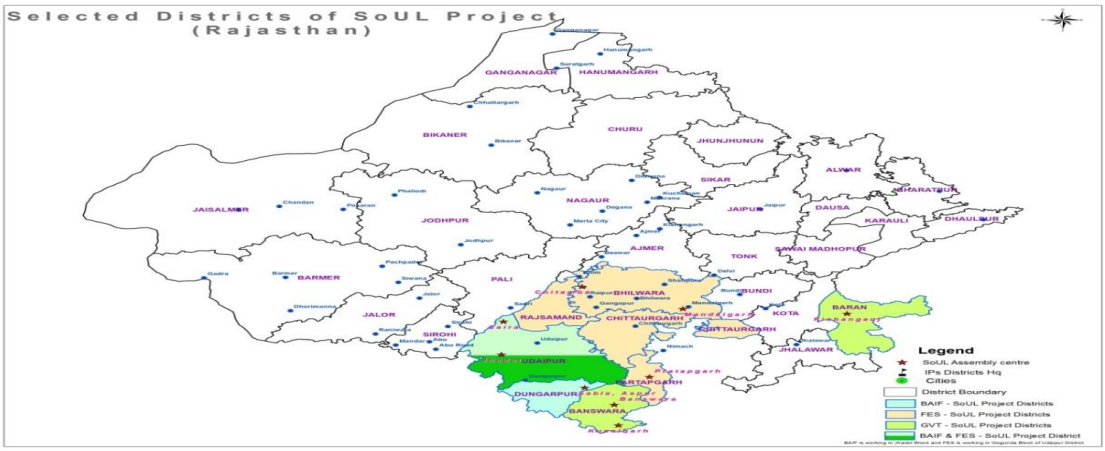
block. Thus, sample of 20 blocks was selected of a total of 72 blocks where one Million SoULs were distributed.

- Using database on recipients of SoUL, villages having sufficient number of SoUL recipients of the required strata were selected. During selection it was ensured that remote and relatively small villages were not left out.

2.2. The MSP in Rajasthan

The MSP is implemented in 14 blocks and eight districts of Rajasthan. For presence of the MSP refer the Figure 2 given below.

Figure 1: Presence of the MSP in Rajasthan



There are three NGO partners and three vendors namely Sirus Solar Energy Systems Private Limited, Tata Power Solar Systems Limited, Gautam Solar Ltd. for supplying the material (disassembled kits) in Rajasthan. In the phase 1 of the MSP, 180193 SoULs were distributed in the state of Rajasthan. An overview of covered blocks in the district, the NGO partners, the vendor, and the number of distributed SoULs in the respective block are given in table 1 below.

Table 1: Overview of NGO partners, Vendors and SoUL Distribution in Rajasthan

NGO Partner	District	Block	Vendor	Distributed SoULs	Start Date	Saturation Date
BAIF	Udaipur	Jhadol	Gautam	19071	8-Aug-2014	20-Mar-2015
BAIF	Dungarpur	Aaspur	Sirus	18084	6-Jun-2014	25-Feb-2015

GVT	Banswara	Kusalgarh	Sirus	12400	16-Jun-2014	3-Mar-2015
GVT	Banswara	Bagidora	Sirus	7563	13-Jun-2014	5-Mar-2015
GVT	Banswara	Talwara-Banswara	Sirus	15686	13-Jun-2014	5-Mar-2015
GVT	Baran	Kishanganj	Gautam	13339	13-Jul-2014	22-May-2015
GVT	Baran	Baran	Gautam	1549	13-Jul-2014	4-May-2015
GVT	Baran	Antah	Gautam	6150	13-Jul-2014	28-Feb-2015
FES	Pratapgarh	Pratapgarh	Tata	17400	16-Jun-2014	13-Jan-2015
FES	Chittaurgarh	Begun	Tata	9916	15-May-2014	26-Nov-2014
FES	Bhilwara	Mandalgarh	Tata	18770	15-May-2014	20-Mar-2015
FES	Bhilwara	Mandal	Tata	20379	9-Aug-2014	16-Mar-2015
FES	Udaipur	Gogunda	Tata	11877	19-Jun-2014	14-Feb-2015
FES	Rajsamand	Kumbhalgarh	Tata	8009	1-Aug-2014	1-Mar-2015

2.3. Profile of Rajasthan

The north-western state of Rajasthan is the largest Indian state with an area of 3, 42,239 sq.km comprising of the 10.41% of the total geographical area of the country. Rajasthan is located in the northwestern part of the subcontinent. It is bounded on the west and northwest by Pakistan, on the north and northeast by the states of Punjab, Haryana, and Uttar Pradesh, on the east and southeast by the states of Uttar Pradesh and Madhya Pradesh, and on the southwest by the state of Gujarat. In the west, Rajasthan is relatively dry and infertile; this area includes some of the Thar Desert, also known as the Great Indian Desert. As per Government of India's 2011 Census, 75.1% of Rajasthan's population resides in rural areas with 56.16% households having 1-5 members and 43.84% with more than 5 members. As per Ministry of Tribal Affairs, five districts of Rajasthan come under Schedule Areas. Except for Abu Road block in Sirohi district other districts are covered in the MSP. The names of these districts are Banswara and Dungarpur districts, Pratapgarh tahsil in Chittaurgarh district, and some villages in Udaipur district.

As per Census 2011, for 39.30% rural households in Rajasthan kerosene were the primary source of light. The latest status of villages electrified as on 31-03-2015 in Rajasthan as per Central Electricity Authority informed that 90.4% villages are electrified. However, this percentage looks commendable due to the definition of an

electrified village which does not require 100% households in the village to be electrified. Even if 10% of the total number of households in the village is electrified the village is considered as the electrified. The household survey conducted under the MSP revealed that 23.95% of the treatment households in Rajasthan were non-electrified highlighting that this is a significant percentage.

2.4. Cluster approach and representative block for the household survey

As aforementioned the distribution of SoUL in Rajasthan has taken place in 14 blocks. All these blocks have predominant tribal population, which resides in remote rural areas. Conducting household survey for the purpose of concurrent evaluation in all the implementation blocks was not feasible considering the geographic spread and resources required; hence 'cluster' approach was taken towards resolving this issue. The cluster of two or more blocks was formed on the basis of their geographic and demographic similarities, and one block is selected as a representative block from each cluster for conducting the concurrent evaluation. This allowed for generalization of impacts without compromising on the validity of the research sample. There were five such clusters on basis of aforementioned criteria and five blocks were selected as a representative blocks for the concurrent evaluation. The following table 2 presents the clusters that were formed and the representative blocks in which the household survey was conducted.

Table 2: Representative Block and Block Cluster

Representative block for HH Survey	Names of Blocks in the Cluster	District	IP's Name
Kusalgarh	Talwara (Banswara)	Banswara	GVT
	Bagidora		
	Kusalgarh		
Pratapgarh	Pratapgarh	Pratapgarh	FES
	Aaspur	Dungarpur	BAIF
Jhadol	Jhadol	Udaipur	BAIF
	Gogunda	Udaipur	FES
	Kumbhalgarh	Rajsamand	FES
Kishanganj	Kishanganj	Baran	GVT

Mandalgarh	Mandalgarh	Bhilwara	FES
	Mandal	Bhilwara	
	Begun	Chittaurgarh	

Chapter 3. Rajasthan – Concurrent Evaluation Result (First Round)

For the concurrent evaluation the household survey was conducted in five representative blocks of Rajasthan and the survey was conducted in the March and April 2015. The total sample household surveyed in Rajasthan were 3326, amongst which 2952 were treatment sample and 374 control sample. The sample households were distributed across 179 villages and 85 Gram Panchayats. Table 3 and 4 below give an overview of block wise sample households and villages covered.

Table 3: Distribution of Sample Households across the Sample blocks in Rajasthan

Block	No. of Treatment Household	Percentage	No. of Control Household	Percentage
Jhadol	957	32.42	130	34.76
Kishanganj	230	7.79	29	7.75
Kusalgarh	749	25.37	93	24.87
Mandalgarh	256	8.67	36	9.63
Pratapgarh	760	25.75	86	22.99
Total HH's covered in Rajasthan	**2952**	**100.00**	**374**	**100.00**

Table 4: Number of Villages and Gram Panchayats covered in Rajasthan

Block	Treatment		Control		Treatment		Control	
	No. of Villages	%	No. of Villages	%	No. of Panchayats	%	No. of Panchayats	%
Jhadol	52	29.05	21	22.11	24	28.24	14	24.14
Kishanganj	10	5.59	7	7.37	7	8.24	6	10.34
Kusalgarh	38	21.23	28	29.47	21	24.71	16	27.59
Mandalgarh	22	12.29	10	10.53	12	14.12	7	12.07
Pratapgarh	57	31.84	29	30.53	21	24.71	15	25.86
Total	**179**	**100.00**	**95**	**100.00**	**85**	**100.00**	**58**	**100.00**

3.1. Socio-economic Background of the Sample Households in Rajasthan

As per Census 2011, in rural Rajasthan 18.52% of the population was Scheduled Caste (SC), 16.88% was Scheduled Tribe (ST), and 64.60% Others. The table 5 given below presents the classification of sample as per social categories as well as the Census 2011 data for the same. In the sample the percentage of Scheduled Tribes (STs) was

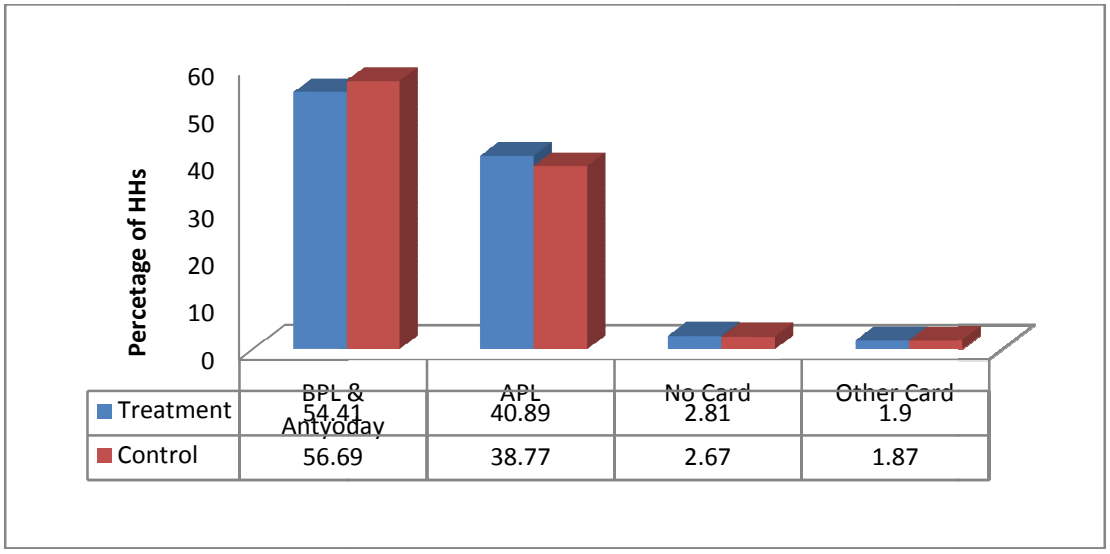
highest in both treatment as well as control sample (56% each), followed by 25.71% other backward castes (OBCs) in the treatment and 24.06% in the control sample.

