

Solar Micro-grids for Livelihood Enhancement in Rural Uttar Pradesh

Processes and baseline

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1. Background

The project “**Innovating to bring clean energy for livelihood generation in India**” initiated in the year 2009 with support from NFA aims towards undertaking a collaborative research on innovating to bring clean energy for livelihood generation of Indian rural communities spread across four geographic and demographic regions. The project aligns with the National Solar Mission in installation of off-grid systems to serve population without access to commercial energy.

One of the key tasks to execute the project is identification of appropriate livelihoods for intervention and to assess the changes in the lives of the people directly or indirectly using the clean energy interventions for income generation activities. The work package of the sub-project involves identification of sites and livelihood activities, energy needs assessment for the identified livelihood activities, baseline and change assessment. The scope of present report limits to reporting of inception phase activities and baseline study undertaken in the state of Uttar Pradesh. The report discusses;

1. Methodology adopted to identify intervention sites and energy needs assessments
2. Progression of business model development and the final business model
3. Technology adopted
4. Reporting of baseline

2. Pre-installation phase activities

Past project reports of TERI linked to clean energy interventions or energy surveys conducted in the state were reviewed to identify districts where TERI made interventions in past. Apart from completed project reports, clusters of Directorate of handlooms and handicrafts were identified in the state. In total, six districts were identified for undertaking a reconnaissance visit to identify intervention options;

1. Rai bareilli
2. Azamgarh
3. Faizabad
4. CSM Nagar1/Amethi
5. Barabanki
6. Unnao



Figure 1.1 District Map of Uttar Pradesh

¹ Chhatrapati Shahuji Maharaj (CSM) Nagar district is the newest district of the state of Uttar Pradesh. The district covers an area of 3,070 km². This district came into existence on 2012 by merging three tehsils of the erstwhile Sultanpur district, namely, Amethi, Gauriganj and Musafirkhana and two tehsils of the erstwhile Raebareli district, namely, Salon and Tiloi. Gauriganj town is the administrative headquarters of this district. The district is recently named as Amethi.

2.1 Reconnaissance visit to 50 villages

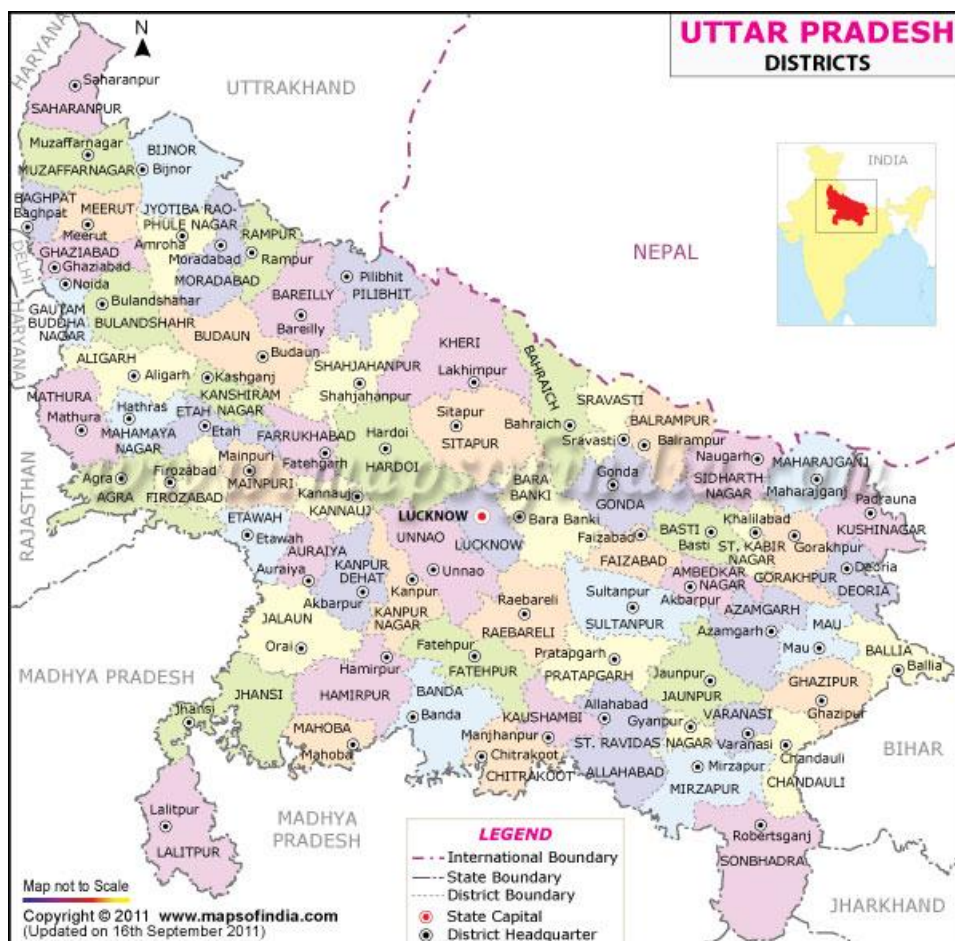


Figure 2 presents approach adopted in the implementation process. Reconnaissance visits were made across 50 villages including market places to understand energy scenario in the villages. In majority of the villages, the primary occupation revolved around agriculture whereas in about seven villages the primary occupation was related to handloom and two villages mentioned of the handicraft as primary means of income generation. In addition, hamlets were also visited where pottery works were the primary occupation. Interactions were made with three poultry unit owners and two gem cutting units. During the visit, the project team interacted with the community and village leaders to understand the livelihood profile and energy needs of the villages.

All the villages had same story to share- power cuts are regular feature from 5.00 PM to 9.00 PM. In addition, interactions revealed that electricity is provided for a week only during day time (5.00 AM to 5.00 PM) and only during night time (9.00 PM to 5.00 AM) the following week. All the villages have a small market place which houses enterprises linked to post harvest technologies, retail units, tent houses, tea shops, medical shops, tent house etc. In one village, handicraft activities are also carried out in the market place. However, handloom and handicraft units are located inside the dwelling place in all other villages.

Community interactions assessed the energy needs of the community in particular for the livelihood activities. The needs, in most cases be it household or enterprise, were linked to the basic energy needs of lighting during evening hours. The shop owners, grinding mill owners, SME owners, handloom and handicraft unit owners, poultry unit owners, all had one energy need in common, light during evening hours. There were customized energy needs such as power looms, powered spinning machines, power for irrigation, power for grinding machines etc.

The project team requested the community to prioritise their energy needs. Majority of the respondents prioritized lighting facilities during evening hours. Considering the budget allocated for hardware in the state, the team realized that if interventions are towards power generation for irrigation, grinding, power looms or such activities, then only a negligible proportion of the village population will reap the benefits. However, if the intervention is directed towards lighting, a considerable population can be influenced within the budget allocated for hardware. The project team along with the community decided to make interventions in the lighting sector.

One of the important and key drivers for developing the business model was sustainability- by and for the community. It was important that a villager preferably youth takes up the ownership of the decentralized generation unit and the end users are able to pay for the lighting services.

One of the primary mandates of the project is to support livelihood through clean energy. The team aimed to develop energy entrepreneurs who would invest, own and operate the decentralized generation units to provide light to the end users. The task ahead was to identify an appropriate clean energy technology which would provide quality light to the livelihood related units and identify energy entrepreneurs. The section further discusses the process framework followed in the pre-installation phase.

