Removing the Darkness and Improving Livelihoods

SOLAR HOME LIGHTING SYSTEM

Learning from Practice

Shilpa Vasavada and Nabarun Sen Gupta

For further information please contact

The Livelihood School
Third Floor, Surbhi Arcade,
Bank Street, Troop Bazar, Koti
Hyderabad - 500 001
Tel. : +91 (0) 4030512500, 30512501
E-mail : info@ tls.org.in
Web : www.thelivelihoodschool.in

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Shilpa Vasavada and Nabarun Sen Gupta[1]

Introduction

Approximately 500 million people in India's countryside still have no access to electricity. The government's ambitious plan to electrify the entire nation by 2012 is based, in large part, on providing rural homes (particularly some 25,000 of the remotest villages) with decentralized renewable energy systems. Such decentralized renewable energy systems will include local energy generation and dissemination systems and will therefore be different from the large national or regional grid system followed elsewhere. It is important, over here, for us to understand that the phrase “rural electrification” refers to providing electricity to around 10 per cent of the households in a village, and is thereby not to be understood as providing cent percent coverage of all rural households. It is therefore, pertinent, for us to look at the decentralized renewable energy systems (as opposed to just the extension of the national grid), which in the present context offers us the best hope for a more complete electrification of India's villages.

Having no access to electricity, rural areas use kerosene lamps at night for indoor lighting and for undertaking urgent family tasks outside the home. These kerosene lamps and lanterns use the heavily subsidized kerosene. These being some of the most polluting energy sources and the majority of rural homes being poorly ventilated, use of kerosene lamps poses an increased health hazard, causing respiratory and eye problems. In addition, inhalation of the fumes affects the longevity of women involved in many of the household chores. The use of kerosene lamps is also a threat to safety. Lamps can set fires in rural homes which are largely made of straw and mud. The light of these kerosene lamps, which are the open wick type (commonly used in rural India), provide low lighting intensity, far below that is required to meet reading needs adequately. Thus education suffers as well. Also to be taken into account is the difficulty that people have to in procuring kerosene. Not only do people often have to trek long distances in order to buy kerosene, they also have to take recourse to the black market as often PDS shops authorized to sell kerosene do not do so but divert the same to the black market.

Issues such as the above serve as the biggest opportunities for solar power. Solar power has proved to be very successful wherever it has been tried out. There is more than one single model that has worked. We have examples of stand-alone solar home lighting systems (SHS) as well as mini grids. They have all successfully

delivered electricity where needed. With reduced cost and long-lasting LED bulbs, solar energy has today become an effective and environmentally sustainable source of light. Use of solar power has scores of advantages. It averts the health hazards of kerosene lighting, which is alleged to be the reason for hundreds of deaths in India. Being decentralized, the solar energy systems offer a level of reliability and control that grid electricity throughout India does not.

It is estimated that a 55 km^2 area of land in an empty desert will be able to meet the energy shortfall for the entire country. India has a large number of sunny days (around 300+) every year. With a production capacity of 6 to 6.4 kilowatts per square metre, the deserts of Rajasthan and the sparsely populated areas of Gujarat serve as captive locations for this form of renewable energy. However, the potential for this is yet to be realized. India had 120 MW of installed PV (photo voltaic) capacity as on March 2007. Of this, less than 2.5 MW was generated by grid-connected solar power plants. The rest was generated through stand-alone systems like solar street lighting (about 70,474), home lighting (4,02,938) and solar lanterns (6,70,059).[2] The scope for extending the same is quite high and this document makes an attempt to draw out the learnings from a few experiments initiated towards tapping this source of energy for rural lighting.

Study objective and methodology

This study, conducted on the behest of the Livelihood School knowledge building efforts, makes an attempt to cull out the learnings inherent to efforts initiated under one of the SDC sponsored Livelihood Triad Fund projects. The project located at Barmer in Rajasthan carried out a solar intervention in extending Solar Housing Systems (SHSs) using micro finance for families requiring the services. The project was implemented at the field by a partner NGO – Dhara Sansthan.

The learnings from this field-implementing project were also validated by seeing two other projects implemented by two other organizations. One of them, Sahjeevan, has a rural setting, whereas SEWA has both rural and urban settings. In all the three projects the focus was to enable poor households to get access to solar technology. Both the organization also had the element of financing these products for poor.

The study has looked at the learnings inherent to the efforts of these three organizations. The focus of the learnings have been on processes initiated by these organizations to enable households to have access to the technology, the technology options chosen, support systems created and the micro financing products developed for the solar products. The study also looked at sustainability of the technology in the context of scaling up and replicability. It is understood that the knowledge gained while the practitioners implemented the project will help others, particularly those intending to take solar power systems to the household as a

means to augment livelihoods. The learnings, many of which have come up from failures and misadventures, are likely to caution practitioners against repeating the same, thereby paving the way for spread of the technology.

Since Dhara Sansthan was supported by the SDC-LTF project of BASIX, effort was made to go into the depth of the same by visiting the organization and field. Indepth discussions with the Director, field staff and accountant of the organisation and field visits to villages gave an insight into many of the learnings. Visits were made to villages where credit was extended by Dhara for solar lights under the SDC-LTF project. Field visits were also made to a few other villages (Ramji ki Dhani and Setrau-both in Barmer, Rajasthan), to understand the system of cash sales and the benefits derived from solar lights.

In addition to this, there was also interaction with representatives from Sahjeevan and SEWA- organisations working in Gujarat. The discussions made with representatives helped in developing understanding about their experiences, the issues they encountered, the problems they faced and the workable models and strategies they evolved with experiences they gained. Discussions were also conducted with a manufacturing company (Pegasus in Ahmedabad) and there was a round of conversation with Grameen Surya Bijlee Foundation (Mumbai) over the telephone. Visits were also made to ICECD which has set up a Centre for Entrepreneurship at Uttarlai, Barmer, Rajasthan, where SHSs are implemented under a programme instituted by ICECD in collaboration with Craine Energy.

Further, literature review was also done to understand the policy environment around non-conventional energy and renewal energy. Discussions with officials were conducted to understand the methodology of the extension of the system. The library of Deen Dayal Petroleum University – the solar energy school - was used for reference work.

The report, based on the observations and data obtained from the various sources, includes a chapter on technology, one on policy environment, one on the work done by the organisations and finally a chapter on the learnings.