Table 5: Distribution of Sample and Rural Population as per Social Categories

Social Category	No. of Treatment HHs	Percentage	No. of Control HHs	Percentage	Percentage of rural population as per Census 2011
ST	1,680	56.91	211	56.42	16.88
SC	218	7.38	33	8.82	18.52
OBC	759	25.71	90	24.06	64.60
General	293	9.93	40	10.7	
Others	2	0.07	0	0.00	
Total	2,952	100	374	100	100

Maximum percentage of treatment households (53.93%) had agriculture as their primary occupation followed by 18.8% households with labour, similarly amongst control households 52.14% had agriculture and 23.36% labour. 13.75% treatment and 10.96% control sample relied on both agriculture and labour as their primary occupation. The households possessing either below poverty line (BPL) or Antyoday cards were defined as poor households and figure 2 below presents the percentage of households and the type of cards possessed by them.

Figure 2: Type of Cards possessed by Sample Households



About the access to the grid electricity either through legal or non-legal (by putting hook) connection, it was seen that 23.95% of the treatment sample and 17.91% of control

sample had no access, i.e. they were non-electrified. However, 74.7% treatment and 80.21% control households had legal connection, which means 1.35% treatment households and 1.88% control households had illegal connection.

3.2. Children Details

In the sample households only the information of children that were either in the school going age group of 5-17 years or were studying between classes 1 to 12 was collected as they come under the age group that should attend the school. Moreover, children studying from class 1 onwards are expected to complete the home-work at home when given or are expected to study at home. Therefore, availability of light at home during dark hours enables them to study. In 2952 treatment households, 6557 children and in 374 control households 775 children were either in the school-going age (5 to 17 years) and or studied in classes from 1st to 12th. In treatment of the total 6,557 children, 96.1% and in control out of 775 children 94.84% were enrolled in the school. The data on households with number of children falling in the school going age of 5 years to 17 years or studying between class I to class XII showed that in both the samples maximum percentage of households (37.94% in treatment and 40.91% in control) have two children followed by 26.93% in treatment and 32.09% in control having one child, and 24.25% in treatment and 17.38% in control with 3 children.

The gender-wise classification of school-going children in the sample showed that 54.66% (n=3584) were male children in treatment, while control had 50.97% (n=395). The classification of children as per the age group showed that maximum percentage (51.56% in treatment and 46.45% in control) of households have children in the age group of 10-15 years, followed by 5-10 years age group (31.48% in treatment and 36.13% in control) then the age group of 15-20 years (approximately 16.87% in treatment and 17.42% in control sample). The classification of school-going children as per the classes showed that in the treatment sample 33.79% studied in upper primary (6th to 8th), while approximately 23.5% studied in primary (between class I-IV) and 19.5% secondary (9th & 10th) and 14.51% in Class V. There were 8.32% children in treatment studying in senior secondary (11th & 12th). In the control sample 30.48%

studied in upper primary followed by 26.53% in primary, 17.82% in secondary, 16.4% in 5th class, and 8.44% in senior secondary. Thus, the pattern emerged was observed to be similar in both the samples. The differentiation as per gender also showed the similar pattern for both the samples.

Of the total of 6,301 school-going children in the treatment sample 57.45% have purchased SoUL. As there was higher percentage of male children in the school-going age group in the sample the gender differentiation was not comparable, while the data within the gender category revealed 59.19% boys have purchased SoUL against 55.29% girls. Thus, no significant differences in gender were observed with regard to purchase of SoUL. Of the 2952 purchased SoULs in the sample, 85.67% of the households had one SoUL, with 13.35% households with two SoULs, and 0.85% with three SoULs. There were only 0.15% households that had 4 SoULs.

The reason for not purchasing SoUL in treatment sample revealed that 48.45% children were not eligible for purchasing SoUL as they studied in classes below class V, followed by 17.94% children that reported to study from SoUL recipient sibling's lamp and then by 14.1% stating SoUL was not required. In the control sample 33.61% children did not purchase SoUL as they had no enough money at the time when SoUL was available for sale followed by 19.73% children who were not eligible, and then by 15.92% children stating SoUL was not available when they wanted to purchase. There were no respondents in both the sample who stated expensiveness was the reason indicating that cost was not a barrier for accessing the SoUL (refer table 6).

Table 6: Reasons for Not Purchasing SoUL by school-going children in Rajasthan

Reason	No. of Children in treatment	%	No. of Children in control	%
Child not available when SoUL was given	15	0.56	47	6.39
Not Eligible	1,299	**48.45**	145	**19.73**
Not Enough Money	141	5.26	247	**33.61**
Not Given in School	181	6.75	57	7.76
Not Required	378	14.1	59	8.03
Purchased number of SoUL are enough	131	4.89	0	0.00
SoUL lamp not available	55	2.05	117	**15.92**
Studies from recipient sibling's lamp	481	**17.94**	0	0.00

Not Aware	0	0.00	45	6.12
Other	0	0.00	3	0.41
One more Solar device available	0	0.00	4	0.54
Electricity present 24 hours	0	0.00	11	1.5
SoUL is expensive	0	0.00	0	0.00
Total	2,681	100	735	100

3.3. Lighting: sources, devices and expenditure

3.3.1. Electricity bill: Interval of receiving it and amount paid by sample households

Maximum percentage of households in both the sample groups 68.43% in treatment and 76.17% in control received the monthly bill below Rs. 300, followed by 22.56% in treatment and 18.12% in control receiving the bill in the range of Rs. 300 to Rs. 600.

3.3.2. Kerosene: purchase, usage, and expenditure

The data related to kerosene purchase, expenditure and usage was calculated for only those households that purchased and consumed kerosene. The distribution of monthly kerosene purchase, usage, and expenditure was examined according to electrification status of the households to know if any differences exist.

There were 88.07% treatment and 90.37% control households that reported purchasing kerosene, while remaining households did not purchase kerosene. Amongst the households that purchased kerosene, for 95.34% treatment and 94.67% control households 'Public distribution system (PDS) was the 'only source of kerosene purchase' making it the predominant source of kerosene purchase. There were only 1.80% treatment and 2.36% control households that purchased from open market, while 2.86% treatment and 2.95% (control households that purchased kerosene from both the sources.

The data on kerosene usage showed that lighting was taking precedence over cooking. There were very few households that reported 'not using kerosene for lighting purpose' (10.46% in treatment and 6.8%, in control), whereas 66.5% in treatment and 75.15% in control reported 'not using kerosene for cooking'. There were 55.77% treatment

households and 65.98% control households that consumed kerosene 'only for lighting' purpose, while remaining households (44.23% in treatment and 34.02% in control) consumed it for other uses including lighting.

For maximum percentage of households in both treatment (83.86%) and control sample (86.36%), per month kerosene purchase was in the range between 2-3 litres from PDS outlet. This was followed by 10.77% treatment and 10.99% control households purchasing 3-4 litres of kerosene. There were 4.07% treatment and 2.42% control households that purchased kerosene in the range of 1-2 litres, while not even one percent households were observed to be purchasing more than 4 litres of kerosene from PDS (refer table 7). As aforementioned open market purchase of kerosene was not much. The maximum percentage of households 47.11% in treatment and 55.56% in control purchased 1-2 litres of kerosene (refer table 7).

Table 7: Monthly Kerosene Purchase from Different Sources in Rajasthan

	PDS Shops				Market			
Kerosene Purchase (in Ltrs)	**No. of Treatment HH's**	**%**	**No. of Control HH's**	**%**	**No. of Treatment HH's**	**%**	**No. of Control HH's**	**%**
0-1	10	0.39	1	0.3	25	20.66	2	11.11
1-2	104	4.07	8	2.42	57	47.11	10	55.56
2-3	2,141	83.86	285	86.36	24	19.83	5	27.78
3-4	275	10.77	36	10.91	4	3.31	0	0
4-5	7	0.27	0	0.00	9	7.44	1	5.56
5-6	11	0.43	0	0.00	0	0	0	0
Above 6 Litres	5	0.2	0	0.00	2	1.65	0	0
Total	2,553	100	330	100	121	100	18	100

Data about the monthly purchase revealed a slight difference in monthly average kerosene purchase with non-electrified control household purchasing more than other categories. However, t-test results showed significant differences. The table 8 below presents t-test results for total monthly kerosene purchased between treatment and

control. It demonstrated that the difference between monthly purchase of kerosene by control households and treatment households is significant at 90% confidence level.

Table 8: T-test results for Total Monthly Kerosene Purchased in Rajasthan

Total Monthly Kerosene Purchased	Treatment	Control	Diff	t-test	p-value
Mean	2.70898	2.82487	0.11589	1.6908	0.091

Kerosene consumption for the lighting purpose as observed in table 9 below showed similar pattern in both the samples with 51.81% treatment households consuming 2-3 litres followed by 21.96% consuming 1-2 litres per month, while in control sample, maximum percentage of households, i.e. 65.09% consumed 2-3 litre per month, followed by 14.2% consuming 1-2 litres. The difference in kerosene consumption pattern was observed between electrified and non electrified households. As compared to electrified treatment (43.78%) and electrified control (61.25%) for larger percentage of non-electrified households in control (80.6%) and in treatment (73.81%) monthly consumption was 2-3 litres. This clearly indicated more kerosene consumption by not only non-electrified households than the electrified, but also by non-electrified control than the non-electrified treatment.

Table 9: Monthly Kerosene Consumption for Lighting in Rajasthan

Kerosene usage for lighting (in litres)	Treatment HHs				Total	%	Control HHs				Total	%
	Electrified		Non-Electrified				Electrified		Non-Electrified			
	No.	%	No	%			No.	%	No.	%		
0-1	257	13.49	8	1.15	265	10.19	26	9.59	1	1.49	27	7.99
1-2	473	**24.83**	98	**14.1**	571	**21.96**	44	**16.24**	4	5.97	48	**14.2**
2-3	834	**43.78**	513	**73.81**	1347	**51.81**	166	**61.25**	54	**80.6**	220	**65.09**
3-4	64	3.36	44	6.33	108	4.15	11	4.06	4	5.97	15	4.44
4-5	9	0.47	18	2.59	27	1.04	1	0.37	3	4.48	4	1.18
5-6	1	0.05	6	0.86	7	0.27	0	0	0	0	0	0
Above 6 Litres	1	0.05	2	0.29	3	0.12	0	0	1	1.49	1	0.3
Kerosene not used for lighting	266	13.96	6	0.86	272	10.46	23	8.49	0	0	23	6.8

Total	1,905	100	695	100	2600	100	271	100	67	100	338	100

As far as consumption of kerosene for cooking is concerned, majority of sample households 66.5% in treatment and 75.15% in control reported not using kerosene for cooking at all. In treatment 17.62% and 14.5% in control consumed less than 1 litre of kerosene per month, whereas few percentage households consumed more than 1 litre of kerosene. Electrification status did not show much difference in the usage pattern.

The use of number of kerosene based lighting devices in treatment and control households was looked into to understand if there is a difference in pattern due to presence of SoUL. 78.76% of treatment and 84.22% control households used simple wick lamps (C*himnis*), whereas usage of hurricane lamp was almost absent as only 7 treatment households (0.24%) in the entire sample used it. Not much difference was observed between treatment and control households about the number of wick lamps used.