2.2 Development, identification and customization of the technology

Direct Current based solar Micro-grids were developed to meet specific energy demand of the smaller segments of community (10 to 100 households/shops/livelihood units). The micro grids operate through Direct Current (DC); thus reducing distribution loss compare to the Alternate Current (AC) based grids. Further, the panels are installed in modular units providing flexibility to the entrepreneur to make appropriate changes in the system based on the demand of the community.

2.3 Revisiting villages

All the villages were revisited after finalizing the technology and business model. Awareness was created on the Solar DC based Micro Grids along with its utility. Village youths were requested to express their interest to be clean energy entrepreneurs. The entrepreneurs were termed as “Energy Provider”.

2.4 Assessment of Energy Providers

Approximately 50 people expressed their interest to be Energy Provider. Jawaharlal Nehru National Solar Mission (JNNSM) guidelines for Off Grid and Decentralized Solar Applications indicate provision of subsidy @ INR 150 per Wp which was calculated approximately 35-45% of the total hardware and installation cost. The team initially decided to limit project contribution as 45% of the total hardware and installation cost.

The energy providers were interviewed at their residence or work locations. The assessment criteria included investment capacity, ability to read and write, basic communication skills, credibility in immediate society, repayment of past loans (if any), and soft skills such as enthusiasm to run an enterprise. Opinions of the village leaders were also one of the guiding factors for selection of Energy Providers.

The selection process took almost two months and finally the project team identified 40 energy providers. At the end, 23 agreed to be Energy Providers.

The project moved with 23 Energy Providers, 30 sites and 34 micro-grids

2.5 Baseline survey

The baseline survey captured information at 25 sites.

2.5.1 Methodology for baseline survey

Development of indicators: Context specific indicators were developed and finalized through a brain storming session.

2.5.1.1 Levels of Baseline: Baseline was conducted at two levels;

- a. Enterprise performance: Information on energy needs of the enterprises were captured through Enterprise Performance schedules in the sites where the lighting provisions were to be provided to any income generation unit such as retail unit, poultry, handloom, handicraft, pottery and so on.
- b. Quality of life: Quality of life schedule captured information on employment, education and skill status, income security, household energy, assets and health status.

Table 1 consolidates different levels of surveys.



Table 1.1 Survey levels

Level	Tool	Respondents
Village level information	Key person's interview- ONE PER VILLAGE	Village <i>Pradhan</i> ^{2/} <i>Panchayat</i> ³ Member/ School teacher (if residing in the village), SHG leader, block level officer
Identification of Energy Providers	Structured interview	Potential Energy Providers
Baseline for Energy Providers and End Users	Structured interview for enterprise performance	Identified energy providers and end users
	Household schedule for quality of life	Identified energy providers and end users

2.6 Business model

Based on the assessment of baseline information on ability and willingness to pay by the end users, and various combinations of revenue models in the cash flow, monthly revenue of INR 150 was identified as the most suitable options in terms of profitability of the energy providers. INR 150 per month is also comparable to the expenditure incurred on convention fuels for lighting and lesser than INR 6-8 per day for connection charges for diesel generator based lighting facilities.

² Head of village level governing body

³ Village level governing body

2.7 Investment sharing

Considering the investment ability of all the entrepreneurs and payback period, the final investment sharing was decided as 55% from the project fund and 45% as Energy Provider's contribution. 14 Energy providers opted loan facility from Regional Rural Banks (RRB) at the interest rate of 12.75 % for a repayment period of five years.

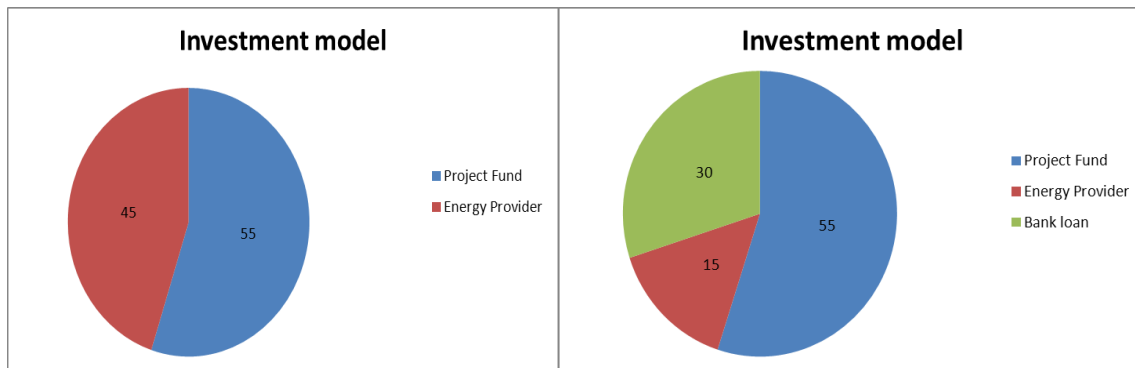


Figure 1.5 Investment model (without loan facility)

Figure 1.4 Investment model (with loan facility)

3. Installation phase

Finally, 34 Solar Micro-grids were installed considering willingness and ability to invest by the energy provider at the time of installation. **In total there are 23 entrepreneurs, 30 sites and 34 micro-grids.**

Table 3.1 Installation site details

SL	Name of Entrepreneur	SITE			Connection (In number)	Supplier	Number of micro-grids	End user category	Baseline conducted
		Village	Block	District					
1	Pankaj Srivastava	Shivgarh	Shivgarh	Rai Bareli	95	Steca-bergen	2	Market Place	Yes
2	Lakshmi Prasad	Kalu khera	Asoha	Unnao	100	India Solar Solution	2	Market Place	Yes
3	Pawan Kumar Tiwari	Pure Tiwaripur	Triwediganj	Barabanki	20	India Solar Solution	1	Households	Yes
4	Ashish Dikshit	Amilahara	Haidergarh	Barabanki	20	India Solar Solution	1	Households	Yes
5	Indra Mohan Singh	Gulalpur	Haidergarh	Barabanki	20	India Solar Solution	1	Households	Yes
6	Kapil Dubey	Misrauli	Jagdishpur	Amethi	20	Steca-bergen	1	Households	Yes
7	Ram Krishna	Dakhin goan	Jagdishpur	Amethi	20	Steca-bergen	1	Households	Yes
8	Sidharth Mishra	Phanhuna	Singhpur	Amethi	40	Steca-bergen	1	Market Place	Yes
9	Sidharth Mishra	Phanhuna	Singhpur	Amethi	40	Steca-bergen	1	Market Place	Yes
10	Sidharth Mishra	Rajafatehpur	Singhpur	Amethi	40	Steca-bergen	1	Market Place	No
11	Sidharth Mishra	Rajafatehpur	Singhpur	Amethi	40	Steca-bergen	1	Market Place	No
12	Shah Alam Ansari	Kintoor	Siroli	Barabanki	25	India Solar Solution	1	Handicraft units	Yes
13	Md. Naushad Ahmad	Chaksikhti,	Sathiyaon	Azamgarh	100	Pawan Energy India Pvt. Ltd	1	Handloom units	Yes
14	Md. Shareef	Naveda	Sathiyaon	Azamgarh	40	Pawan Energy India Pvt. Ltd	1	Handloom units	Yes
15	Md. Bailal	Rasoolpur	Sathiyaon	Azamgarh	20	Pawan Energy India Pvt. Ltd	1	Handloom units	Yes
16	Ayodha prasad	Jamo	Jamo	Amethi	40	Steca-bergen	1	Market Place	Yes
17	Ayodha prasad	Jamo	Jamo	Amethi	80	Steca-bergen	2	Market Place	Yes
18	Ayodha prasad	Jamo	Jamo	Amethi	40	Steca-bergen	1	Market Place	Yes
19	Rahul Gupta	Mohna	Bajarsukul	Amethi	40	Steca-bergen	1	Market Place	Yes