It is hoped that the study will help practitioners, particularly those contemplating taking the technology to rural areas, understand the nuances of the system and also the process which shall help them develop products for financing the same. The study understands that financing the poor to get the technology is likely to help them augment their livelihood – both in the short as well as long run.

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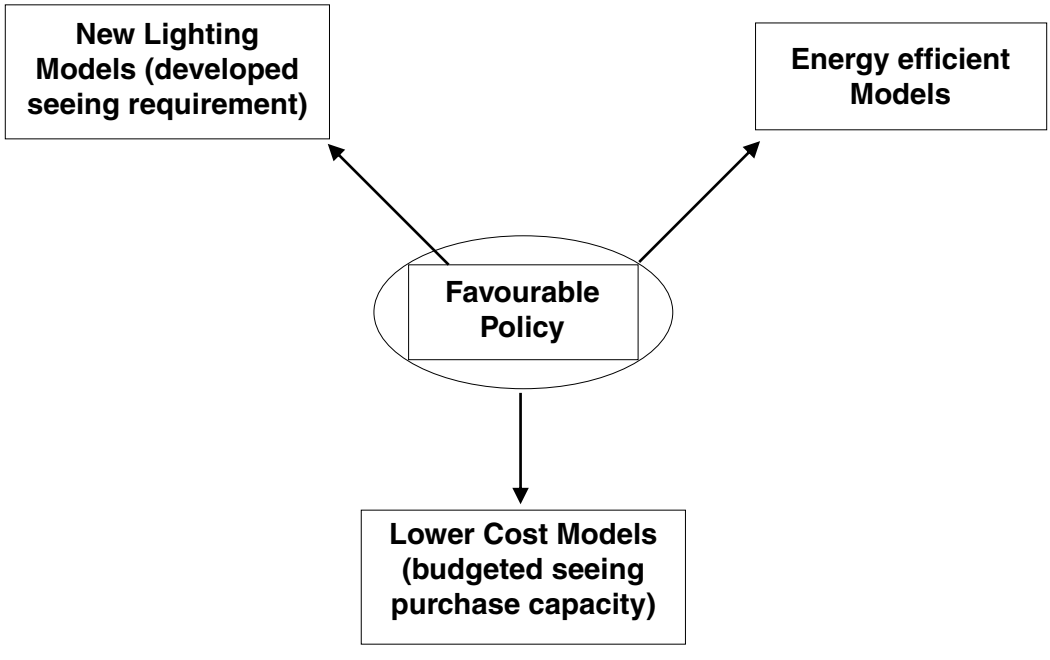
CHAPTER 1
Solar power systems: The policy environment

The 11th Five Year Plan has targeted a 14,000 MW capacity of grid interactive power through New and Renewable Energy Sources (NRES).[3] In addition, the achievement of another 950 MW of non-grid wind/hybrid, small hydro and bio-mass power and around 50 MW of solar power (grid/off-grid) is also on the cards. This would take the total capacity generated through the NRES to 15,000 MW. In order to induce projects towards achieving this target, in January 2008 the Union Ministry of New and Renewable Energy (MNRE) announced a generation-based incentive scheme for solar thermal and solar photovoltaic (PV) ventures.[4] Since then the Government has been gearing up to launch several mega schemes so as to harness the abundant solar sources that are available. This has also been highlighted in India's National Action Plan on Climate Change document. Seeing a scope for resources and having a favorable policy environment, Industry also has shown an increased level of interest in tapping this energy source of the future. The MNRE[5] has initiated various schemes and incentives, which include subsidies, soft loans, concessional duty on raw material imports and excise duty exemption on certain devices/systems. These exemptions have given an impetus to the production and use of solar energy systems. The Indian Renewable Energy Development Agency (IREDA) also provides revolving fund to financing and leasing companies, offering affordable credit for the purchase of PV systems. The emphasis is on encouraging manufacturing industries to get their manufactured goods installed as solar PV systems are capital intensive.

An Expert Committee constituted by the Planning Commission has prepared an Integrated Energy Policy[6] which envisions a 10 million square meter solar collector area, to be set up by 2022. This will be capable of conserving electricity equivalent to that generated from a 500 MW power plant. There are examples of state initiatives towards solar energy as well. The one in the state of West Bengal, where the use of solar power is mandatory in all new multi-storeyed buildings, deserves special mention in this context.

In spite of this favorable policy environment, the support of the Government remains insignificant when compared to policies adopted by governments in Europe and East Asia. The latter have more resources earmarked for solar energy systems. The Indian official policy formulated to tap renewable energy and provide electricity in rural India continues to be unclear in many respects. Experts agree that the idea of extending the grid system mindlessly without seriously looking at decentralised distributed generation is appalling. A clear directive that grid lines will not be taken to villages where solar power plants are feasible exists in West Bengal.[7] The silver lining is that policies now look at the link between energy and poverty, and the need to adopt the livelihood approach to energy solutions. The

RGGVY has a small capital subsidy component of Rs 540 crore for decentralized distributed generation systems. There is also an increasing realization among power officials who are seriously considering setting up solar power plants in rural India to generate and deliver grid-quality power locally. It is against this backdrop that the work to install the PV systems is taking place. These favorable policies have helped technicians to come up with models that will suit the requirement of lighting and also suit the budget that individual households can allocate towards getting the system installed. The third dimension consists of innovations in technology. This is represented in the figure below:



Situational Analysis of the Solar power systems in Rajasthan

The Western part of Rajasthan in general and Barmer district in particular, has scattered settlements known as Dhanis. Since these are widely dispersed, it is hardly feasible that the National electricity grid will reach these settlements. Hence, for these remote villages in the desert, solar energy offers the best and may be the only viable option. The viability is further strengthened by the fact that this part of Rajasthan receives abundant supply of the most common source of energy on earth, i.e. sunlight.