In treatment sample 51.74% and 56.19% in control sample used two simple wick lamps followed by usage of one wick lamp by 41.08% treatment and 34.92% control households. There were few households that used 2 or more wick lamps. **However, compared to electrified households in both the groups, i.e. treatment and control, as well as non-electrified treatment households, the percentage of non-electrified control households that used two simple wick lamps was much higher at 70%**.

Table 10: Number of Chimni's used in Sample Households as per electrification status in Rajasthan

Number	Treatment Households						Control Households					
	Electrified		Un-electrified		Total	%	Electrified		Un-electrified		Total	%
	No.	%	No.	%			No.	%	No.	%		
1	720	**43.9**	237	**34.4**	957	41.08	96	**38.71**	14	**20.9**	110	34.92
2	801	**48.84**	403	**58.49**	1,204	51.74	130	**52.42**	47	**70.15**	177	56.19
3	87	5.3	42	6.1	129	5.51	19	7.66	6	8.96	25	7.94
4	28	1.71	6	0.87	34	1.46	3	1.21	0	0.00	3	0.95
5	3	0.18	1	0.15	4	0.17	0	0.00	0	0.00	0	0.00
6	1	0.06	0	0.00	1	0.04	0	0.00	0	0.00	0	0.00

7	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	1,640	100	689	100	2,329	100	248	100	67	100	315	100

The per day usage of simple wick lamps in hours showed that maximum percentage of households (70.97% treatment and 68.25% control) used it for less than 2 hours, followed by 25.2% treatment and 27.62% in control using it for 2-4 hours. There were very few households that used it for more than 4 hours. Table 8 given below presents electrification status and per day usage (in hours) of simple kerosene lamp. The data revealed that percentage of non-electrified households in both the groups that fall in the category of 2-4 hours was much higher (49.64% in treatment and 47.76% in control) than the electrified households in both the groups (14.88% in treatment and 22.18% in control). In contrary to the non-electrified households, for higher percentage electrified households (84.21% in treatment and 77% in control) the per day usage of kerosene simple wick lamp was less than 2 hours**.**

Table 11: Usage of Chimni in Hours for Lighting in Rajasthan

No. of hrs	Treatment						Control					
	Electrified		Un-electrified		Total	%	Electrified		Un-electrified		Total	%
	No.	%	No.	%			No.	%	No.	%		
0-2	1,381	**84.21**	273	39.62	1,654	70.97	191	**77.02**	24	35.82	215	68.25
2-4	244	14.88	342	**49.64**	586	25.2	55	22.18	32	**47.76**	87	27.62
4-6	11	0.67	68	9.87	79	3.4	2	0.81	11	16.42	13	4.13
6-8	0	0.00	4	0.58	4	0.17	0	0	0	0	0	0.00
8-10	1	0.06	0	0	1	0.04	0	0	0	0	0	0.00
10-12	3	0.18	2	0.29	5	0.22	0	0	0	0	0	0.00
Total	1,640	100	689	100	2,329	100	248	100	67	100	315	100

The average cost of one litre of kerosene for was Rs. 17.77 and Rs. 36.28 from PDS and market respectively. The expenditure on kerosene purchased from PDS was Rs. 54 in both the groups, while average expenditure on kerosene bought from market was Rs. 81.56 for treatment and Rs. 90.83 for control households. The average monthly kerosene purchase was 3.12 litres in both the groups, with exception of non-electrified control households for which monthly average of kerosene purchased was 3.29 litres. The average monthly expenditure on kerosene was observed to be higher in non-

electrified households than the electrified household in both treatment and control groups. The comparison between non-electrified households in both the samples revealed that non-electrified control households were spending more (Rs. 67.5) than non-electrified treatment (Rs. 60.67) group (refer table 12).

Table 12: Source-wise per litre Kerosene Cost and Monthly Expenditure as per electrification status in Rajasthan

	Treatment HHs						Control HHs					
	Electrified		Non - Electrified		Total HHs	Rs.	Electrified		Non - Electrified		Total HHs	Rs.
	Amount	Nos.	Amount	Nos.			Amount	Nos.	Amount	Nos.		
Average Price from PDS Shops	17.63	1878	18.26	675	2553	17.8	17.59	265	18.36	65	330	17.74
Average Expenditure on PDS	54.39	1878	54.39	675	2553	54.39	54.23	265	55.26	65	330	54.43
Average Price from Market	34.01	57	34.96	64	121	34.51	40	8	36.5	10	18	38.05
Average Expenditure on Market	81.65	57	81.48	64	121	81.56	91.25	8	90.5	10	18	90.83
Total Kerosene Purchased*	3.12L	1905	3.12L	695	2600	3.12L	3.08L	271	**3.29L**	67	338	3.12L
Total Average kerosene Expenditure*	56.06	1905	**60.67**	695	2600	57.29	55.83	271	**67.5**	67	338	58.15

3.4. Electricity based devices used for lighting

In Rajasthan there were 76.05% treatment and 82.09% control households had the electricity. Amongst the electrified households' 62.44% treatment and 64.49% control households used incandescent bulb, 60.53% in treatment and 54.07% in control used compact fluorescent lamp (CFL), and 19.06% in treatment and 17.91% in control used chargeable torch. There was less percentage of households that had light-emitting diode (LED) and tube lights.

Regarding the number of incandescent bulbs in the households in treatment group 42.94% had one bulb followed by 39.23% with two bulbs, and 12.77% with 3 bulbs, while in the control sample 53.03% had one incandescent bulb followed by 26.26% with two, and 15.66% with three. About the number of CFL, in treatment 39.81% had two CFLs followed by 27.67% with two CFLs and 17.37% with three CFLs, while in control 47.59% had two and 28.92% had one, and 13.25% had three. Average of per unit cost

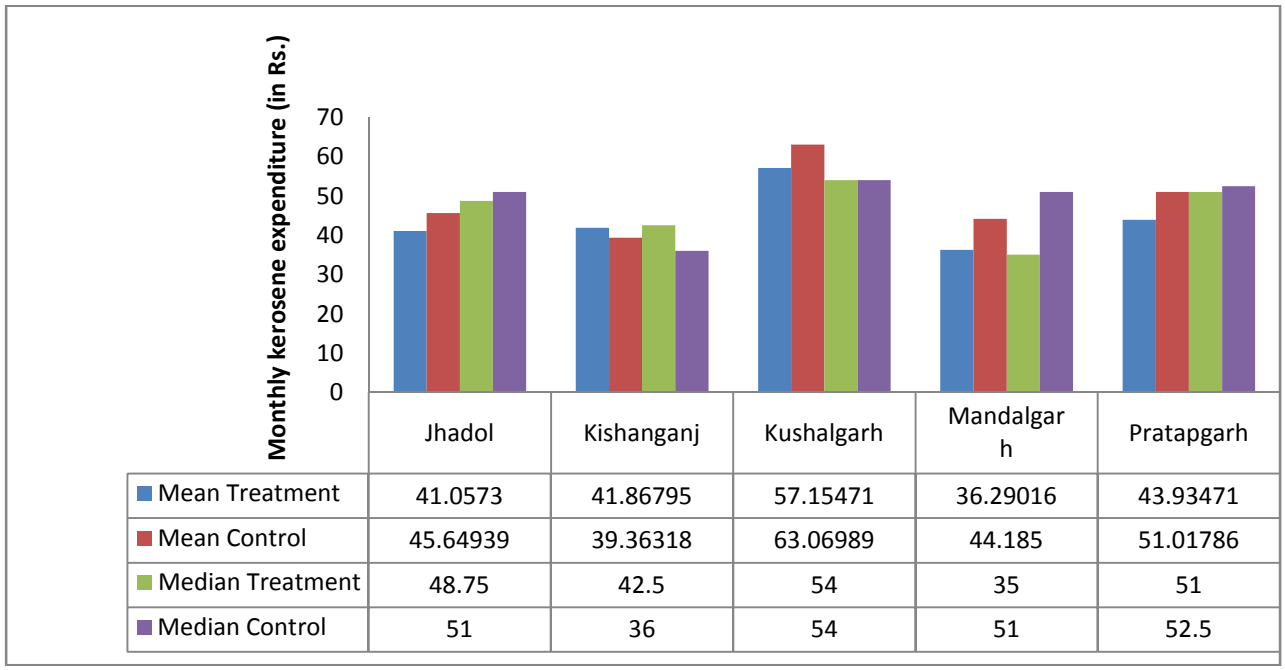
reported by respondent households was Rs. 11 for incandescent bulb and Rs. 114 for CFL. The average bulb life was stated to be approximately one and half months and for CFL it was one year. There were very few households that possessed tube light and amongst these majorities light (77.78% and 62.50%) in both the groups had one tube. There was not a single control household that had LED, while only 11 treatment households had it with 63.64% households having 1 LED. Amongst those households possessing rechargeable torch, majority of households in both the samples [92.99% in treatment and 98.18% in control] had one.

3.5. Expenditure on lighting in Rajasthan

In order to see the impact of SoUL on 'lighting expenditure' of the households the comparison was made between treatment and control households. However for this analysis, data was calculated for those households which had SoUL in working condition, while the households with non working SoULs were not considered. In order to arrive at monthly lighting expenditure monthly mean and median expenditure on various heads such as electrical lighting devices like CFL, incandescent bulb, electricity bill, and kerosene purchased for lighting purpose was calculated separately and then the total mean and median lighting expenditure was calculated.

3.5.1. Monthly expenditure on kerosene used for lighting: For entire Rajasthan it was observed that the 'mean of monthly kerosene expenditure on lighting' was lesser in treatment group than in control group and this difference were of Rs. 4.87. The mean and median of monthly kerosene expenditure on lighting in treatment and control group across the sample blocks in Rajasthan represented in Figure 3 shows that in four blocks, with the exception for Kishanganj block, control group was spending more than the treatment group.

Figure 3: Mean & Median of Monthly Kerosene Expenditure in Rajasthan



The table 13 given below makes two comparisons about kerosene expenditure on lighting: (a) electrified treatment and electrified control group (b) non-electrified treatment and non-electrified control group.

Table 13: Monthly Expenditure on Kerosene as per electrification status in Rajasthan blocks

Rajasthan Blocks	Treatment				Control				Difference			
	Electrified		Non - Electrified		Electrified		Non - Electrified		Electrified		Non - Electrified	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Jhadol	39.14	36	48.40	51.99	44.85	51	53.27	51	**5.71**	15	**4.87**	-0.99
Kishanganj	40.70	36	47.40	51	38.81	36	51	51	-1.90	0	**3.60227**	0
Kusalgarh	53.47	52.5	59.88	54	59.43	54	66.479	54	**5.97**	1.5	**6.60**	0
Mandalgarh	36.09	35	38.71	35	43.43	51	54	54	**7.34**	16	**15.29**	19
Pratapgarh	42.46	51	58.68	52.5	50.00	52.5	61.83	61.25	**7.55**	1.5	**3.16**	8.75

The difference in monthly mean kerosene expenditure on lighting was observed between electrified and non-electrified households. It was found that non-electrified as well electrified control households tend to spend more on kerosene than the treatment households in all blocks except for Kishanganj.