SL	Name of Entrepreneur	SITE			Connection (In number)	Supplier	Number of micro-	End user category	Baseline conducted
20	Rahul Gupta	Raniganj	Jagdishpur	Amethi	100	Steca-bergen	2	Market Place	Yes
21	Rahul Gupta	Mohna	Bajarsukul	Amethi	40	Steca-bergen	1	Market Place	Yes
22	Mehdi hasen	Pure zalim	Musaffir khana	Amethi	40	Steca-bergen	1	Market Place	Yes
23	Sushil Kumar Jaiswal	Kadipur	Sidhaur	Barabanki	40	India Solar Solution	1	Market Place	Yes
24	Dinesh Kumar pandey	Pure Pandey, Saidpur	Mawai	Faizabad	40	India Solar Solution	1	Market Place	Yes
25	Dinesh pal	Godiyani ka purva	Jagdishpur	Amethi	10	Steca-bergen	1	Households	Yes
26	Pappu Khan	Jainamganj	Bajarsukul	Amethi	40	Steca-bergen	1	Market Place	Yes
27	Ram Milan	Bamhrauli	Haidergarh	Barabanki	20	India Solar Solution	1	Households	Yes
28	Ram Sukh Varma	Manikapur	Triwediganj	Barabanki	40	India Solar Solution	1	Market Place	Yes
29	Nanhe Babu	Katehti	Jagdishpur	Amethi	10	Steca-bergen	1	Poultry	Yes
30	Vikas Jaiswal	Rasoolpur chauraha	Sidhaur	Barabanki	40	India Solar Solution	1	Market Place	Yes
TOTAL					1260		34		

3.1 Technology

The project aims towards enhancing rural livelihoods through provisions of renewable based technologies. Uttar Pradesh has been identified as one among the four states for interventions assessing the poor rural electrification scenario. To promote renewable energy for livelihoods on sustainable basis, it is binding to develop business model where the rural inhabitants themselves invest, operate and are able to generate revenue from the renewable based enterprise.

The technology identified for addressing the mentioned energy gap is solar micro grid. Photovoltaic power panels are installed in modular units allowing generation capacity to scale up easily to meet community demand. Power is generated during the day but consumed at night. To bridge this gap, one or two battery banks charge during the day while power is being generated and discharges at night when consumers are lighting their houses. Power is distributed over a short distance from the battery banks to the cluster of households or business centers (each cluster comprises of 10 to 100 households or business centers) within the village. Low voltage electricity is distributed for 4 hours each night to power the household lights. By utilizing LED lights, power consumption per household is reduced, thus reducing the requirements to distribute large quantities of power. Each household / business center is provided with one or two LED lights. These lights will provide lighting far superior to kerosene at a lower cost.

In total 23 energy providers⁴ at various locations covering five districts are identified. The system capacities ranges from 60 Wp to 1000 Wp depending on the Energy Provider's ability to invest and number of end users willing to take up connections. As per date, the approximate number of potential end users stands at 1300.

3.2 Technology selection

As from the energy demand analysis it was observed that power requirement was very low, therefore it was decided to go for a DC micro grid. Due to less no. of houses and only lighting load Solar PV was found the best technology for the DC Micro grid.

3.2.1 DC Micro Grid Technology

The interest in DC micro grids over the past 10 years has been growing. A micro grid consists of interconnected distributed energy resources capable of providing energy to a significant portion of internal load demand. A DC micro grid can be deployed in a portion of a building, building-wide or covering several buildings.

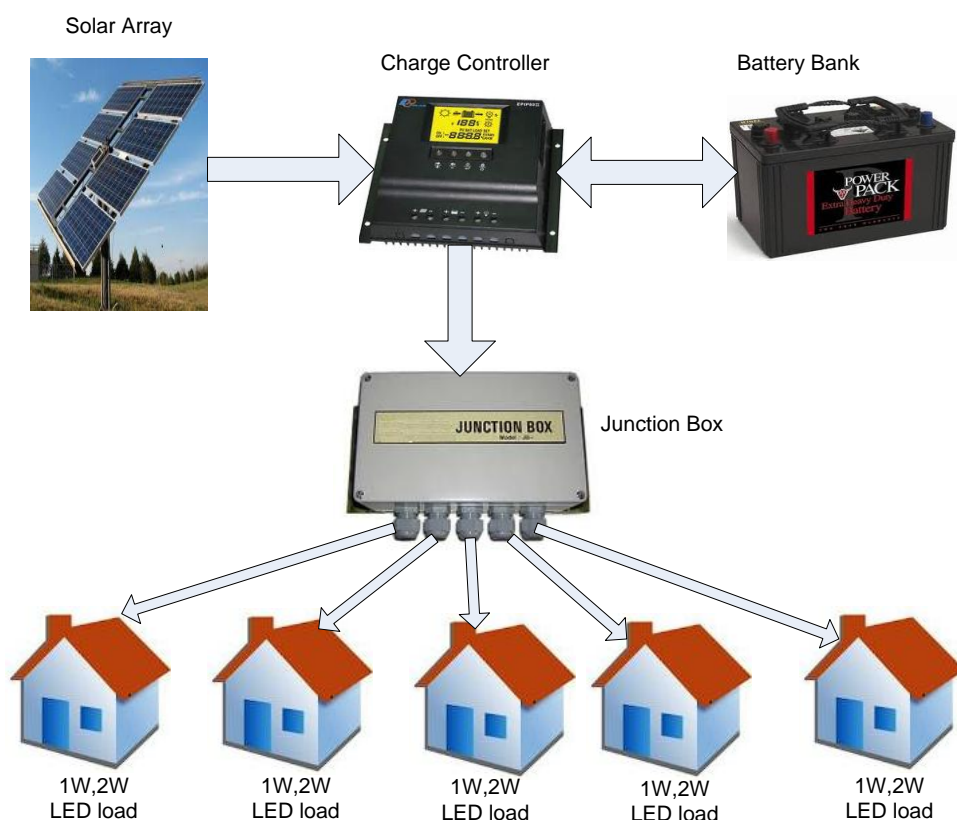


Figure 3.1 Schematic for a DC Micro Grid

⁴ Energy provider is a villager who is capable and agrees to invest and operate solar micro grid under the above mentioned project

This defined physical area that the DC micro grid serves is an important element when considering the deployment—more so than power level—because an important design consideration of DC networks at these voltages has to do with scale. DC power is highly susceptible to impedance (or resistance) losses, which are those imposed by the transmission medium itself, usually wire. The nature of DC is such that resistance can quickly sap power, but the efficiencies of DC systems—as we shall see—are dramatic and must be considered in deciding the scale of a DC system. Better redundancy is only the beginning benefit a DC network brings because a DC Network does not need the ubiquitous AC to DC converting power supply for every electronic device. DC micro grids have superior compatibility of the DC power with electricity storage. During every major grid blackout (or brown-out, as periods of insufficient power production are called) experts note that further development of grid-scale power storage would vastly improve the stability of the grid.