The Rajasthan Renewable Energy Corporation (RREC), which is the nodal agency under the MNRE, providing solar home lighting system, has installed around 73,590 SHSs in Rajasthan since 1999. This is in itself more than a fifth of the total such systems installed across the country. The success of solar lighting system in Rajasthan has been attributed to the fact that the state receives plenty of sunlight throughout the year. In Rajasthan, this system is introduced through gram panchayats. When people experience its benefits, they come forward and pay. The state government also offers a huge subsidy. This subsidy is given directly to the people, with the funds coming from MNRE through the state nodal agencies. The RREC provides extra funds and subsidies from other government agencies, particularly through the Tribal Area Development Agency.[8] In spite of these successes, the spread of SHSs has become somewhat restricted due to various reasons. While the feasibility of solar energy has been proven, it lacks scale penetration. The literature on the subject mentions multiple reasons, some of which are:

a. Prices beyond reach: In Rajasthan the model promoted is SPV DLS Model-2 (37 Wp SPV Module with 2 Light Points of 9W CFL).[9] The price for this model as on 31 October, 2008 was INR 15075. The subsidy amount paid by the GOI and by GOR together contributed towards reducing the price by INR 4550. Thus the amount of INR 10525 to be paid by the household for getting this system installed is on the higher side. The interesting element is that though there are many other players in the market, who have almost similar systems available at a much lower price range, starting from INR 4000 to 8000, their products do not conform to the subsidy requirements. Therefore, those willing to avail subsidy will have to conform to the models which have been technically approved and, since the price of these is beyond the reach of most families, the penetration is low.

b. Financial services are not available: In desert ecology, where livelihoods are generally based on a combination of rainfed agriculture, livestock rearing, mining and migration, the income level is on the lower side. Provision of credit facilities in such an environment could have helped many families to adopt this system. However, the unwillingness of the financial sector to lend money for such installation adds to the misfortune and thereby low penetration of solar systems in rural Rajasthan.

c. The assistance provided is not appropriate: Asking families to pay INR 1800 at one go for a solar lantern issued at 50 % of its original price has not encouraged many takers. The schema is faulty. The poor could have paid installments of INR 200 per month and they could have paid more than INR 1800 to get the system. Loans to the poor, at a subsidized interest rate, would have been a better strategy than a subsidy on the unit cost of INR 1800. This is the opinion of many of those who sell the product in the market. Paying a monthly installment of INR 200 would be far easier and implementable than expecting a lump sum payment. The existing

subsidy regime benefits only a few. Subsidized interest rate is the way to go. State money can be leveraged better this way.[10] An interest-rate subsidy is universal. It can generate mass consumer interest and help solar lighting systems gain rapid rural attraction. Flawed financing has thus hindered many from acquiring solar-powered systems.

d. Access to after sales services: Purchasing power, however, is just one side of the coin. The other side has issues related to installation and maintenance services. The lack of a legitimate support and necessary infrastructure to maintain solar-powered equipment is also seen as a contributing reason for low penetration of the government-sponsored solar lighting program.

One may conclude that policy environment, though positive to the spread of the solar system, still needs to be more specific and responsive to the changing environment and keep pace with it as well.

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Chapter 2
Rural solar home lighting: The technological options

Rural solar home lighting systems have seen a lot of technological innovations in recent times. Much of this has been a result of the support this sector has been receiving, i.e. positive policy environment. Many of these innovations have looked at the suitability and the affordability issues of the rural population. The high energy efficiency of newer lighting technologies which have come up recently, like the compact florescent (CFL) and light emitting diode (LED), has revolutionized solar energy products. These innovations are so energy efficient that effective lighting capacity can be achieved from the energy generated from a small, solar photovoltaic (PV) panel. Some modifications have also been made in the battery which is needed to store the solar energy captured during the day, to enable emitting of light at night. The rural solar lighting system which the market currently offers has taken on a variety of forms like:

(1) Home lighting systems: This consists of a complete installed unit, namely a solar PV panel, a battery, a few meters of wiring, and lighting bulbs.

(2) Lanterns: This also requires almost the same equipment. But here the battery unit and the lighting bulbs are together, and can be taken to various locations once they are charged.

(3) Street lighting systems: This is typically a stand-alone unit and may come with dimmer options which will provide reduced light output during the later part of the night.

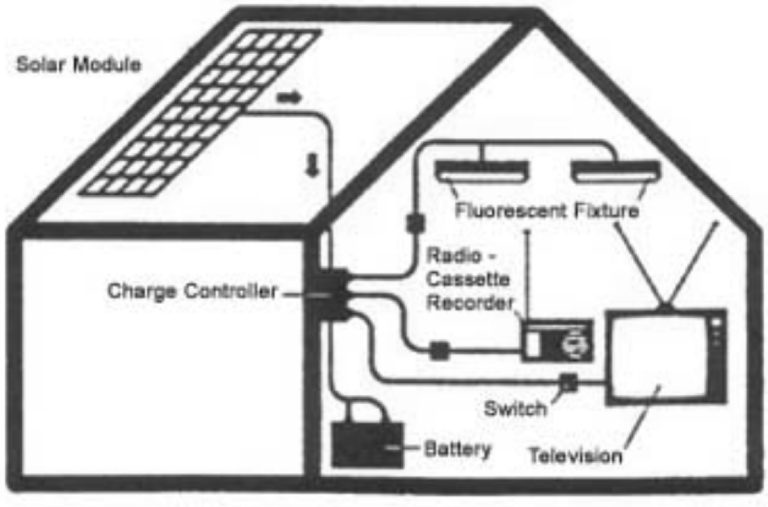
(4) Community center or school lighting systems: Almost similar to the home lighting systems, except the fact that here the system is larger in size to generate more power.

We will elaborate on each of these systems. Many of these aspects often drive the decision for a choice and hence must therefore be understood.

Solar Home System (SHS)

Depending on the size, an SHS can operate one or several lights. It has also added on features like running a black-and-white television set, a radio, a cassette player and a small fan. Each of these add-ons would imply higher size of panel and battery, thereby resulting in higher cost as well. The SHS is normally designed to provide enough power for three to four hours, depending on the combination of the gadgets it seeks to run. The 'System Size' (20, 35, or 50Wp) indicates the number of 'light-hours' or 'TV-hours' available.

Normally an SHS will have a 12-volt direct-current (DC) stand-alone system which uses PV to electrify small rural homes. Each SHS comes along with a PV module (also called Panel), a battery, a charge controller, wiring, fluorescent or LED lights, and outlets for other appliances. A typical design[11] of an SHS with all its components is shown below:



It is important that those involved in choosing this system understand the different components. An elaboration of each of them is given below:

Module

Solar modules for an SHS would range between 20-60 Wp. They are mounted on a rooftop or atop a pole. The technology of this could be either crystalline or thin-film technology[12] (also called amorphous).

The crystalline silicon cells are produced by slowly extracting large crystals from a liquid silicon bath. These crystals are sliced into 1/100th-of-an-inch thick slices, or 'wafers', which are then processed into solar cells that are then connected and laminated into solar 'modules'. While this production process yields highly efficient (10-15%) cells, it is expensive. This ultimately translates to a costly system for the buyer.