3.5.2. Monthly expenditure on electric devices: The data on mean and median monthly expenditure on electrical devices showed that in all blocks treatment households were spending more than control and this difference was in the range of Rs. 2 to Rs. 20.

3.5.3. Monthly expenditure on electricity bill: The data on mean of monthly expenditure on electricity bill showed that except for Kishanganj in all blocks treatment group was spending more than the control and this difference was in the range of Rs. 19 to Rs. 89. For Kishanganj the difference in mean was merely of Rs. 2. However, regarding median for Kusalgarh and Pratapgarh the median was same, while for Jhadol treatment group spend Rs. 4 more than control, and in Kishanganj and Mandalgarh treatment group spends Rs 50 more than the control.

Table 14: Monthly Expenditure on Electricity Bill across Sample Blocks in Rajasthan

Rajasthan Blocks	Treatment		Control		Difference	
	Mean	Median	Mean	Median	Mean	Median
Jhadol	233.395	154	193.466	150	-39.929	-4
Kishanganj	503.382	400	**505.31**	350	1.9271	-50
Kusalgarh	305.019	250	285.965	250	-19.053	0
Mandalgarh	356.558	300	267.786	250	-88.773	-50
Pratapgarh	371.984	300	336.045	300	-35.939	0

3.5.4. Monthly expenditure on lighting: In Kishanganj and Kusalgarh mean and median of total monthly expenditure on lighting was observed to be more in control than in treatment group. For Kishanganj the mean was more by Rs. 59 and for Kusalgarh it was more by Rs. 13. Although median monthly lighting expenditure in Jhadol and Pratapgarh was observed to be more in control than the treatment group, but the mean was higher in treatment than in control. In Mandalgarh, mean and median both, were higher for treatment than control group (table 15). Although the treatment and control group level broad findings showed mixed results, however data as per electrification status revealed expected results whereby monthly lighting expenditure of non-electrified control group was higher than the treatment.

Table 15: Monthly Expenditure on Lighting across Sample Blocks in Rajasthan

Rajasthan Blocks	Treatment		Control		Difference	
	Mean	Median	Mean	Median	Mean	Median
Jhadol	249.814	205	238.642	221.167	-11.172	16.1667
Kishanganj	473.076	364	**531.79**	400.833	58.7106	36.8333
Kusalgarh	194.085	62.5	**206.96**	125	12.874	62.5
Mandalgarh	398.18	334.1667	311.343	272.167	-86.837	-62
Pratapgarh	414.879	353	**382.57**	365.5	-32.304	12.5

As observed in the table 16 below 'mean monthly expenditure on lighting' was more for non-electrified control than non-electrified treatment in all blocks of Rajasthan.

Table 16: Monthly Expenditure on Lighting in Electrified and Non-electrified Households across Sample Blocks in Rajasthan

Rajasthan Blocks	Treatment				Control				Difference			
	Electrified		Non - Electrified		Electrified		Non - Electrified		Electrified		Non - Electrified	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Jhadol	291.18	230	46.29	51.99	255.78	224.33	53.27	51	-35.40	-5.67	**6.99**	-0.99
Kishanganj	534.56	412.08	45.33	51	548.96	402.42	51	51	**14.39**	-9.67	**5.66**	0
Kusalgarh	368.05	311	58.18	54	356.80	325	66.48	54	-11.25	**14**	**8.30**	0
Mandalgarh	412.68	337.5	33.88	35	318.70	280	54	54	-93.99	-57.5	**20.13**	**19**
Pratapgarh	439.59	374.17	58.68	52.5	406.63	378.33	61.83	61.25	-32.96	**4.17**	**3.16**	**8.75**

T-test for statistical significance

T-test was conducted for checking the statistical significance of the difference in the monthly expenditure on lighting between two samples i.e. treatment group and control group and the related heads. Furthermore t-test was also conducted in order to see any differences between electrified and non-electrified households across both groups. In the t-test mean treatment was subtracted from mean control to observe whether the differences are statistically significant or not. The expected outcome shall be that the expenditure on lighting in treatment should be less than those in control group.

Table 17 given below presents t-test results, which were run for two samples, i.e. treatment and control, by calculating 'the mean' for total expenditure on lighting and for related heads separately.

Table 17: Two Sample (Treatment & Control) T-test Results

	Exp on Electricity Bill		Exp on Electric Devices		Exp on Kerosene used for lighting		Total Exp	
	t- test	**P-Value**	**t- test**	**P-Value**	**t- test**	**P-Value**	**t- test**	**P-Value**
Consolidated RJ	-2.3626	0.0182	-1.9266	0.0542	**3.7916**	**0.0002**	-0.8296	0.4069
Block Wise	**t- test**	**P-Value**	**t- test**	**P-Value**	**t- test**	**P-Value**	**t- test**	**P-Value**
Jhadol	-1.8238	0.0686	-1.3773	0.1688	3.2672	**0.0011**	-0.5288	0.5971
Kishanganj	0.0213	0.983	-0.5442	0.587	-0.8868	0.3766	0.5539	0.5802
Kusalgarh	-0.5314	0.5955	-1.4238	0.1555	1.9793	**0.0482**	0.538	0.5907
Mandalgarh	-1.8461	0.0662	-1.6352	0.1033	1.8848	**0.0623**	-1.7358	0.0839
Pratapgarh	-1.0782	0.2814	-0.9564	0.3392	2.945	**0.0034**	-0.9637	0.3355

T-test results as per 'lighting expenditure' showed that they were only significant for 'expenditure on kerosene used for lighting' and were insignificant for 'electricity bill' 'expenditure on electric devices', and 'total expenditure on lighting'.

T-test for difference in kerosene expenditure on lighting was significant at 99% confidence level for entire Rajasthan state as well as for Jhadol and Pratapgarh and for Kusalgarh at 95% confidence level and 90% confidence level for Mandalgarh. Kishanganj was the only exceptional block for which t-test results were insignificant.

Two sample (treatment & control) t-test results with electrification status as a constraint:
As mentioned earlier electrification status was put as a constraint to explore whether there were any differences between the expenditure pattern of electrified and non electrified households in control and treatment groups. As observed in table 18, t-test results for 'expenditure on kerosene used for lighting' for Rajasthan was significant for both electrified and non-electrified households. For electrified households it was significant at 99% confidence and for non-electrified households it was significant at 95% confidence level, both indicating higher expenditure on kerosene for lighting by control electrified as well as control non-electrified households than the treatment. For

total expenditure on lighting although the results were insignificant for electrified household, but they were significant for non-electrified households at 95% confidence level indicating higher expenditure on lighting by non-electrified control households than the non-electrified treatment households.

Table 18: Two Sample (Treatment & Control) T-test Results – Electrification Status as a Constraint

	Exp on Kerosene used for lighting				Total Exp on lighting			
	Electrified		Non- Electrified		Electrified		Non- Electrified	
	t- test	P-Value	t- test	P-Value	t- test	P-Value	t- test	P-Value
Consolidated RJ	4.6147	**0.0000**	2.1133	**0.035**	-2.0712	**0.0385**	2.525	**0.0118**

3.6. Studying during dark hours: lighting devices, electrification status, gender differentiation (studying during dark hours henceforth referred as studying in night)[3]

Regarding usage of lighting devices for study at night it was reported that 90.29% children in treatment and 90.70% in control study at night. The reason for not studying during the night were asked, which revealed that in treatment 94.12% and in control 91.8% children were not interested in studying followed by 5.88% in treatment and 8.2% in control who were in lower classes, i.e. class I to IV and did not study at night.

The 'lighting devices used for study at night' is a single and or multiple response question. The respondents from the treatment sample informed that **82.93%** beneficiary children[4] used **SoUL to study at night as one of the study device** (either as the only lighting device or along with other devices), while 17.07% children did not use SoUL as one of the studying devices. Amongst the children not using SoUL, for the maximum percentage of students (96.7%) non-functioning of SoUL was the reason.

[3] Dark hours are defined as the time when there is no daylight and there is darkness and lighting devices are required for the illumination. The dark hours pertain to hours from dusk (darker stage of twilight) to dawn (the first appearance of light in the sky before sunrise). These hours will vary from season to season for example in winters it becomes dark early in the evening and the nights are longer as sun rises late and vice-versa during summer.

[4] Beneficiary children are defined as children who are using SoUL for studying during dark hours and they could be both recipients as well as non-recipients of SoUL.

The data on usage of **solely kerosene** based **lighting devices** like C*himni* (simple wick lamp) and hurricane revealed that in treatment group only 4.75%, whereas in control group **17.21%** children used it. There were **10.07%** in treatment and **64.39%** (n=434) in control used **electricity as a single source** to study at night. It was observed in the treatment group that **21.8%** children used **'merely SoUL'** as a lighting device and maximum percentage (59.27%) of treatment households used SoUL and electricity (refer table 19). The comparison across the blocks revealed that Kusalgarh had highest percentage (52.82%) of 'only SoUL' users followed by 26.37% in Jhadol, and 15.24% in Pratapgarh. Kishanganj and Mandalgarh had less than 4% 'only SoUL' users.

Table 19: Lighting Devices used for Study at Night in Rajasthan

Lighting Devices Used for Night study	No. of Children in treatment	%	No. of Children in control	%
Electricity, Kerosene Source	85	1.49	109	16.17
Only Electricity	609	10.7	434	64.39
Only Kerosene Source	270	4.75	116	17.21
Only SoUL	**1,240**	**21.8**	0	0.00
Other Solar Device	1	0.02	1	0.15
SoUL, Electricity	3,372	59.27	0	0.00
SoUL, Kerosene Source	106	1.86	0	0.00
Electricity, Other Device	6	0.11	0	0.00
Electricity, Other Solar Device	0	0.00	14	2.08
Total	5,689	100	674	100

The following table 20 presents t-test results two samples, i.e. treatment and control, by calculating 'the mean' for children studying during night using 'only kerosene based devices' and mean for children studying 'only in grid electricity'. T-test results in both the cases were significant at 99% confidence level confirming reduced usage of kerosene based devices as well as usage of grid electricity based devices for studying in the treatment group and shift towards usage of SoUL, a clean energy, as a study device during dark hours.

Table 20: T-test Results for Users of 'Only Kerosene based Devices' and 'Only Electricity' for Study Purpose

	Only kerosene based devices		Only Electricity Users	
	t- value	**p-value**	**t- value**	**p-value**
Consolidated RJ	12.9849	0.0000	39.7751	0.0000

Thus, the data on lighting devices used for night study and t-test results indicated primarily two important points (a) children from treatment group are less exposed to harmful effects of kerosene fumes as compared to control group as they have ceased using kerosene based devices in treatment households; (b) children from treatment group study in harmful (to eyes, lungs) and better lighting conditions as compared to control group.

3.6.1. Study hours during night

The data on studying hours showed that maximum percentage of children (55.28%) in treatment studied for less than an hour at night followed by 37.66% studying for 1-2 hours, and 5.68% for 2-3 hours. In control group, 46.14% children studied for 1-2 hours, followed by 44.07% studying for less than an hour, and 8.16% studying for 2-3 hours. In both the groups less than 2% each are observed to study for more than 3 hours. Thus, not much of a difference could be observed between treatment and control group with regard to study hours and similarly no gender differentiation was observed in this regard.