In a DC system, only the voltage needs to be considered, whereas AC systems require each element to have identical wave shapes—or be synchronized—to operate. Therefore, given a suitably robust generator and ample storage, we now have quite an efficient local grid network that uses solar PV and integrates electrical storage at higher efficiencies than are possible in a conventional AC system. By locally managing sources and loads, a DC micro grid can optimize its net surplus of power (output to the grid) or deficit (input from the grid). This local management of both supply and demand creates a buffer to the grid and relieves some of its burden.



Figure 3.2 Solar Micro-grid

3.3 Proposed Configurations of DC Micro Grids at different project sites

Table 3.2 Technical specification of each configuration for a DC micro-grid

Particulars	75 Wp (Watt peak) capacity system	150 Wp capacity system	220 Wp capacity system	300 Wp capacity system	800 Wp capacity system
Systems Voltage	12 Volts	24 Volts	24 Volts	24 Volts	24 Volts
Solar modules	1 Unit (75 Wp)	2 Units (75 Wp each)	2 Units (110 Wp each)	2 Units (150 Wp each)	8 Units (100 Wp each)
Solar Batteries	12V-75Ah (1 Unit 12 Volts, 75 Ah)	24V-75Ah (2 Unit 12 Volts, 75 AH)	24V-100Ah (2 Units 12 Volts, 100 Ah)	24V-150Ah (2 Units 12 Volts, 150 Ah)	24V-400Ah (8 Units 12 Volts, 100 Ah)
Charge Controller	1 Unit (12 Volts, 10 Ampere)	1 Unit (24 Volts, 10 Ampere)	1 Unit (24 Volts, 20 Ampere)	1 Unit (24 Volts, 20 Ampere)	1 Unit (24 Volts, 30 Ampere)
LED Luminary (households)	1 Watt (10 Units), 2 Watts (10 Units)	1 Watt (20 Units), 2 Watts (20 Units)	1 Watt (30 Units), 2 Watts (30 Units)	1 Watt (40 Units), 2 Watts (40 Units)	1 Watt (100 Units), 2 Watts (100 Units)
LED Luminary (shops)	3 Watts (10 Units)	3 Watts (20 Units)	3 Watts (30 Units)	3 Watts (40 Units)	3 Watts (100 Units)
Light Intensity (households)	100-120 Lumens for 1 Watt and 220-240 Lumens for 2 Watts	100-120 Lumens for 1 Watt and 220-240 Lumens for 2 Watts	100-120 Lumens for 1 Watt and 220-240 Lumens for 2 Watts	100-120 Lumens for 1 Watt and 220-240 Lumens for 2 Watts	100-120 Lumens for 1 Watt and 220-240 Lumens for 2 Watts
Light Intensity (shops)	330-360 Lumens for 3 watts	330-360 Lumens for 3 watts	330-360 Lumens for 3 watts	330-360 Lumens for 3 watts	330-360 Lumens for 3 watts
Number of HH / BC covered	10	20	30	40	100
Number of light points per household	2 light points - 1 Watt & 2 Watts	2 light points - 1 Watt & 2 Watts	2 light points - 1 Watt & 2 Watts	2 light points - 1 Watt & 2 Watts	2 light points - 1 Watt & 2 Watts
Number of light points per shop	1 light point - 3 Watts	1 light point - 3 Watts	1 light point - 3 Watts	1 light point - 3 Watts	1 light point - 3 Watts
Hours of operation in a day	4 hours	4 hours	4 hours	4 hours	4 hours

3.4 Institutional Model

The energy provider decides the scale of connections based on their investing capacity. The system size ranges from 1000 Wp to 75 Wp, with majority being of 300 Wp capacity. Based on the guidelines of National Solar Mission and considering the overall economics and payback period, the investment share from MFA and TERI on total system cost (including LED lights and installation cost) has been identified at 55 per cent. The entrepreneur in consultation with the end users has identified tariff, which for most of the sites is INR 5 per day.

The Energy Providers are the investors, operators and owners of the solar micro-grid system. Other key players in the framework are funding institution, regional rural banks and the Panchayat. Usage charges were decided by the end users and Energy Providers jointly to address the issue of affordability.

The ownership of the systems is transferred to the core actors- the Energy Providers.

Local Energy Entrepreneurs, operators and technicians are trained to provide after sales service support to the SMGs, for ensuring reliable and sustainable service for a longer period of time. These SMGs are linked to the network of 55 Energy Entrepreneurs across India who is trained to take up retailing, installations and repairs of solar based lighting products.

3.5 Economics

The average system and installation cost per Watt peak (Wp) was calculated as INR 380. (Please refer table 1 for total system and installation cost). Considering the investment capacity of the energy providers and to reduce perceived financial risks in the new technology, 55% of the system and installation cost per site was shared from the project fund.

Table 3.3 Solar Micro Grids: Investments and returns

System capacity (Wp)	System and installation cost (INR)	Cost per Wp (INR)	Energy Providers Share (45% of the total system and installation cost) (INR)	Yearly revenue (INR)	Break even
75	30155	382	13578	18104	Year 2
150	62273	436	28028	36153	Year 1
300	125255	436	56384	70780	Year 1
400	145541	382	65491	72307	Year 1
600	231753	382	104261	144614	Year 1
800	312130	382	140469	177768	Year 1
1000	363115	382	163372	180767	Year 1
Average	181476	382	81631	74433	



Figure 3.3 Solar photovoltaic panels

3.6 Involvement of Banks

Two Regional Rural Banks (RRB) with intensive network in the intervention districts developed circular for the branches for providing loan to the interested energy providers at the interest rate of 12.50 with repayment period of five years. The cash flow indicates break even in year one to two years depending on the system capacity. The banks followed their due diligence process of approving loan applications which also includes assessment of financial feasibility of the project.