The other technology which has become more acceptable among the major producers is the thin-film technology. This alternate 'thin-film' technology has only a

thin layer of semi conducting material deposited onto cheaper substrates like glass or steel. The thin-film silicon cells are produced by depositing vaporized silicon directly onto a glass or stainless steel substrate. While the efficiencies achieved are lower than with crystalline silicon, the production process is less expensive. These 'Amorphous Silicon' solar panels have slightly reduced efficiency, and are therefore slightly larger in size compared to crystalline silicon panels. However, with reduced cost, the system makes economic sense to the buyer. These thin-film solar solutions can work even under cloudy weather conditions. The Modules having crystalline cells have a lifetime of over 20 years, whereas the thin-film ones have a lifetime of around 10 years.

Battery[13]

An electro-chemical storage battery is used to store the electricity converted by the solar module. During the day, electricity from the module charges the storage battery. During the evening, the battery is discharged to power the lights and other applications. Batteries are typically the 12-volt lead-acid batteries, ranging in capacity from 20-100 Amp-Hours (Ah). Batteries are typically sized to provide several days of electricity or 'autonomy', in the event of overcast weather preventing recharging.

Among the models available, the deep-cycle batteries are the best. SHSs designed using these batteries operate over larger ranges of charge levels. These deep-cycle batteries can be discharged to 70-80 per cent without incurring damage (car batteries on the other hand get discharged to only 15 per cent of their capacity).

In case of SHSs, both deep-cycle and automotive batteries are used. They are available in all markets and so replacement is not a problem. Car batteries have a 3-5 year lifetime, whereas deep-cycle batteries (sealed and unsealed) last for 7-10 years. The price also varies accordingly.

Charge controller

A charge controller is utilized to control the flow of electricity between the module, the battery and the loads. It prevents battery damage by ensuring that the battery is operating within its normal charge levels. If the charge level in the battery falls below a certain level, a 'low voltage disconnect' (LVD) will cut the current to the loads, to prevent further discharge. Likewise, it will also cut the current from the module in case of overcharging. Of course, some systems do not have this facility. With increasing realization in the context of the rural market, the charge controller assumes significance. Those which do not have the automatic charge controller would use indicator lights on the controller to display the relative state of charge of the battery. This is seen in most of the models available in the market.

This device is important as once overused, it takes a long time for the battery to get charged. In rural areas, where literacy levels are relatively lower, the presence of this device built into the system help prevent overuse of the battery, thereby increasing the life of the system.

Lights

As has been mentioned earlier, there are two technologies as regards the lighting bulbs. Compact fluorescent light bulbs, fluorescent tube lights and LED bulbs (off late) are used for lighting. One must weigh the choice of the technology based on parameters like cost, brightness, spread of light in the area, accessibility to bulbs in nearby markets and lifespan of the technology. Usually these considerations are important but normally less understood by those who adopt or market the system.

An SHS normally would have anything between a two-light system to a six-light system. The choice of lighting technology for an SHS can provide substantially higher lighting levels if understood. A 9 watt CFL provides illumination equivalent to a 60 watt incandescent bulb. These compact fluorescent lights have a 5-year lifetime. The tubes have much shorter life, but are cheaper and more readily available.

The third choice is LED bulbs.[14] These are lit solely by the movement of electrons. Unlike incandescent lights, they have no filament that will burn out, and unlike CFLs, they contain no mercury or other toxic substances.[15] Proponents say, LEDs can last some 60 times longer than that of the incandescent lights and about 10 times longer than the CFLs. Unlike incandescent lights, which generate a lot of waste heat, LEDs don't get very hot and use a much higher percentage of electricity for directly generating light. Thus, LEDs offer more efficient technology than incandescent lights and CFLs.[16]

However, LED bulbs are not known for their brightness. The structure and the material used, trap the light emanating from the LED. This reduces the brightness of the light and makes it unsuitable as the main lighting source in the house. Efforts to resolve this problem have seen innovations in the LED system. The manufacturers cluster many small LED bulbs together in a single casing to concentrate the light emitted. But such LED 'bulbs' still don't generate light much brighter than a 35-watt incandescent, which most people consider too little for reading or other focused tasks.[17] These bulbs also have problems of fusing in the casing which again makes replacement difficult in rural areas where the market for such bulbs is yet to be penetrated. One of the manufacturers, Pegasus, has come up with a two LED bulb casing giving the same light as 42 LED bulb casing of another company. In short, manufacturers are aware of the problems and are innovating briskly to resolve them and make the lights more user-friendly.

An important consideration for any user of solar system is the cost. The cost of the lamp can go up with the use of LED bulb. The CFL is cheaper than the LED but LED lighting systems require smaller panels, which brings down the cost.

The field interactions with agencies have shown that technical partners of Dhara and ICECD (GSBF and Pegasus) use LED bulbs, whereas the technical partners of Sahjeevan and SEWA use CFL bulbs. Very recently they too have started using LED lighting systems.

Wiring & Mounting devices

An SHS will also have additional materials for mounting and connections. Metal frames are included to attach the PV Modules to a pole or roof. The SHS components are connected by wires and contain switches for the lights. In some cases, wiring is housed inside conduits attached to interior walls. These are important considerations as damages to wires by rats in rural areas can considerably reduce the life of the system. Similarly, the high velocity of the desert wind can destabilize the PV modules if not clamped well on the roofs. These two considerations are likely to be understood by those involved in installing the system.

The technology as regards the solar panel, the battery and the bulbs is constantly being developed. The focus of the development is three-fold:

a. Efficiency of the system,
b. Cost reduction and
c. Rough and tough to suit to the conditions of the rural areas.

In addition to this, a part of the focus of the technology is on adding user-required features to the system, keeping in mind the constantly changing and evolving needs of the rural population. In most cases, these features do not cost much, except for the fact that while the manufacturing is done, provisions for charging other gadgets could be included. The cost, however, will increase if the system is seeking to charge or run gadgets which require higher power (watt). This would require larger sized panels and different batteries and would, therefore, cost more than the one that has been described above. For practitioners taking such solar lighting systems to the people, an understanding of the requirement of the people will help in seeking adequate interface with the technology provider to tailor systems based on the parameters above. This could very well be understood if the agency does a thorough need assessment in the community.

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CHAPTER 3
Understanding the interventions of the Solar Home Light system

The understanding of the solar home light intervention as highlighted in the methodology section was acquired from field visits in Barmer (Dhara Sansthan) and through interactions with representatives from two other organizations. This chapter begins with a note on the benefits that households have derived from using the solar lighting system. Then it goes on to give the reader an idea about how each of the three organizations worked towards popularizing the adoption of the system and how these organizations have designed and executed financial services.