The following table 21 presents t-test results for hours of study during night with 'constraint' for 'only SoUL users' in treatment against all children studying in night using various lighting devices in control sample. In this t-test 'the mean of study hours' was calculated. T-test results with constraint of children that use 'only SoUL' for night study in treatment although were not significant, however they showed expected direction with 'only SoUL users' studying for more hours than the children in control households.

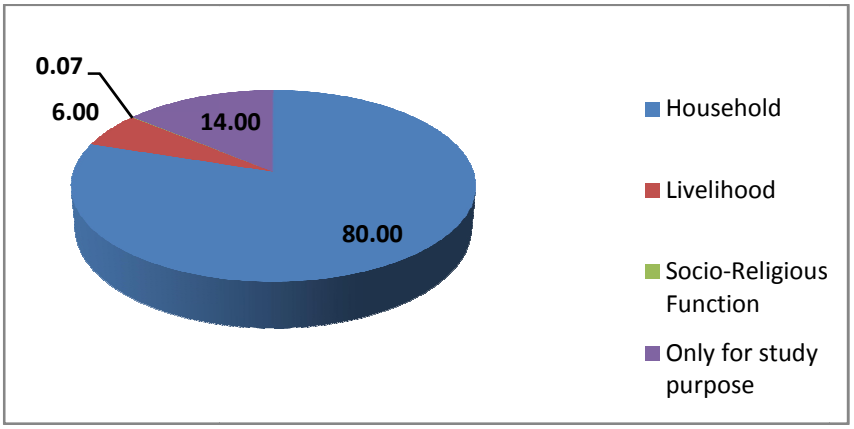
Table 21: T- test Results for Average Hours of Study

Hours of Study	Mean Treatment	Mean Control	Diff	t-value	p value
Only SoUL users in treatment & all studying children in control	1.68	1.64	-0.04	-1.3183	0.1876

3.7. Uses of SoUL other than the study purpose

"Other uses of SoUL" is a multiple answer question. The data showed that the beneficiary households besides using SoUL for studying during night also used it for multiple and diverse purposes. As presented in Figure 4 below there were 14% household that reported using it only while studying during night, whereas 86% households reported using SoUL for other purposes. Amongst those using SoUL for other purposes, 80.25% households used it as an aid in domestic activities, while 6% used it in livelihood activities, and 2 households reporting its use in socio-religious function. The main domestic activities include aid during cooking (60.64%), having dinner (9.55%), whereas activities in which SoUL aids as a torch were going out of the house during dark hours and going outside for toilet.

Figure 4: Percentage of Households using SoUL in various activities in Rajasthan

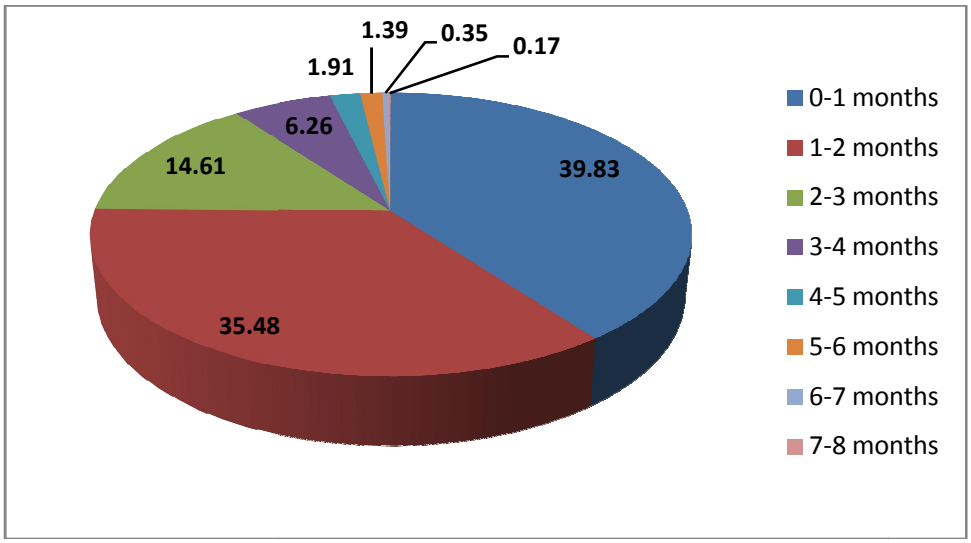


3.8. Performance of SoUL

Out of 3408 SoULs received by 2952 treatment households, **16.87%** were found **non-functional.** The data on period for which non-working SoULs worked for before they stopped functioning is given in the pie chart below (refer figure 5). As evident from the

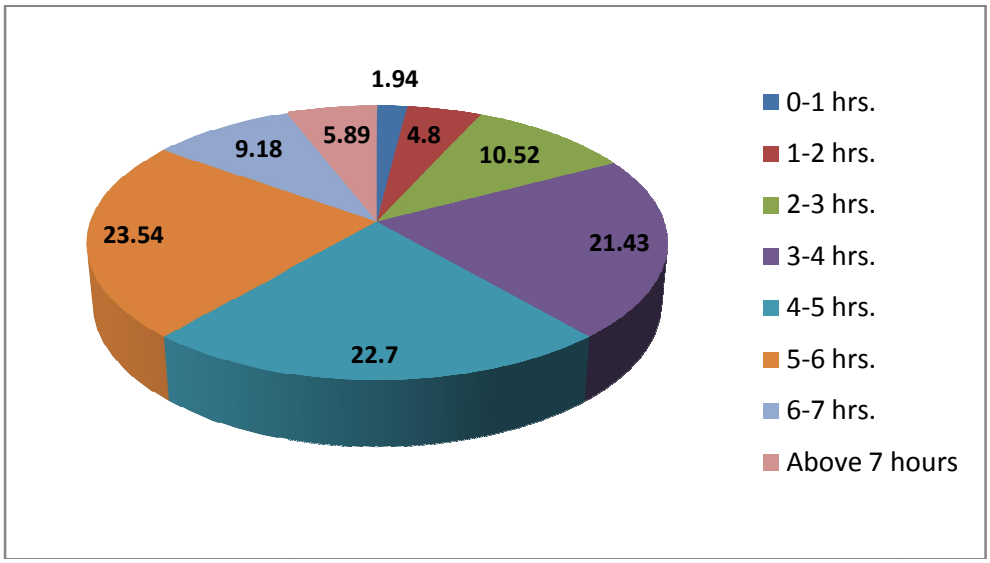
figure 6, maximum percentage of lamps functioned up to 1 month (39.83%) and between 1-2 month (35.48%).

Figure 5: Percentage of SoUL and Number of Months they functioned before stop functioning



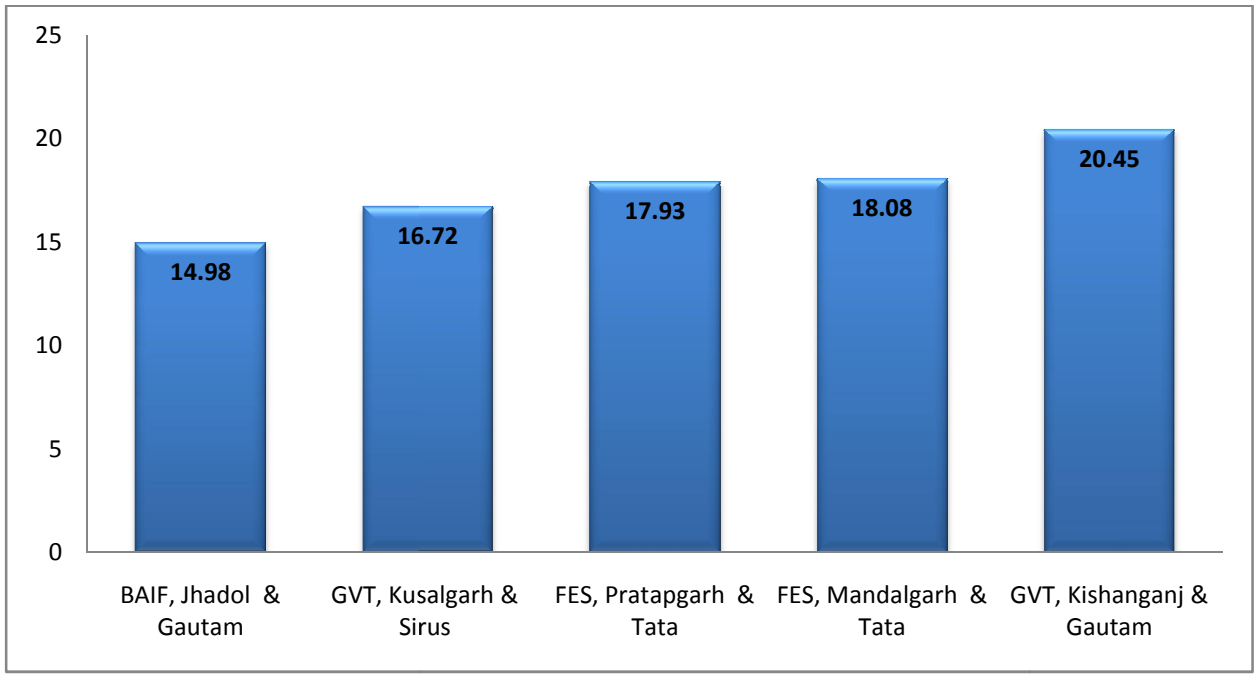
The working SoULs were checked for functioning of its various parts. Amongst 2833 functioning SoULs, 90.47% were without any problem or no part defectives, whereas 9.53% lamps had some problem relating to one or the other part of the lamp. Amongst the SoULs with some problem, the main problem identified in 3.92% lamps was loose connection followed by switch related problem in 3.32% and green light not working in 2.01%. LED, panel and red light indicator related problems together were less than 1.8%. The respondents were asked about the lighting back-up in hours that SoUL provides after one day of charging. There was a broad range of response ranging from less than an hour to more than 7 hours. As it can be seen from figure 6 below there are 17.26% households reporting back-up of less than 3 hours, while 82.74% households reported the back-up of more than 3 hours and for 61.31% households the back-up received was more than 4 hours.

Figure 6: Back-up provided by SoUL



The vendor-wise comparison of working SoULs pointed that all three vendors in Rajasthan were almost at par with each other with slight differences. 83.96% of Gautam lamp, 83.28% of Sirus, and 82.03% of Tata lamps were in working conditions in the sample blocks. The working of SoUL was also looked at as per the NGO partner and the block in which NGO distributed the lamps. BAIF in Jhadol (85.02%), GVT in Kusalgarh (83.28%), and FES in Pratapgarh (82.07) and Mandalgarh (81.92) had more than 80% SoULs in working condition. GVT's Kishanganj was the only block in which 79.55% lamps functioned. Figure 7 below gives an overview of percentage of non-working SoULs as per NGO partners, block in which they have implemented the MSP, and vendors who have supplied lamp material in the block.