4. Situational analysis of enterprises: reporting of baseline

The objective of baseline survey was twofold;

1. To understand primary energy needs of the community for income generation activities as well as in household sectors
2. To create baseline scenario on energy usage for livelihood activities to assess change resulting out of interventions

Based on the primary income generation activities of the majority of the end users, the sites are classified as:

1. Handicraft
2. Handloom
3. Households
4. Market place
5. Poultry

Table 4.1 Sample size

Row label	Total Connections (Number of enterprises/households)	End User-sample (Number of enterprises/households)	Confidence interval	Confidence Level (%)	Energy Provider (Number)	Grand Total (Total number of respondents)
Handicraft	25	11 (44%)	22.05	95	1	12
Handloom	160	80 (50%)	7.77		95	3
Household	130	94 (72%)	4.80		95	8
Market	935	194 (21%)		5.11	95	11
Poultry	10 (one poultry unit)					1
Grand Total		379				24
						403

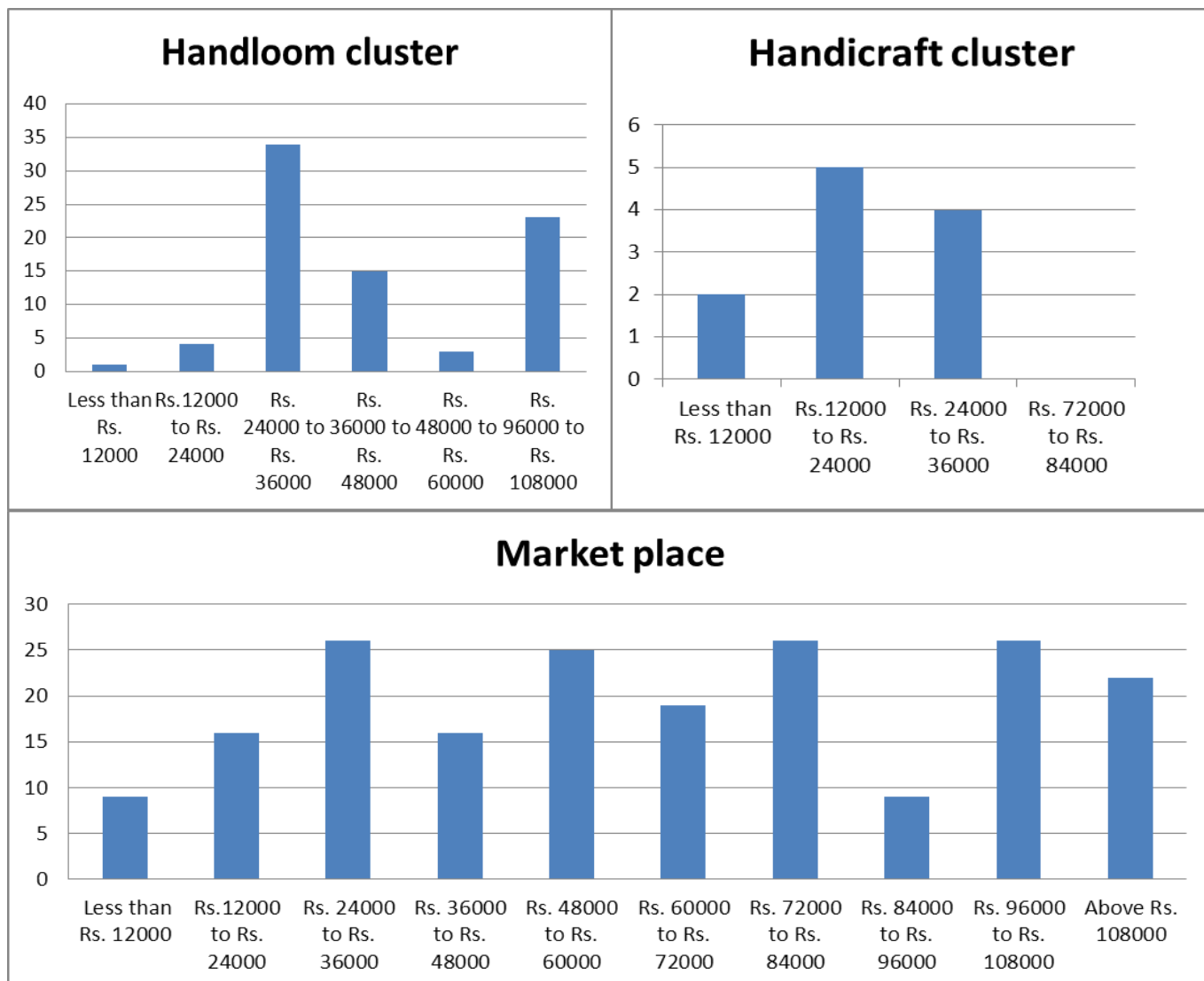
The further sections discuss the baseline scenario of the Energy Providers as well as end users.

4.1 Revenue generated from the sale of products/services

Table 4.2 Revenue generated- in the past one year from sale of products/services

Revenue generated- in the past one year from sale of products/services (No. of enterprises)						
Range of revenue generated	End User		Energy Provider		Grand Total	
	HHs/ Enterprise	% of Column Total	HHs/ Enterprise	% of Column Total	HHs/ Enterprise	% of Column Total
Handicraft cluster	11	3.86%	1	6.25%	12	3.99%
Less than Rs. 12000	2	0.70%		0.00%	2	0.66%
Rs.12000 to Rs. 24000	5	1.75%		0.00%	5	1.66%
Rs. 24000 to Rs. 36000	4	1.40%		0.00%	4	1.33%
Rs. 72000 to Rs. 84000		0.00%	1	6.25%	1	0.33%
Handloom cluster	80	28.07%	3	18.75%	83	27.57%
Less than Rs. 12000	1	0.35%		0.00%	1	0.33%
Rs.12000 to Rs. 24000	4	1.40%	1	6.25%	5	1.66%
Rs. 24000 to Rs. 36000	34	11.93%		0.00%	34	11.30%
Rs. 36000 to Rs. 48000	15	5.26%	1	6.25%	16	5.32%
Rs. 48000 to Rs. 60000	3	1.05%	1	6.25%	4	1.33%
Rs. 96000 to Rs. 108000	23	8.07%		0.00%	23	7.64%
Households		0.00%		0.00%		0.00%
(blank)		0.00%		0.00%		0.00%
Market place	194	68.07%	11	68.75%	205	68.11%
NA		0.00%	1	6.25%	1	0.33%
Less than Rs. 12000	9	3.16%		0.00%	9	2.99%
Rs.12000 to Rs. 24000	16	5.61%		0.00%	16	5.32%
Rs. 24000 to Rs. 36000	26	9.12%		0.00%	26	8.64%
Rs. 36000 to Rs. 48000	16	5.61%		0.00%	16	5.32%
Rs. 48000 to Rs. 60000	25	8.77%		0.00%	25	8.31%
Rs. 60000 to Rs. 72000	19	6.67%	1	6.25%	20	6.64%
Rs. 72000 to Rs. 84000	26	9.12%		0.00%	26	8.64%
Rs. 84000 to Rs. 96000	9	3.16%		0.00%	9	2.99%
Rs. 96000 to Rs. 108000	26	9.12%	1	6.25%	27	8.97%
Above Rs. 108000	22	7.72%	8	50.00%	30	9.97%
Poultry		0.00%	1	6.25%	1	0.33%
Rs. 72000 to Rs. 84000		0.00%	1	6.25%	1	0.33%
Grand Total	285	100.00%	16	100.00%	301	100.00%

Figure 4.1 Revenue generated in the past one year from sale of products/services among end users



No particular trend is observed among end users in terms of total revenue generation from sale of services or products. About 50% of the end users reported annual income of more than one lakh.