A. Benefits derived from solar home lights

The benefits derived from the use of solar lamps have improved the overall wellbeing of the households. This has been observed during interaction with the users at the field locations. Some of the benefits are listed below:

1. A leap towards children's education: Most parents met during the field visits mentioned that the reading habit of the children had increased. They study during the evening hours. This is especially true for those villages which have regular teachers at the village school. In the first village, where the teacher is not sincere, it was difficult to find a single child who would open a book after coming home from school. The parents attributed the reason to low quality teaching in school. However, in three other villages visited, children do study using this light. One gentleman desperately approached the office to get his equipment repaired since his daughter's Board examination was coming up and his system had suddenly broken down. He was ready to do anything to get it repaired. This showed the benefit children received due to the lights.

2. Improvement in health: With the solar systems in place, fewer women will tend to suffer from respiratory problems. Kerosene fumes will cease to affect the eyes of the family members. In the desert area of Barmer, this applies all the more. Winters being cold, the circular 'Zonpas' (houses) are kept shut all the time, and the kerosene lamp emits so much carbon that not only do the eyes burn, but also respiratory problems develop. Women are affected much more severely than men since they stay at home for much longer hours. They suffer due to the rigid patriarchal structure, where suffering in silence is understood to be the order. The summer season is prone to gusty storms which can result in fire. Houses getting gutted during summers are a common phenomenon. With the solar system in place, these two ills have been taken care of to an extent.

3. Saving of money: In several houses, the supply of kerosene, which is normally 3-5 litres a month, comes from the ration shop. This consumption has stopped entirely or reduced drastically, helping the family save an average of INR 50 a month. The savings can go up to INR 100 for families which do not have access to subsidized kerosene supplies (which is also quite erratic in the area). This is over and above the hardships one has to face to go all the way to the ration shop which is normally about 3-4 km from the village, only to find that the shop is closed or that kerosene is not in supply.

The other monetary benefit is the saving of money households spend on charging the mobile and/or the Kisan torch. This amounts to a savings of another INR 100 a month. Again, the benefit is also non-monetary as it is handy to charge the same from solar light when needed, rather than banking on someone going to the main market about 15-20 km away for charging it.

There are not too many livelihood enhancement opportunities in the villages. Still a small shop owner has put one of the lights of the SHS connection in his shop and in another village where embroidery orders are common from the contractor, women stay up till late night and work under the solar light as against under kerosene lamps earlier. Of course, they did complain that the light is not enough to put the thread in the needle at night. Yet, the light is much better than the light from the kerosene lamps. In one village stitching is done by a woman on a sewing machine. However, she rarely uses it at night as she does not get so many orders for sewing. Still, solar lights are always there as a safeguard, in case she has more orders. During the visit, no example of additional livelihood enhancement was seen to have taken place as a result of this lighting system. However, the feeling of security did get reflected in the voices of people, the fact that *"there is a light available in case we require to extend our work"*.

4. Increasing safety for the family: The benefits go much beyond financial calculations. For example, the light helps one to see that there are no stray insects in the food while eating, that no scorpions and snakes are around etc. These are benefits which are directly linked to the lives of the family members. Also, the light enables young mothers to nurture their infants at night and also help women working on manual floor mills. These are examples of benefits experienced by women. The safety which the Dayan (midwife) feels with the solar light on during delivery of a child at home is a benefit that goes much beyond finances.

These lights have made a world of difference to many of the villagers. According to one woman, *"Now that we are used to living with these lights, we feel as if the world has stopped if the lights are gone!"*

B. About the promoting organizations

As has been mentioned, the monograph has tried to capture work done by three organizations. A small brief about each of them follows:

Dhara Sansthan, Rajasthan

The organisation, based in Barmer, helped in implementing a programme under the SDC-LTF project of BASIX. It was an intervention aimed at building a business model on solar energy which would help enhance livelihoods of people in rural Barmer.

The intervention had three institutions partnering. The Grameen Surya Bijli foundation (GSBF), a non-profit set up which aims to harness renewable energy sources, primarily solar energy; Dhara, a local NGO involved in promoting livelihoods in Barmer district; and Indian Grameen Services, an organization carrying out action research projects for developing financially sustainable livelihood models for enhancing livelihoods of the poor in India. The project named Urja Samruddhi had the two broad objectives:

1. Enhance the livelihoods of the poor by providing the households lights so that the duration of economic and social activities increases, thereby making a positive impact on the lives of the household.
2. Develop a revenue model for providing solar lights to households, the success of which would enable replication of the model in all parts of India.

Field visits to the locations where the solar systems were installed were done apart from perusal of the records and reports of Dhara.

Sahjeevan, Gujarat

This organization working in Kutchh, Gujarat, has been working on cleaner energy since its inception. It has worked on smokeless chullas (stoves) for cooking and biogas plants in the past. It set up a renewable energy cell in 2002. The organization partnered with other experienced players like Auroville Renewable Energy (AuroRE) located in Auroville and several vendors and suppliers of renewable energy technologies. In the past three years, Sahjeevan has gained extensive experience with varied applications of solar energy systems like solar PV pumps, solar lanterns, solar PV home lights, and solar PV street lights. Sahjeevan has positioned itself as a technology and energy service provider with an effective role in advocacy with government to bring long lasting change in the lives of people and the environment.

SEWA Bank, Gujarat

Shri Mahila Sewa Sahakari Bank Ltd., popularly known as Sewa Bank, is a Micro Finance Bank providing banking services to poor self employed women. The main objective of the bank is to help women come out of the vicious cycle of poverty and help build their capital, assets and businesses. Sewa Bank provides a large range of services which includes savings, loans, insurance products, financial counseling, business counseling/advice and literacy for self employed poor women. A significant portion of the over 300,000 Sewa Bank members belongs to the poorer section of society and require improvement in terms of living conditions and infrastructure. The bank came up with a separate portfolio for improved access to energy services and other services like water and sanitation. SEWA Bank, along with SELCO (as its technological partner), has been offering credit support to its member borrowers to instal PV solar systems since 2006. The major objective of the portfolio is to address poverty by reducing drudgery, increase revenue and time availability and improve health of poor self employed women. Their focus on energy interventions has been in Ahmedabad city and in the rural areas of Ahmedabad, Gandhinagar and Kutchh districts.