Figure 7: Overview of Non-working SoULs in Rajasthan

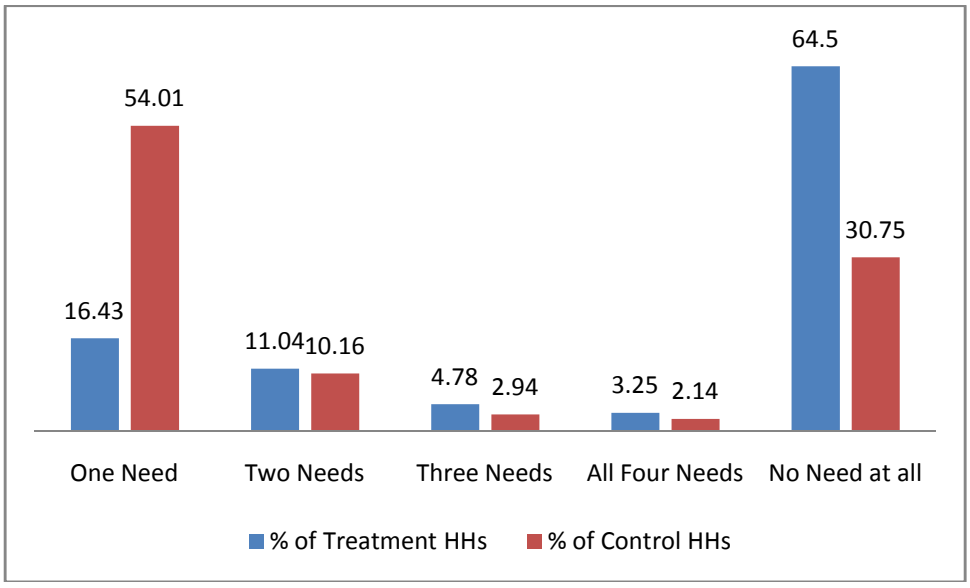


3.9. Need for solar energy based products and willingness to pay

The household survey tried to explore the household level solar energy related needs and in case of existence of such needs then willingness or capacity to pay assuming there is no subsidy available and they are to purchase it from the market. The exploration of these two needs was linked to assessing the market potential for the solar products in rural areas. However, households in the SoUL Program implementation areas being rural and tribal tend to have less exposure to solar technology and solar products. So the barrier about knowing or visualising the product and state some cost that they think they can afford to pay was anticipated. In order to overcome this barrier a placard illustrating pictures of solar products like solar light, solar torch, solar home lighting system, solar fan, solar pump for irrigation, solar drier for drying crops (food grains, vegetables) and their approximate costs in the market at present was prepared. While administering the questionnaire it was shown to them and care was taken to inform and assure them that any kind of marketing of solar products was not intended and there is no commitment when they state they can afford certain amount.

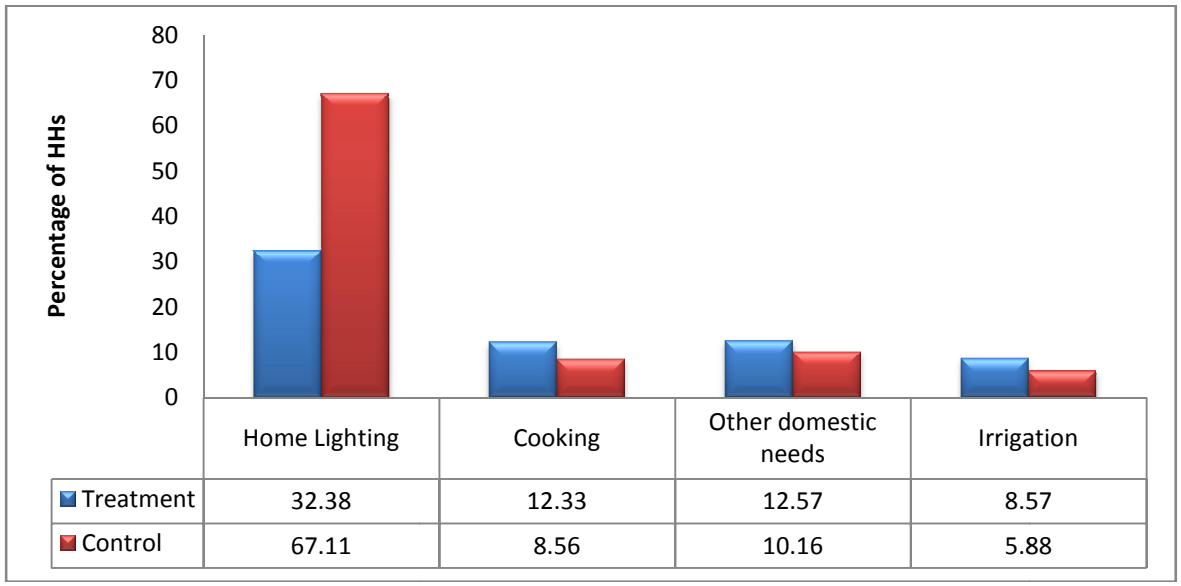
Need for solar energy based products mainly covered four types of needs: lighting, cooking, irrigation and additionally if they expressed any other specific need it was recorded. About stating the cost it was noticed that the respondent households were hesitant to state any amount as most of them belonged to poor households. The figure 9 below shows the percentage of households and the number of solar product needs that they have expressed. Maximum percentage of households, 16.43% in treatment and 54.01% in control had one need.

Figure 8: Percentage of Sample Households & Need for Solar Products



From the following figure 9, it could be observed that maximum percentage of households in both the groups (67.11% control households and 32.38% treatment) have expressed the need for solar home lighting.

Figure 9: Percentage of Households expressing Needs that are to be addressed by Solar Technology



	Home Lighting	Cooking	Other domestic needs	Irrigation
Treatment	32.38	12.33	12.57	8.57
Control	67.11	8.56	10.16	5.88

For solar home lighting in both the samples maximum percentage of household showed willing to pay less than Rs. 500. In this, there were 83.16% households in treatment and 96.02% in control, followed by 16.63% treatment and 3.98% in control willing to pay in the range of Rs. 500 – 1000. The need for solar cooking was stated by 12.33% treatment and 5.88% control households. Amongst these there were 32.26% treatment households willing to spend between Rs. 500 to Rs. 1000 followed by 20.33% with expenditure capacity of Rs. 1000 to Rs. 1500. There were 40.63% control households with the capacity to spend in the range of Rs. 1500-2000 followed by 28.13% ready to spend than Rs. 500-1000. The need for solar based pump for irrigation was reported by less households with 8.57% treatment and 5.88% control households. In treatment sample 75.89% and 72.23% in control were willing to spend in above Rs. 25,000 for solar irrigation pump. There were 7.51% treatment households that expressed to spend between Rs. 5000-10000.

Chapter 4 Conclusion and Recommendations

1. Low cost of SoUL as a positive discrimination: The findings indicated that the cost or the beneficiary contribution of Rs. 120 acted as a positive discrimination and was 'not the barrier' in purchasing or accessing the SoUL. This has contributed in reaching the school-going children from needy communities by providing the clean light irrespective of their socio-economic status in rural areas. In the entire sample in Rajasthan there was not a single respondent from control sample who stated that they did not purchase SoUL as they thought it to be expensive. The field investigators reported that it was difficult to identify control households in the sample villages. This confirmed that the principle of saturation[5] and localisation approach was successful in the sample blocks and most of the eligible beneficiaries have purchased the SoUL.

2. SoUL reaching the marginalised and poor households: The access to the grid electricity either through legal or non-legal (by putting hook) connection revealed that 23.95% of the treatment sample was non-electrified. The socio-economic profile of the treatment sample in Rajasthan showed that 56.91% were scheduled tribes (STs), followed by 25.71% other backward castes (OBCs), and 7.38% scheduled castes (SC) households, while 54.41% of them were poor as they possessed either below poverty line (BPL) or Antyoday cards.

3. Continued dependence on kerosene for illumination: Though control households are purchasing slightly more than the treatment, maximum percentage of households (more than 84%) in both the groups were observed to be consuming 2-3 litres per month primarily for illumination purpose indicating continued dependence on kerosene. There were 79% treatment and 84% control households that used kerosene wick lamp/s, with more than 68% households in both the groups using it for less than two hours daily.

[5] In the MSP principle of 'saturation' is defined as reaching out to a minimum of 75% of enrolled class V – XII children in the given block. On an average, a block in India has 17,600 school children studying in 5th to 12th standard. This makes it possible to reach the maximum number of school going children enrolled in V – XII and thus strive towards providing 'right to clean light to every child'.

People depend exclusively on PDS outlet, with few households purchasing kerosene from the market. The continued dependence on kerosene for lighting could be explained with the fact that it is unreasonable to expect cease of usage of kerosene lamp with presence of one solar study lamp as the requirement remains unfulfilled given that the household has multiple rooms as well as multiple lighting needs.

4. Decline in kerosene purchase of treatment households: T-test results for total monthly kerosene purchased between treatment and control showed that monthly purchase of kerosene by control households was significant at 90% confidence level (p 0.091) indicating higher purchase by control sample and declined purchase in treatment sample.

5. Significant decline in expenditure on Kerosene for Illumination in treatment sample: T-test results for difference in expenditure on kerosene for illumination were significant at 99% confidence level for entire Rajasthan state as well as for Jhadol and Pratapgarh and 95% confidence level for Kusalgarh and 90% confidence level for Mandalgarh. Kishanganj was the only exceptional block for which t-test results were insignificant. T-test results with electrification status as 'constraint' for Rajasthan was significant for both electrified and non-electrified households. For electrified sample the significance was at 99% confidence and for non-electrified households significance was at 95% (p 0.035) confidence level. Thus, t-test results confirmed the significance of higher expenditure by control electrified as well as control non-electrified households than the treatment sample.

6. No difference in total expenditure on illumination: Regarding 'electricity bill', 'expenditure on electric devices' and 'total expenditure on illumination' no difference was observed between treatment and control group. The possible explanation for this could be that the presence of one solar study lamp will have limited impact as it can at the most replace one kerosene lamp and the need for kerosene as a source of light and grid electricity for lighting continue to exist as most of the households have more than 1 room.

7. Slightly higher study hours for children using only SoUL as a study device: T-test results with constraint of children that use 'only SoUL' for night study in treatment were although not significant, however they showed expected direction with 'only SoUL users' studying for more hours than the children in control households.

8. Significant decline in kerosene use for night study: Shift in illumination pattern for study at night from kerosene based devices to SoUL was observed. T-test results for both children using 'only kerosene devices for study' and 'only grid electricity' were significant at 99% confidence level with higher percentage of children in control than treatment sample using 'only kerosene devices' and 'only grid electricity based devices'. T-test results confirmed reduced usage of both kerosene based devices as well as grid electricity based devices for studying in the treatment sample. Thus, there is a visible shift towards usage of SoUL, a clean and better quality light, as a study device during dark hours. 82.93% of beneficiary children used SoUL to study at night as one of the study device (either as the only lighting device or along with other devices). Amongst the children who did not use SoUL as one of the studying devices for 96.7% the main reason was non-functioning of SoUL.

Thus, the data on lighting devices used for night study and t-test results indicated two significant impacts (a) Children from treatment sample have almost stopped studying in kerosene based devices demonstrating replacement of one kerosene wick lamp and thus decline in kerosene consumption. (b) Children from treatment sample study in clean and better light as compared to control sample as a result they are not exposed to harmful effects of kerosene fumes while studying.