4.2 Fuel usage for production or processing purpose

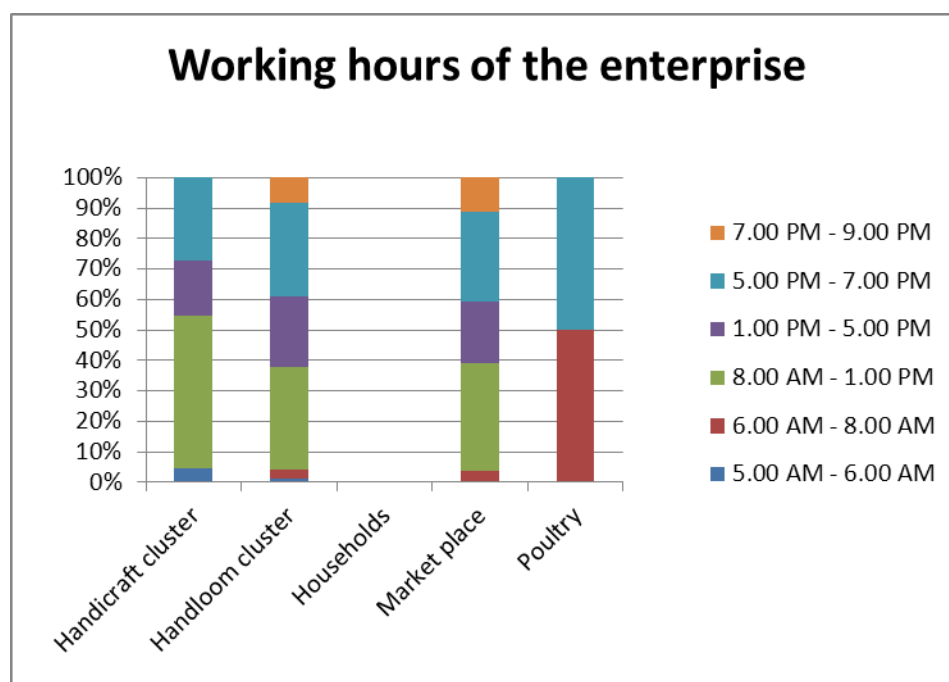
Table 7 indicates that only 22 enterprises out of 205 in the market place use fuel for production or processing. Majority among these are teashops which use fuel for cooking purpose.

Table 4.3 Fuel used for manufacturing, service providing, processing, repairing

							(No. of enterprises)
Fuel used for manufacturing, service providing, processing, repairing	Automobile repair	Heating	NA	Operate generator	Others	Grand Total	
Handicraft			12			12	
None			12			12	
Handloom			83			83	
None			83			83	
Household							
(blank)							
Market place	1	21	162	1	20	205	
Coal/coke					2	2	
Diesel				1		1	
Electricity	1				18	19	
Firewood		14				14	
Kerosene		1				1	
LPG		6				6	
None			162			162	
Poultry			1			1	
None			1			1	
Grand Total	1	21	258	1	20	301	

4.3 Working hours

Handicraft and handloom units depend entirely on family labour. In market places, 22 shops reported to hire one labour whereas 170 shops sustains on family labour. No shop reported to hire female labour. Majority of the enterprises reported working hours in between 8.00 AM and 1.00 PM, and 5.00 PM and 7.00 PM. 72% of the enterprises reported of 7-8 hours of daily work while 20% enterprises work for 9-10 hours.



(Unit: No. of enterprises)

4.4 Electrification status

Table 4.4 Availability of electricity at the time of need

Availability of electricity (No. of enterprises)						
Availability of electricity	Handicraft	Handloom	House hold	Market place	Poultry	Grand Total
1-2 days in a week		63 (76%)		6 (3%)		69 (23%)
3-4 days in a week	1 (8%)	19 (23%)		8 (4%)		28 (9%)
Available every alternate week	11 (92%)	1 (1%)		156 (76%)	1 (100%)	169 (56%)
Enterprise don't have electricity connection				35 (17%)		35 (12%)
Grand Total	12	83		205	1	301

Note: Figures in parenthesis are % with base as column total

About 76% of the retail units and 92% of the handicraft units reported availability of electricity every alternate week (Refer table 8). Majority of the handloom units are able to access electricity at the time of need only for one or two days a week.

Table 4.5 Alternate lighting arrangement during evening hours

Alternate lighting arrangement for evening hours				(No. of enterprises)		
Alternate lighting arrangement for evening hours	Handicraft	Handloom	Households	Market place	Poultry	Grand Total
Battery operated light	1 (8%)			89 (43%)		90 (30%)
Candle				3 (1%)		3 (1%)
CFL				4 (2%)		4 (1%)
Incandescent bulb				2 (1%)		2 (1%)
Kerosene lantern	1 (8%)	26 (31%)		22 (11%)	1 (100%)	50 (17%)
Kerosene wick lamp	3 (25%)	11 (13%)		17 (8%)		31 (10%)
None		45 (54%)		40 (20%)		85 (28%)
Petro-max	7 (58%)	1 (1%)		28 (14%)		36 (12%)
Grand Total	12	83		205	1	301

Note: Figures in parenthesis are % with column total

Battery operated lights are the most preferred alternative in absence of electricity among the retail unit owners. About 20% of the shops close during evening hours in case of power cuts.

4.5 Willingness to pay

All the respondents among the handicraft and handloom category expressed their willingness to pay for the lighting facility. 88% of the respondents who are retail unit owners also agreed to pay for the lighting facilities through clean energy sources.

Table 4.6 Willingness to pay for the lighting facility through Solar Micro grid

Willingness to pay			(No. of enterprises)			
Willingness to pay	Handicraft	Handloom	Households	Market place	Poultry	Grand Total
Can't say				6%		4%
NA					100%	0%
No				6%		4%
Yes	100%	100%		88%		91%
Grand Total	12	83		205	1	301

5. Situational analysis at household level: reporting of baseline

The handicraft and handloom units are located inside the residential premises and in majority of these units almost all household members contribute their labour in some form. The retail units are located in market places located within or outside the residential area of the villages, however within the village premises. The chapter provides the household scenario of the end-user categories- household, handicraft, handloom and poultry. The reporting is also made for the market places.

5.1 Households Below Poverty Line (BPL)

Table 11 indicates that about 56% of the retail unit owners belong to households possessing BPL cards. The study does not make any attempt to calculate the monthly or yearly income of the households to classify households as BPL. The classification of APL and BPL is based purely on the possession of BPL card by the household.

Table 5.1 Proportion of BPL households

Possession of BPL card				
End user's category	No (No. of households) (% with base as row total)	Yes (No. of households) (% with base as row total)	Grand Total (No. of households)	
Handicraft cluster		67%	33%	12
Handloom cluster		73%	27%	83
Households		55%	45%	102
Market place		44%	56%	205
Poultry		100%	0%	1
Grand Total		216	187	403