C: Product profile[18]

The product profile varied with each of the organizations, and also according to the technology partner with whom it associated. However, a more or less one common stream ran through all of them. They all selected products which demonstrated newer technologies.

Dhara supplied home lighting systems which comprised a one roof mounted 10-watt solar photovoltaic panel, one 12-volt storage battery, interior wiring, switches and two LED bulbs and one small night lamp which provide three to four hours of light, manufactured by GSBF.

ICECD, another organization working in the same geographical location, also started with the same product manufactured by GSBF but then shifted to similarly designed products by Pegasus.[19]

Sahjeevan started with solar lanterns but has now moved on to LED based lighting system, provided by various suppliers. These systems include solar home light system and portable products, which can be charged through hand cranking.

SEWA Bank has a diversified product profile. It has technology partnership with SELCO. It gets products which are customized to the needs of different segments of society and are primarily into lighting and cooking through solar power.

D: Assessing need of the users

This is an important process which can make or break the chance of success. The study revealed that some organizations chose to do this assessment in a structured and scientific manner, whereas some relied on the experience and understanding of the technology provider.

Dhara, in Barmer, had its product designed by the supplier company. While no structured process of need assessment or feedback was undertaken either by the NGO or by the supplier company, the product underwent evolution when the second consignment was ordered. The second consignment had a point for mobile charger. This was demanded by the users and the technology provider developed the same and supplied it.

Sahjeevan, which initially popularized only solar lanterns among the fishing community and salt pan workers,[20] carried out an intensive, structured survey among different segments of society. This assessment looked at the livelihood pattern and the links it had with other sources of dependency like kerosene, the existing use of kerosene, the expenditure incurred by the people, and their ability to pay. This assessment gave the organisation an idea about the needs of the community and how they differed according to livelihood patterns. The assessment also gave an idea of the affordability of solar products by the community.

SEWA also carried out similar assessments before initiating the programme. It tried to understand the different occupations the members were involved in, along with the need and existing methods adopted by them to meet the energy needs. The intensive survey included details on expenditure incurred on electricity (since they work in areas where electricity is available, though erratic), the average fuel expenditure, time spent by women on accessing fuel, etc.

E: Identifying product range suited to need of the community

While Dhara had one fixed SHS - with two lights and a night lamp component - supplied by one manufacturer, Sahjeevan chose a slightly different route. A team from Berkley University (US) had visited the organization in 2006, with six of their products. The products comprised various torches and other home lighting systems of WLED. These were given to different members of the community. Based on the needs identified, affordability analysis done and feedback received for the product use value, two prototypes of home lighting system were left behind by the team for further development. Sahjeevan approached manufacturing companies with some suggestions in product modification to cater to the needs of the end user.

Eventually, Sahjeevan conducted inhouse testing and research on the current market which helped it to develop a varied range of products, each of which catered to different segments of the community. One of the examples is a prototype lantern costing INR. 800 which gives five times the light of a kerosene lamp and could, hence, be useful to poor families. Currently, the range of products developed by the organization includes home lighting system, torches, street light system and the like.

SEWA had initially started with lanterns and over time got into home lighting systems. However, structured need assessment made it move towards developing products which enabled midwives and flower pickers to keep their hands free while they worked. The organization has developed a product which is fitted on a cap and this keeps the light focused. It has also moved into solar cooking range products, like solar cooker, roti maker, etc. Recently, it has also introduced mobile charging units in its product range.

It is essential to note in this context that as the organizations got involved with assessing the requirement of the population and also their capability to spend, they could advise the technology partners in developing systems to suit the needs and budget of the people.

F. Promotional efforts

Organizations choose different strategies to promote and popularize the solar lighting systems.

Dhara promoted the solar product of SHS through word of mouth and through the network of relatives of key functionaries of the organization residing in different villages. Solar home lights sold for cash as well as on credit helped create demand. However, the organization did express the need for investing on creating some basic literature and taking up promotional efforts.

Working on introduction of new concepts and launch of new products, Sahjeevan took up extensive promotional efforts, especially among the fishing community and the salt pan workers. An intensive campaign was launched which involved photographic booklets, pamphlets, huge flex banners and docudrama in Kuttchi (local language) to highlight problems of darkness and the advantages of solar light. Work in Vandhs[21] has started off late, and the campaign has not covered these areas as yet. However, pamphlets on different technological options and product range available have been disseminated on a large scale.

The organization also took up demonstration of the product in different localities. The SHS was made to rotate from one household to another every seven days and this helped people experience the benefit. In Vandhs, due to long distances

between two households the field staff would go in the evening time, put on the lantern for two-three hours, and then come back. This exposed people to the advantages of solar lights and motivated many to buy them.

SEWA also made good investments in promotional efforts. The initial one-and-a-half years of establishing the products were really difficult, as electricity through national grid was available in their areas of work. However, with a firm commitment to making a difference to women's health, increasing their savings and creating assets of their own, SEWA has been spending a lot of time and efforts on promoting the system. Meetings, leaflets, brochures and energy fairs are some of the different methods being tried out. Promotional films are also part of the strategy. SEWA does the initial introduction in a meeting in a slum or rural area, where after introducing itself and the energy project, discussion is carried out on the benefits of solar energy. Having identified three or four interested women from the initial meeting, individual counseling is done to convince them about the benefits of solar products. Once they agree, demonstrations are given at their houses for about a week. This strategy has helped in generating demand for the range of products available for use.

G. Capacity building of the end users

Building the capacity of end users is a strategy used by all the organizations. However, they differ from one another in terms of intent and methodology.

Dhara, along with GSBF, conducted basic training for the end users. This basic training was done with males and the orientation was done while installing the system. The orientation pertained to very basic levels. The villagers were explained what they should and what they should not do. For instance, they should keep the thin-film solar panel clear from dust, they should not tamper with the battery and the electronic systems installed inside. The GSBF[22] mentioned that a lot more effort is needed to be put in for creating awareness of how to use the system, what to use the system for and what not to use it for, why one should not charge a radio or tape on the same battery, etc. This requires intensive effort at a later stage rather than just basic explanation of how the system functions at the time of installation. The lack of awareness among people on usage-related aspects is understood to have done damages to the system, causing many to become non-functional.

SEWA entered into technical partnership with SELCO, which conducted a series of meetings and training programmes to build capacity of different levels of SEWA members. This included senior staff, bank saathis, whose role is to introduce the product and to get recovery. They also trained the end users. A formal process documentation of each structured programme enabled both SEWA and SELCO to reflect and change and move towards workable solutions. This strengthened the team and the end users' capacity in maintaining the systems.