9. Aid in other activities besides study: The clean and better quality of light provided by SoUL induced its uses in other activities besides the study purpose. 86% households reported using SoUL for other purposes and amongst these households 80.25% used SoUL as an aid in domestic activities, while 6% used it in livelihood activities like grocery shop. The main domestic activities included aid during cooking (60.64%),

having dinner (9.55%), while activities in which SoUL aided as a torch were going out of the house during dark hours and going outside for toilet. The usage of SoUL in other activities reaffirmed its utility merit and emphasises the requirement of home lighting system in order to fulfil domestic lighting needs.

10. Performance of SoUL: Mid-course Correction: The MSP is accountable to the commitment of providing high quality solar study lamps that remain in functional state till the end of the phase 1 i.e. December 2015 (approximately for 1 year after distribution of lamp). Another aspect linked to functioning of SoUL till the end of phase 1 was faith and confidence of the rural community in solar technology. Hence, to address these two concerns following mid-course corrections are recommended, which are based on the results of user perspective about performance of SoUL.

10a. Stringent quality control at vendors & at NGO assembly centres: The high percentage of non-functional SoULs (16.87%) in the sample is a cause of concern and it called for stringent quality control at vendor's end as well as at the assembling level that comes under the purview of NGO partners. It was noticed that before SoULs stopped functioning 39.83% functioned up to 1 month and 35.48% between 1-2 month. So, the non-functionality rate within first 2 months of distribution is alarming. The vendor-wise comparison of working SoULs pointed that all three vendors in Rajasthan were almost at par with each other with slight differences. 83.96% of Gautam lamp, 83.28% of Sirus, and 82.03% of Tata lamps were in working conditions in the sample blocks. NGOs, BAIF (85.02%), GVT (83.28%) in Kusalgarh, and FES in Pratapgarh (82.07) and Mandalgarh (81.92) had more than 80% SoULs in working condition were in working conditions. In order to deliver high quality SoULs IIT-B should set up the benchmark for non-functionality rate for vendors as well as for NGO partners. IIT-B at its end should have a separate quality control team who can regularly supervise vendors and NGO partners.

10b. Requirement of SRC awareness campaign to ensure availing of service: In almost all the cases in which SoUL was reported to be non-functional respondents had not

taken it for repairing at SoUL repair centres (SRC) set up in the vicinity to provide free after sale service. The reason for not availing SRC service was unawareness SRCs existence. This is another area that needs immediate action. An aggressive awareness campaign need to be taken up on a priority basis to ensure that people avail the SRC facility so that all SoULs are in working condition till the end of phase 1.

10c. Monitoring mechanism for SRC operations: Absence of awareness about SRCs and non-conversion of non-functional SoULs into functional point towards lack of effective campaigning strategy of SRCs, though this happened in the initial stage of SRC set-up. Despite monitoring mechanism for SRC operation being in place the reason for not identifying the SoUL performance related problems should be identified and accordingly modification in it could be made.

10d. Improvements in the SoUL design: Amongst the working SoULs, 9.53% had problems related to one or the other part of the lamp. The main problem identified was loose connection and switch related problems. LED, panel and red light indicator related problems were not much. The switch related problems pertain to accumulation dust, switch not working, and operating it with wet hands. Many respondents suggested for better design as well quality switch that would address the problem faced. Another suggestion was making the bottom of lamp sturdier and better quality goose-neck as it falls down after a while since the tension in is lost. The loose connection was assembling related issue calling for stringent quality control.

11. Positive feedback on back-up provided and quality of light: The feedback on the lighting back-up (in hours) provided by SoUL after one day of charging was positive. For 82.74% households the backup they got was for more than 3 hours, while for 61.31% households the back-up received was more than 4 hours. There was unanimity of opinion regarding the quality of light that SoUL provides. All respondents were satisfied with the brightness of SoUL and they also noted absence of negative effects such as safety concerns, fumes and pollution adversely impacting eyes and health.

12. Demonstration of market potential for solar technology: Through medium of SoUL the people residing in remote and rural blocks of Rajasthan have got exposure to solar technology. The first hand usage has increased the confidence of people in the solar PV which was reflected in the needs assessment of solar as 16% treatment and 54% control expressed at least one type of solar need. The highest percentage of sample expressed the need for solar lighting followed by need for solar cooking, and then for other solar based domestic product like fan demonstrating market potential for solar technology. However, there were very few households expressing the need for solar irrigation pump.

13. Requirement of financial mechanism for converting need into purchase: The capacity to pay for these expressed needs revealed the paying capacity of the people is quite less, with majority households' ready to spend up to Rs. 500 for lighting, Rs. 1000 for cooking, and above Rs. 25,000 for irrigation pump respectively. This less paying capacity puts the question mark on conversion of need into purchase. This also highlights the requirement for development of a mechanism or a model with the help of NGO partners, vendors, or financial institutions like NABARD that will facilitate purchase of solar products.

To conclude, the results clearly indicate direct positive impacts of SoUL such as elimination of one kerosene lamp specifically for study purpose, complete cease of exposure of children to kerosene fumes while studying, significant decline in kerosene expenditure for lighting due to saving from one kerosene lamp. Other impacts though not significant but they showed positive direction such as reduction in total expenditure on lighting as well as expenditure on electricity bill, and increased night study hours. However, it needs to be acknowledged that complete elimination of kerosene cannot be possible with SoUL or a small solar study lamp as it would have limited impact. Therefore, unless the need for lighting for entire house gets fulfilled through solar home lighting the significant impact in terms of elimination of kerosene consumption for lighting and its expenditure cannot be expected.

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Annexure

A1. Household Impact Survey

State	[Pre-printed]	District	[Pre-printed]	Block	[Pre-printed]

Form Number												Interviewer's Name	Date	Gram Panchayat	Village	Hamlet
			/					/								
Block code [Pre-printed]			/	Village code				/	Serial number							

A. Household Details						
A1	Full Name of respondent		A3	Full Name of head of household		
			A4	Sex of head of household	◯ Male	◯ Female
A2	Relation of the respondent to the beneficiary		A5	Mobile Number		
			A6	Number of Members in the Family		
			A7	No of rooms in the house(including kitchen)		

B. Children's Details (Irrespective of receipt of SoUL lamp, applicable to all children from 5 to 17 years or up to 12th Class)										
	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10
S. No.	Full Name	Age	Sex (M/F)	Does he/she go to school? (Yes/ No)	Class	Has he/she received SoUL lamp? (Yes/ No)	If **"Yes" for B6**, specify the **lamp code** here. If only one child has bought and others are applicable why other children have not brought SoUL?*	Which devices** do you use for studying (Specify all the devices, else specify the reason for not studying in the dark hours)	If, **for B8**, one of the devices is SoUL lamp, specify **time** of **study using SoUL lamp**. If, **for B8**, none of the devices is SoUL lamp, specify the **reason for not using SoUL lamp** for studying	If the SoUL is working, and the child is using Chimni/Electricity with SoUL, mention the reason for using the same?
1										
2										
3										
4										
5										
6										

*If unable to obtain the lamp code, state the reason in B7

** If studying in street light or community light (in temple) etc. then specify in B8

C. Performance of SoUL lamp (Interviewers can themselves check SoUL lamp for following details)											
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
S. No.	Lamp Code	Is the SoUL lamp working? (Yes/ No) **If "Yes" go to C4**	If No, for how much time did it work? (days/weeks/ months) **Specify and go to E1**	Is the Switch working? (Yes / No)	Is LED working? (Yes / No)	Is red light in indicator working properly? (Yes/ No)	Is green light in indicator working properly? (Yes/ No)	After one day of charging, for how much time SoUL lamp works?	Is there any loose connection? (Yes/ No)	Is the panel broken? (Yes/ No)	State other problem, if any. If SoUL is not working; then state the problem with it?
1											
2											
3											
4											

D. Usage of SoUL lamp									
D1 Lamp code	D2 Do you charge SoUL lamp with mobile charger? (Yes/ No)	D3 What is the usage of SoUL in hours per day for purposes **other than Studies**?	D4 For what other purposes **other than Studies** SoUL lamp is used & used by whom **(Relation to the beneficiary)**						
			Other purpose 1	Used by whom	Other purpose 2	Used by whom	Other purpose 3	Used by whom

E. Repair and Maintenance of SoUL										
S. No.	E1 Lamp code**(Repeat the lamp code again if R&M availed more than once)**	E2 Have you availed R&M service?[#] (Yes/ No) **If Yes, Go to E4**	E3 If **E2 is "No"**, & SoUL lamp is not working then why service is not availed? **Specify and go to E11**	E4 If **E2 is "Yes"**, what was the problem in the SoUL lamp before repair?	E5 Was it repaired at SoUL R&M centre? (Yes / No)	E6 Where was it repaired? (Shop name, Village name, Gram Panchayat name)	E7 When did you avail R&M? (Month & year)	E8 In how many days was SoUL lamp repaired?	E9 How much did you pay for it? (Rs.)	E10 Are you satisfied with R&M service? (Yes/ No)
A										
B										
C										
D										
E										
F										

E11 If any of the SoUL lamps have been repaired at home (yourself), was it successful? (Yes/ No):

E12 Specify which component was not working before repair at home (yourself):

F1 Kerosene Purchased					
S. No.		Litre/s per month	Avg. Price per litre	Frequency (Number of trips for purchase per month)	Generally collected by whom? (specify whether Adult woman/Adult man/ Girl child/boy child)
1	Purchased from Govt. Ration shop - PDS				
2	Purchased from Market				

F2 Kerosene Used				
	Lighting	Cooking	Heating water	Other (Please specify)*
Consumption (litre/s per month)				

*Other use may also include resale, in vehicles, etc.

F3 Usage of other oil for lighting (For example, if used for lighting purpose, any of the cooking oils like groundnut, mustard, sunflower, etc.)			
Name of oil	Consumption (litre/s per month)	Avg. Price per litre	Device/s used

F4 Devices using kerosene/ other oil					
S. No.	Device	Do you use the device? (Yes/ No)	Quantity used*	Number of hours per day	Number of days per month
1	Chimni (Simple wick lamp)				
2	Hurricane lamp				
3	Wick stove				
4	Other (Please specify)				

*By "Quantity used" we mean number of devices they are actually using for lighting purpose and NOT the number of devices they possess.

F5 Do you have electricity at home? If "No" go to F10	◯ Yes	◯ No
F6 Do you have electric meter/ one point connection/ shared connection?	◯ Yes	◯ No

F7 Interval of electricity bill receipt		
◯ Not applicable	◯ Every month	◯ Every 3 months
◯ Every 6 months	◯ Every year	◯ Other (Please specify)

F8	**Electricity bill amount paid as per the above mentioned interval (Rs)**	

F9 Features of electric lighting devices (bulbs/ tubes) used at home				
S. No.	Type of device	Number of devices	How much period (days/weeks/ months/ years) does this device last for?	Avg. price of device (Rs per unit)
1	Incandescent bulb			

2	CFL			
3	Tubes			
4	LED			
5	Chargeable torch			
6	Other (Please Specify)*			

* If using torch in mobile phone specify that also as other electric lighting device.