5.2 Primary income source

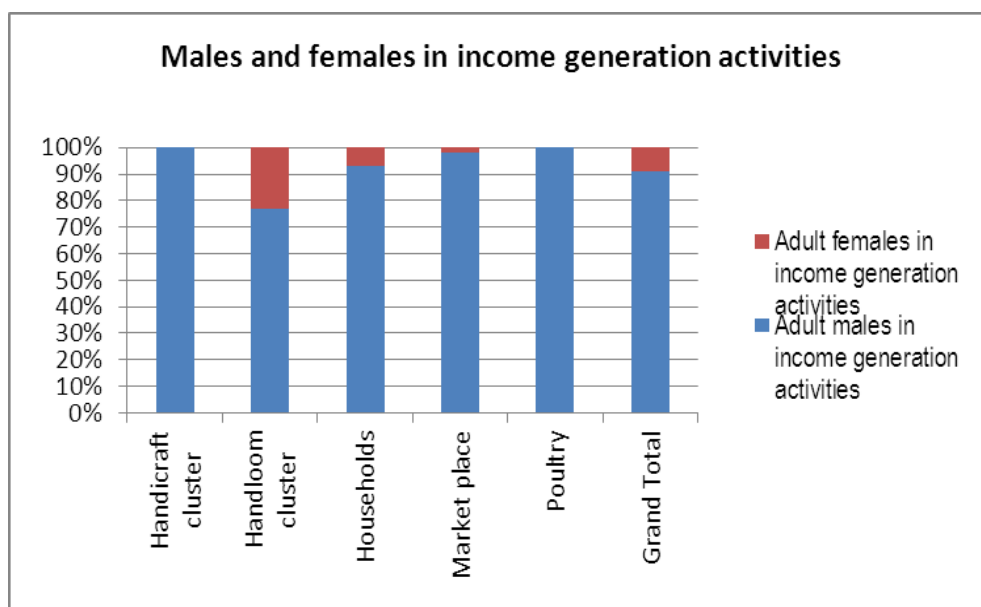
92% of the respondents among the handicraft category and 93% of the respondents among the handloom category reports handicraft or handloom units as the primary source of income generation. Among the respondents from market place, 80% mentions that retail units as their primary source of income. In majority of the cases, the project intervention directly impacts the primary income source of the households.

Table 5.2 Primary income source of the households

Primary income source	End user's category		Households	(% with base as column total)			Grand Total
	Handicraft	Handloom		Market place	Poultry	(No. of households)	
Cattle rearing/sale of milk and milk products			4%	1%			1%
Farming on own agricultural land/leased in land			75%	11%			25%
Government service			2%				1%
Labour work in agriculture			5%				1%
Labour work in industry/mines/public works			3%				1%
Leases out agricultural land			2%				1%
No income source							
Others			4%	2%	100%		2%
Owns small business	8%	7%	4%	80%			43%
Pension							
Production and sale of handloom/handicraft products	92%	93%					22%
Provides health services							
Regular service in private sector/industry			1%				
Works in shop/restaurant/tea shops/sweet shops				2%			1%
Grand Total	12	83	102	205	1		403

5.3 Engagement of males and females in income generation activities

Figure 6 clearly indicates that the proportion of females directly contributing to income generation is negligible among the households across handicraft and poultry units. About 25% of the females among the handloom category are directly engaged with the income generation activities.



(Unit: No. of households)

Figure 5. 1 Engagement of males and females in income generation activities

About 76% of the households reported females' involvement with expenditures related to food and clothes. In about 20% households, females manage expenditures on children education in addition to food and clothes. Only 6% of the households among the handloom category mention that female members are actively involved in buying raw materials and selling products. The total proportion of females involved in managing purchase of raw materials/equipment as well as sale of finished products is mere 3%.

Table 4.7 Nature of women's involvement in managing household income and expenditure

Nature of women's involvement	Nature of women's involvement					
	Handicraft	Handloom	Households	Market place	Poultry	Grand Total
Buying necessary raw material and equipment	0%	0%	2%	0%	0%	1%
Buying necessary raw material and selling produce	0%	6%	1%	2%	0%	2%
Expenditure on children education	0%	0%	0%	1%	0%	1%
Expenditure on food and clothes	100%	71%	88%	70%	100%	76%
Expenditure on food, clothes and children education	0%	23%	9%	26%	0%	20%

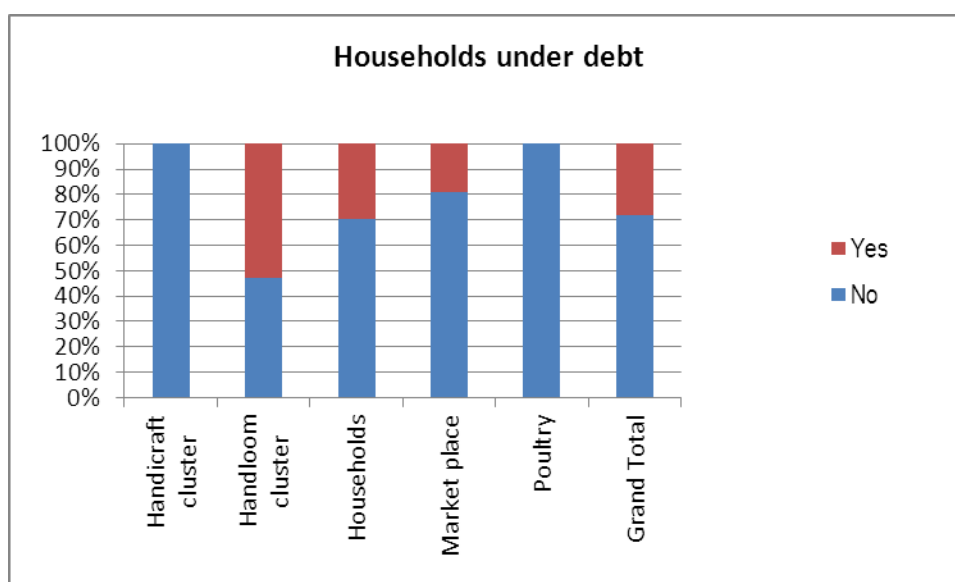
Nature of women's involvement	(% with base as Column total)					
	(No. of households)					
Grand Total	12	83	102	205	1	403

5.4 Income security

38% of the households possess no savings during the time of baseline survey whereas 19% reports of savings in the range of INR 10 to 1000. None among the handloom or handicraft units reported of savings above INR 1500 on the date of survey.

Present Cash Savings	(% with base as column total)					
	(No. of households)					
Present Cash Savings	Handicraft	Handloom	Households	Market place	Poultry	Grand Total
Nil		29%	37%	44%		38%
Rs 10 and Rs 400	50%		15%	2%		6%
Rs 400 and Rs 1000	42%	25%	10%	7%		13%
Rs 1000 and Rs 1500	8%	46%	8%	2%		13%
Rs 1500 and Rs 3000			21%	4%		7%
Rs 3000 and Rs 6000				11%		6%
Rs 6000 and Rs 12000				17%		9%
More than Rs 12000			10%	11%	100%	8%
Grand Total	12	83	102	205	1	403

“At least one household member is under debt at the time of survey”, reports 53% of the households in the handloom category. The corresponding figure for the market place category is 20%. About 90% households report bank as the loaning institution while others mentions of taking loan either from informal sources or SHGs. Only five household reports association with any SHG/cooperative.



(Unit: No. of households)

Figure 5.2 Households under debt

5.5 Education

Among the households which reported members attending primary and secondary schools, 82% mentions that the students study for up to 2 hours a day.

Table 5.3 Average number of hours of study

Average number of hours of study	(% with base as column total) (No. of households)					
	Handicraft	Handloom	House holds	Market place	Poultry	Grand Total
None	11%	0%	34%	9%	0%	14%
Up to 2 hours	78%	100%	64%	84%	100%	82%
More than 2 hours	11%	0%	3%	7%	0%	4%
Grand Total	9	59	74	112	1	255

About 52% of the households reported that the school going children prefer to study during evening hours. Provision of clean and quality light at households would definitely create convenience for the children who prefer to study during evening hours. 40% of the school going children study during early morning as well as evening time at home.