H. Establishing distribution channel

Distribution channels are part of the system which helps in marketing as well as in repair and maintenance. Some systems, if in place, may make the system function better. Let us see how these three organizations carried out this function.

Dhara directly distributed the shipments of the solar home lighting systems. Right now there is a halt in sales after two shipments.

Sahjeevan itself distributed the systems directly to the users. However, with the NGO involved in promotional efforts, distribution of the same was becoming difficult. It was not sustainable for the NGO to engage in distributing the home lights from its office or by its field teams. Off late, efforts are being made to link the distribution to traders. This has worked and it is understood that this strategy will lead to deeper penetration of the technology, and eventually introduction of the products in wider markets.[23]

SELCO, the technical collaborator of SEWA, maintains a service outlet in Ahmedabad, which caters to all needs expressed by SEWA. Once SEWA Bank's field workers and Bank Saathis motivate customers and gets the order, SELCO goes for installation, services and repairs. In Kutchh district, SEWA has developed an entrepreneur woman who has single handedly sold 50 lanterns. The two separate channels have enabled SEWA to focus on deeper penetration of the system among its members. It has helped them in capacity building and in loan recovery as well.

I. Incorporating client's need

In the age of designing services and products to suit the needs of the client or end users, we come across similar processes undertaken by the three organizations. Though this was not initially part of the strategy, as the organizations ventured into the sales of the models they also realized the requirements and consequently made efforts to incorporate the same.

The first batch of solar home systems supplied by GSBF to Dhara Sansthan did not have mobile chargers. However, on demand, and based on the informal feedback the NGO staff and company officials received during their field visits to the villages, the second consignment had provision for charging mobile phones. They also had provisions for radio sets.

Starting with lanterns having the CFL technology, Sahjeevan introduced home light systems with LED bulbs and street lights after carrying out a need assessment survey. When the structured feedback reflected overuse of battery and hence total

rundown of battery, the organization asked the manufacturers to manufacture battery with a back up storage of 8 hours. This feedback mechanism helped in providing services which people needed the most. Thus, not only did the product portfolio diversify, but product manufacturing also changed.

SEWA too started with lanterns and home light systems. While the lantern had a fixed model, SEWA, along with SELCO, offered a range of options with a combination of lights and fans. These products came with different wattages. There were products with 1, 2 and 3 lights, with or without fans. The lights also varied in output from 7, 11 to 14 watts. This variety gave users the option to choose products based on the size of their rooms, their affordability and their requirement.

It is essential, therefore, to understand the context from the angle of the users before a product is launched and offered. The variety and the mix are important and tailoring the product through assembling the same at the behest of the customer is always a good marketing strategy.

J. Creating support systems for maintenance

One of the major bottlenecks generally encountered when new products are launched is the investment the company has to make towards ensuring that services for maintenance of the product are easily available to users. This holds true for the solar lighting system as well. The absence of adequate maintenance services is likely to affect the adoption of the systems. This aspect is detailed out in the next point.

K. Preparing youth service agents for maintenance

The Urja Samruddhi project envisaged identification and training of local youths in maintenance. The technology partner was supposed to provide this. Two youths were identified and sent to Mumbai. However, they could not translate the knowledge gained into actual aftercare services and start their own business. The two-day training was ineffective as whatever knowledge the youths gained could not get translated into practice. The company officials also mentioned that the youths nominated did not have the aptitude to learn the technology and therefore proved ineffective.[24]

Sahjeevan is known to be a technical organization. The renewal energy intervention project has three technicians who form the core group. The team having one engineer has undergone three-month training in repairs. They are capable of repairing any part of the home lighting system, including the most difficult part, the circuit in the battery. This training was imparted when the organization was in the R&D phase. Sahjeevan took the support of companies like

Vimal and others, which helped in building the existing knowledge. Auroville, the technical partner of Sahjeevan, helped in defining and charting out capacity building of the team. The approach was to build the capacity of local youths and this was successfully done by the organization.

Paying heed to the need for decentralized aftercare services, Sahjeevan is now in the process of training local youths as para- technicians. These youths will carry out repairs and also provide maintenance services to the users of solar home lights and other products. The organization is contemplating giving these para-technicians kits and spare parts (as accessing spare parts is difficult in the remote villages, and sometimes even at the district capital of Bhuj). The para-technicians would be able to rectify the basic problems. Battery related problems, however, will continue to be addressed by technicians from the organization. This set of services will be possible among the concentrated fishing community and salt pan workers, where the sales have reached some volumes. However, in less concentrated area like the Vandhs, where the volumes are low at present (3-5 per Vandh), the organization is exploring the option of tie-up with distribution channels present at the market places. It appears that this option will become dominant over a period of time.

SEWA Bank's tie-up with SELCO has helped to deliver maintenance with the promptness it deserves. SELCO, through its network of solar service centre (SSCs) and service technicians, provides after-sales services for one year to all SHS customers. Periodic maintenance checks on installed systems are also made throughout the year to ensure smooth functioning of the equipment, and provide needed user instructions. Thus, while one model looks at developing local skills for a decentralized model, SELCO's service centre in Ahmedabad and 21 centres in Gujarat and Karnataka cater to all technical needs in the form of company managed centralized services.

Similar to the SELCO services, one comes across Tata BP, which operates in Barmer. It has also set up its own service centre in smaller towns and many of them are “just a phone call away”. The toll-free after sales customer service helpline number ensures that service is provided within 24 hours. This promptness of service has helped in building trust of the users.

However, such centralized services can only be provided by large players like SELCO and TATA BP. For others, the trader-cum-local technician channel will continue to be the dominant one.

L. Creating space for starting businesses

One of the two youths trained came from one of the villages in the credit cluster. This

youth was engaged in repairing radios at his own home. The other person nominated for the training worked with Dhara. While the former managed to carry out some basic repairs after the training (like replacement of fuse, change of wire in the fuse, etc.), the other could not do any. However, with almost no access to spare parts and maintenance kits, both encountered difficulties in providing the services. There were strict instructions from the technology supplier that attempts should not be made by anyone other than a company representative to repair the battery. Thus, whenever any problem came up which could not be resolved, the system was transported to the company in Mumbai for repairs.