F10 Features of candle		
Number consumed/ month (Specify candle or pack)	Usage in hours per day	Avg. price of candle or pack (Rs per unit)

F11 Features of battery torch at home (non-rechargeable)				
	Number of cells	Number of times cells replaced per month	Avg. price of torch (Rs per unit)	Maintenance Cost (Rs per unit)**
Torch 1				
Torch 2				
Torch 3				

** If use-and-throw (Chinese) torch, then in 'Maintenance Cost' write **not applicable**

F12 Features of renewable energy devices other than SoUL used at home								
S. No.	Name of device	Purchase inspired by SoUL lamp (Yes/ No)	Number	Capacity	Initial investment (Rs)*	Working (Yes/ No)	Maintenance Cost (Rs per unit)	Year of purchase
1								
2								
3								

* If no investment has been made (grant/ donation), then in 'Initial investment' write **not applicable**

G. Willingness to pay for other Solar Products (Please tick in the appropriate circle)			
G3	**What are the solar energy related needs of the household?**	**Energy Needs**	**As you are aware, actual cost of SoUL lamp is Rs 500 but due to subsidy it is available for students at Rs 120. Keeping this in mind, how much you are willing to invest for the following uses?**
		◯ Lighting	
		◯ Cooking	
		◯ Irrigation	
		◯ Others (Please specify)	
		◯ None	

G.3.1 Preference of Lighting in the household			
G3.1	**What is the preferred source of lighting for the Household- Electricity; Kerosene Source; Solar Product? (Eg. Rank1 given to first preferred source etc.)**	**Energy Needs**	**Preferred Source of Lighting**
		Rank 1	
		Rank 2	
		Rank 3	
		Remarks (if any)	

G.3.2 Solar Needs		
G3.2	**Does SoUL lamp satisfy your child's study lighting needs? If No, then why?**	

H. Community Details (Please tick in the appropriate circle)		
H1	**Type of Card Holder (Please tick in the appropriate circle)**	
◯ Below Poverty Line (BPL)	◯ Antyoday	◯ Other (Please specify)
◯ Above Poverty Line (APL)	◯ No card	

H2	Primary Source of Income (Please tick only one)	
◯ Agriculture	◯ Labor	◯ Agriculture + Labor
◯ Service	◯ Dairy	◯ Skill-based occupation (carpentry, pottery, etc.)
◯ MGNREGS	◯ Remittance	◯ Other (Please specify)

H3	Religion (Please tick only one)		
	◯ Hindu	◯ Muslim	◯ Christian
	◯ Sikh	◯ Buddhist	◯ Jain
	◯ Other (Please specify)		

H4	Social Group (Please tick only one)	
	◯ Scheduled Tribe (ST)	◯ Scheduled Caste (SC)
	◯ Other Backward Caste (OBC)	◯ Nomadic/ Denotified Nomadic Tribe/ Vimukta Jati Nomadic Tribe (NT/ DNT/ VJNT)
	◯ Open (General)	◯ Other (Please specify)

H5	Name of caste/ tribe you belong to	

H6	Wealth Indicator					
Name of the asset	**#**	**Name of the asset**	**#**	**Name of the asset**	**#**
Radio		table		other asset 1	
Bicycle		chair		other asset 2	
motorcycle/scooter		mattress		other asset 3	
washing machine		bullock cart			
Fans		thresher			
Heaters		tractor			
colour television		buffalo			
b/w television		Cow			
telephone set/ mobile phone		bullock			
sewing machine		goats			
pressure cooker		cock/hen/duck			
Watches		Pigs			

H7 Household type: Tick the correct option		
Kacchha	**Semi- Pakka**	**Pakka**

H8: Preferred Activity for the children in the family					
How do all *MALE* children spend their non-schooling hours? Enlist three activities in which he spends most of his time and the number of hours spent on the same	**Activities**	**No. of Hours**	**How do all *FEMALE* children spend their non-schooling hours? Enlist three activities in which he spends most of his time and the number of hours spent on the same**	**Activities**	**No. of Hours**
Remarks (if any)			**Remarks (if any)**		

Signature of the respondent		Signature of the interviewer	

Please note the suggestions and complaints by the respondent below.

Interviewer's Notes:

A2. Household Control Survey Form

State	[Pre-printed]	District	[Pre-printed]	Block	[Pre-printed]

Form Number												Interviewer's Name	Date	Gram Panchayat	Village	Hamlet
			/					/								
Block code [Pre-printed]			/	Village code				/	Serial number							

A. Household Details						
A1	Full Name of respondent		A4	Full Name of head of household		
A2	Mobile Number		A5	Sex of head of household	◯ Male	◯ Female
A3	Number of Members in the family		A6	No of Rooms in the House(including Kitchen)		

B. Children's Details (Irrespective of receipt of SoUL lamp, applicable to all children from 5 to 17 years or up to 12th Class)								
	B1	B2	B3	B4	B5	B6	B7	B8
S. No.	Full Name	Age	Sex (M/F)	Does he/she go to school? (Yes/ No)	Class	Why has he/she not received SoUL lamp? (Specify the reason)	Which devices* do you use for studying (Specify all the devices, else specify the reason for not studying in the dark hours)	If, **for B7**, devices are used for studying, specify **time** of **study (mins/hours)**. If, **for B7**, no devices are used for studying, **go to C1**
1								
2								
3								
4								
5								
6								

*If studying in street light or community light (in temple) etc. then specify in B7

C1 Kerosene/ Other oil Purchased					
S. No.		Litre/s per month	Avg. Price per litre	Frequency (Number of trips for purchase per month)	Generally collected by whom? (specify whether Adult woman/Adult man/ Girl child/boy child)
1	Purchased from Govt. Ration shop - PDS				
2	Purchased from Market				

C2 Kerosene Used				
	Lighting	Cooking	Heating water	Other (Please specify)*
Consumption (litre/s per month)				

*Other use may also include resale, in vehicles, etc.

C3 Usage of other oil for lighting (For example, if used for lighting purpose, any of the cooking oils like groundnut, mustard, sunflower, etc.)			
Name of oil	Consumption (litre/s per month)	Avg. Price per litre	Device/s used

C4 Devices using kerosene/ other oil					
S. No.	Device	Do you use the device? (Yes/ No)	Quantity used*	Number of hours per day	Number of days per month
1	Chimni (Simple wick lamp)				
2	Hurricane lamp				
3	Wick stove				
4	Other (Please specify)				

*By "Quantity used" we mean number of devices they are actually using for lighting purpose and NOT the number of devices they possess.

C5 Do you have electricity at home? If "No" go to C12	◯ Yes	◯ No
C6 Do you have electric meter/ one point connection/ shared connection?	◯ Yes	◯ No
C7 Do you have inverter at home?	◯ Yes	◯ No
C8 Do you have generator at home?	◯ Yes	◯ No

C9 Interval of electricity bill receipt

◯ Not applicable	◯ Every month	◯ Every 3 months
◯ Every 6 months	◯ Every year	◯ Other (Please specify)

C10	**Electricity bill amount paid as per the above mentioned interval (Rs)**	

C11 Features of electric lighting devices (bulbs/ tubes) used at home

S. No.	Type of device	Number of devices	How much period (days/weeks/ months/ years) does this device last for?	Avg. price of device (Rs per unit)
1	Incandescent bulb			
2	CFL			
3	Tubes			
4	LED			
5	Chargeable torch			
6	Other (Please Specify)*			

* If using torch in mobile phone specify that also as other electric lighting device.

C12 Features of candle

Number consumed/ month (Specify candle or pack)	Usage in hours per day	Avg. price of candle or pack (Rs per unit)

C13 Features of battery torch at home (non-rechargeable)

	Number of cells	Number of times cells replaced per month	Avg. price of torch (Rs per unit)	Maintenance Cost (Rs per unit)**
Torch 1				
Torch 2				
Torch 3				

** If use-and-throw (Chinese) torch, then in 'Maintenance Cost' write **not applicable**

C14 Features of renewable energy devices used at home

S. No.	Name of device	Number	Capacity	Initial investment (Rs)*	Working (Yes/ No)	Maintenance Cost (Rs per unit)	Year of purchase

1							
2							
3							

* If no investment has been made (grant/ donation), then in 'Initial investment' write **not applicable**

D. Willingness to pay for other Solar Products (Please tick in the appropriate circle)			
D1	**What are the solar energy related needs of the household?**	**Energy Needs**	**As you are aware, actual cost of SoUL lamp is Rs 500 but due to subsidy it is available for students at Rs 120. Keeping this in mind, how much you are willing to invest for the following uses?**
		◯ Lighting	
		◯ Cooking	
		◯ Irrigation	
		◯ Others (Please specify)	
		◯ None	

D.2 Preference of Lighting in the household			
D.2	**What is the preferred source of lighting for the Household- Electricity; Kerosene Source; Solar Product? (Eg. Rank1 given to first preferred source etc.)**	**Energy Needs**	**Preferred Source of Lighting**
		Rank 1	
		Rank 2	
		Rank 3	
		Remarks (if any)	

E. Community Details (Please tick in the appropriate circle)		
E1	**Type of Card Holder (Please tick in the appropriate circle)**	
◯ Below Poverty Line (BPL)	◯ Antyoday	◯ Other (Please specify)

◯ Above Poverty Line (APL)	◯ No card	

E2	Primary Source of Income (Please tick only one)		
◯ Agriculture	◯ Labor	◯ Agriculture + Labor	
◯ Service	◯ Dairy	◯ Skill-based occupation (carpentry, pottery, etc.)	
◯ MGNREGS	◯ Remittance	◯ Other (Please specify)	

E3	Religion (Please tick only one)		
	◯ Hindu	◯ Muslim	◯ Christian
	◯ Sikh	◯ Buddhist	◯ Jain
	◯ Other (Please specify)		

E4	Social Group (Please tick only one)	
	◯ Scheduled Tribe (ST)	◯ Scheduled Caste (SC)
	◯ Other Backward Caste (OBC)	◯ Nomadic/ Denotified Nomadic Tribe/ Vimukta Jati Nomadic Tribe (NT/ DNT/ VJNT)
	◯ Open (General)	◯ Other (Please specify)

E5	Name of caste/ tribe you belong to	

E6	Wealth Indicator					
Name of the asset	**#**	**Name of the asset**	**#**	**Name of the asset**	**#**
Radio		table		other asset 1	
Bicycle		chair		other asset 2	
motorcycle/scooter		mattress		other asset 3	
washing machine		bullock cart			
Fans		thresher			
Heaters		tractor			
colour television		buffalo			
b/w television		cow			
telephone set/ mobile phone		bullock			
sewing machine		goats			
pressure cooker		cock/hen/duck			
Watches		pigs			

E7 Household type: Tick the correct option		
Kacchha	**Semi- Pakka**	**Pakka**

E8: Preferred Activity for the children in the family					
How do all *MALE* children spend their non-schooling hours? Enlist three activities in which he spends most of his time and the number of hours spent on the same	**Activities**	**No. of Hours**	**How do all *FEMALE* children spend their non-schooling hours? Enlist three activities in which he spends most of his time and the number of hours spent on the same**	**Activities**	**No. of Hours**
Remarks (if any)			**Remarks (if any)**		

Signature of the respondent		Signature of the interviewer	

Please note the suggestions and complaints by the respondent below.

Interviewer's Notes:

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