Table 5.4 Time of study

Time of study	(% with base as column total) (No. of households)				
	Handicraft	Handloom	Households	Market place	Grand Total
Afternoon		2%	2%	15%	8%
In early morning and evening		39%	29%	49%	40%
In the evening	100%	59%	69%	35%	52%
Grand Total	8	59	49	99	215

5.6 Cooking energy

Majority of the households among the handloom clusters, households and market places use fire wood as primary cooking fuel. Two major determinants of usage of LPG as primary cooking fuel are supply and affordability. The identification of reasons for usage of the mentioned primary cooking fuel was not under the scope of study.

Table 5.5 Primary fuel for cooking

Primary Fuel for Cooking	(No. of households) (% with base as column total)					
	Handicraft	Handloom	Households	Market place	Poultry	Grand Total
Firewood	50%	73%	90%	55%	0%	67%
LPG	50%	27%	10%	45%	100%	33%
Grand Total	12	83	102	205	1	403

5.7 Household electrification

40% of the respondent households among the household category are un-electrified. In total, only 16% of the households are un-electrified. The project intervention would directly impact the electrification status of the un-electrified households among the categories-household, handloom and handicraft.

Table 5.6 Household electrification status

Electrification status of the households	(% with base as column total) (No. of households)					
	Handicraft cluster	Handloom cluster	Households	Market place	Poultry	Grand Total
Un-electrified		1%	40%	11%		16%
Electrified	100%	99%	60%	89%	100%	84%
Grand Total	12	83	102	205	1	403

Un-electrified households depend on kerosene lamps as lighting device. Incandescent bulbs are popular lighting device among handloom clusters whereas the most popular lighting device in the market places is CFL. Incandescent bulbs are commonly used in the handloom units.

Table 5.7 Primary lighting device

Primary lighting device ,						
(% with base as column total) (No. of households)						
Primary lighting device	Handicraft	Handloom	Households	Market place	Poultry	Grand Total
CFL	58%	11%	17%	47%	100%	32%
Incandescent bulb	42%	88%	43%	40%		51%
Kerosene lamp		1%	40%	11%		16%
Solar lantern				1%		
Tube light						
Grand Total	12	83	102	205	1	403

Kerosene lamps are the most popular devices for lighting. A considerable number of households among the handicraft and household category use battery operated lights as secondary device for lighting. 2% of the households reports usage of solar lanterns during power cuts.

Table 5.8 Secondary lighting device

Secondary lighting device ,						
(% with base as column total) (No. of households)						
Secondary lighting device	Handicraft cluster	Handloom cluster	Households	Market place	Poultry	Grand Total
Battery operated light	50%	0%	14%	7%	0%	9%
Candle	0%	1%	40%	11%	0%	16%
Kerosene lamp	50%	99%	46%	77%	100%	73%
Solar lantern	0%	0%	0%	5%	0%	2%
Grand Total	12	83	102	205	1	403

50% of the households use 2-4 litres of kerosene in a month exclusively for lighting purpose whereas 25% households reported usage of less than 2 litres a month for lighting purpose. 11% of the households are envisaged to depend on battery operated lights, generator sets, inverters, solar lanterns or candles during power cuts.

Table 5.9 Monthly consumption of kerosene for lighting purpose

Monthly consumption of kerosene for lighting purpose						
Monthly consumption	Handicraft cluster	Handloom cluster	Households	(% with base as column total)		
				Market place	Poultry	Grand Total
Not applicable	50%		14%	12%		11%
Less than 2 litres			44%	27%		25%
2-4 litres	50%	99%	27%	58%	100%	58%
4-6 litres		1%	15%	3%		5%
Grand Total	12	83	102	205	1	403

Majority of the households reported expenditure on kerosene for lighting purpose in the range of INR 150-250.

Table 5.10 Monthly expenditure on kerosene for lighting purpose

Monthly expenditure on kerosene for lighting purpose						
Monthly expenditure	Handicraft cluster	Handloom cluster	Households	(% with base as column total)		
				Market place	Poultry	Grand Total
NA	50%		14%	12%		11%
Less than Rs 50			20%	1%		5%
Rs 50-Rs 150	50%	28%	40%	41%		38%
Rs 150-Rs 250		72%	26%	46%	100%	45%
Grand Total	12	83	102	205	1	403

5.8 Ownership of assets

The project interventions are unlikely to directly impact ownership of basic assets at household level. The present section reports the assets owned by the households only to understand the household profile of the end users and energy providers.

Table 5.11 Type of dwelling

Type of dwelling							(% with base as column total) (No. of households)
Type of dwelling	Handicraft cluster	Handloom cluster	Households	Market place	Poultry	Grand Total	
Kutcha house	42%	14%	31%	39%	0%	32%	
Pucca	42%	33%	20%	20%	100%	23%	
Semi pucca	17%	53%	49%	41%	0%	45%	
Grand Total	12	83	102	205	1	403	

Majority of the dwellings are semi pucca while 32% households reported kutcha house. 83% of the households mention that they own radio whereas only 45% households own television. Only 16% of the households reported to possess television.

6. Conclusion

34 Solar Micro-grids are installed at 30 sites. The initiative has enabled 23 Energy Providers in gaining additional income by retailing energy services up the energy ladder. Depending on the number of connections, an Energy Provider is able to avail annual revenue of INR 18,000 (10 connections) to INR 1,80,000 (100 connections). Unemployed youths have also expressed their interest to invest and own solar micro-grids. Three of the Energy Providers are trained to repair the systems and act as service providers to all the Energy Providers. The employment created by entrepreneurship based solar micro-grids is modest but are permanent in nature.

The retail and service providing units in the rural market places are expected to extend working hours. On an average the households and other units indicated use of 2-4 Litres of Kerosene a month for lighting purpose. The End Users are benefited by the clean and quality lighting at comparable cost, INR 150 per month. In addition to reduced use of kerosene for lighting purpose, the intervention has also replaced diesel generator in two market places. The handloom and handicraft workers are envisaged to work conveniently mentioned of increased productivity by reducing the production time by 7 to 14 hours for a five meter cloth piece weaved.

The institutional model comprises of Energy Providers, Banks, and End Users as the stakeholders. The Energy Providers operate the enterprise with modest but regular profit. The Energy Provider is the key stakeholder to liaison with Banks, End Users, Service Providers and the facilitating Institute (TERI). The model supports promotion of Solar based micro decentralized units through local level human resources. Loans were availed from Regional Rural Banks and nationalized banks for 14 sites at the interest rate ranging between 12 to 13%. The Entrepreneurs will start repaying loans from the year 2015. In one site, Village Panchayat (Local level governance) has provided the match amount from the village development fund.

Entrepreneurs at rural level are willing to invest in solar based Energy Services provided they are convinced about the profitability and short payback period. However, robust entry point activities are to be designed as one among the pre-installation phase activities. The present institutional model and technology received encouraging responses from the rural market places and the handloom units. Basic lighting facilities on payment basis find more arcade in the income generation units than in the households.

A detailed impact assessment study will be conducted by mid of year 2014.

7. Photographs



Energy entrepreneur



Energy SMG installed in rural market place



Income enhancement: Handloom workers are able to work during evening hours.



SMG in handloom unit



Light for pottery work