An important aspect which could have been useful for Dhara was to out source the repair work to other technical persons. There was one such person (about 80 km from Barmer) who repaired solar home lights. It would have been prudent to use his services through some partnership. Similarly, another set of youths was available in the outskirts of Barmer where the Centre of Entrepreneurship had the same technology partner. The ICECD used a different strategy to ensure sales and maintenance. Tie-ups with these youths could have helped Dhara.

ICECD[25] has taken initiative to create channel for promotion, distribution and maintenance. It identified about 60 youths from the Crain Energy affected villages, and used Pegasus Limited, an Ahmedabad company, to train these youths in solar products repair and services. These youths then carried out sales, installation and providing repairs. They received an incentive of INR 150 at the time of booking the order, and another INR 150 after six months of services. This strategy worked well. On an average, the youths selling about 7 to 8 systems every month, earned around INR 2000-2500 per month.

These local entrepreneurs carried out minor repairs. For battery related problems they got the systems to the office of ICECD in the outskirts of Barmer, in Uttarlai, where a person in charge of the entire dealing did the repairs. In case of faults beyond the person's capability, the unit would be dispatched to the company for repairs or replacement. Different systems were evolved to help users get services at the doorstep. This approach has involved all players, both small and big.

M. Availability of spare systems with the host organization and warranty

When a home lighting system encountered a technical snag, the user would contact the staff of the NGO. Dhara did not have spare systems. But in all the SETU centres, Sahjeevan has provided four such spare systems which can be immediately given on replacement. The organization also has an additional 30 systems in its stock inventory. In case of SEWA-SELCO, the repair work is done immediately and so spare systems are generally not required. However, provision

of a few working sets at the offices of the organizations could help when the systems do not work and there is an emergency at the user's end.

N. Uses put into by the users of solar home light systems

It is important for the intervening agency to understand the layout of the house. The organization in Barmer had taken to a three-bulb SHS. Interestingly, the Dhani where people have their homes normally has a three to five unit independent, yet linked structures. They all open to a front courtyard. One of these independent units serves as the kitchen and the others can house animals, store grains and be used for living. The number would depend on the total size of the family and the type - nuclear or extended household.

The field observation helped us realize that there is a typical pattern of using the three bulbs supplied. One of the bigger lights is put in one of the rooms where multiple activities take place. This includes children reading in the evening, adults doing activities like repairs or other economic activities. The second lamp is normally put in the *'Angan'* or the front courtyard. During summer (when the days are long) people sit out and have dinner, children play, family members engage in discussions, and so these lights are a great help after sunset. They help people to identify reptiles and other dangerous visitors which are not very rare to these places. In most houses, the smaller light, normally considered as a night lamp, is installed in the kitchen. This illumination helps during cooking. This light is also kept running throughout the night and helps women in the feeding of infants, fetching water for family members and the like. The light from this lamp also helps them to grind flour (using the hand operated chakki) in the early morning hours. The women did mention how they found it relatively easier to perform domestic chores in a lighted area.

O. Experiencing problems from the Solar Lighting Systems

The work of installing the solar lighting system in rural Barmer also brought out a range of problems. Interestingly, these problems can be managed and the incidence of their occurrence can be reduced. We present some of the problems so as to help practitioners find out solutions and workable plans to counter the same beforehand.

P. Functional status of equipment

Problems that have cropped up in the home lighting systems include one of the lights (out of the three) going off, bulb getting fused, mobile pin getting tilted or broken, LED within bulbs getting fused, bulb holders breaking, power of the lights getting dim, wire getting eaten up by rat, etc.

In such cases, knowledge acquired by the staff is put into practice to deal with the problems. Some cases are referred to an electrician.

Q. Meeting differing needs of rural people in the product portfolio

The reasons for problems faced could be traced partly to the product and partly to the lack of awareness among people about the logic behind not tampering with the system. The user's urge to fulfill diversified needs on the domestic front with the product supplied, regardless of its capacity, was also a reason.

Right now they charge a Kisan torch by paying INR 10 and this lasts for 4-5 days. A mobile is charged for INR 7 to 10 and lasts for 3-4 days. Both are extremely necessary as the settlements are widely scattered and it is difficult to go out in the pitch dark of the night to answer nature's calls, leave alone visits to neighbours' houses in the same village. Mobiles serve as a necessity rather than luxury in this area as they help people to keep in touch with one another in the vastly scattered settlement. Again, most of the families have someone who has migrated to the near by town or even farther away and it is necessary to keep in touch with them. Hence, several households have two mobile connections. Charging them is not only costly but one also has to wait until someone goes to the nearest market place, which is generally some 20 km away from the cluster of villages. That is why, a mobile charging unit inbuilt into the system is a very useful addition.

Thus, faced with the necessity of charging Kisan torch and mobile phone, and also attempting to charge tape recorder and/or radio, people fiddle with the system. Quite used to working with wires for various purposes on their own, the villagers have taken direct connection of wires and try to repair the fuses on their own. These attempts have in some cases broken the mobile charger and other parts in the system. With no one to monitor or guide, and the houses being so far removed from one another, several households today have one or more pieces damaged though the entire system may not have become dysfunctional.

A major cause of tampering with the system is the lack of availability of product designs to meet the varied requirements. This indicates not only the necessity of having a local person for repair and maintenance, but also the need to create proper awareness. For instance, people should be explained why a tape recorder should not be charged on the same, rather than just being told that it should not be charged. While some people know that charging a tape recorder with the help of the battery is inadvisable because of the different power required by tape recorders, radios and Kisan torches, it is difficult for them to ignore the need of getting these gadgets charged. Thus, as livelihood promotion practitioners, we need to help not just in the provision of services but also be able to judge the necessity of the people.

Damages have occurred due to misuse of the systems, rather than their inability to conform to the quality standards.

To conclude, these specific aspects of the implementation impart very valuable lessons. We see how the three organizations approached the issues in different ways and how they developed and evolved systems to give things a better shape. In the next chapter, we will highlight how the projects included the micro financing strategy and the inherent approaches adopted towards the same.

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CHAPTER 4
Experiencing the different Models

Though three models were seen to have been practiced, our focus will be on two models: the direct purchase model and the credit linked purchase model. However, for the purpose of knowledge, we shall also briefly describe the features of the rental model. Let us first have a look at certain aspects of volumes of sales done by the organizations.

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Volume of operation

All the three organizations achieved some volume of sales. For instance :

Dhara procured two consignments of solar home light systems. The first shipment, had 32 systems, which came in June 2008. The second had 100 systems and was delivered in October 2008. Another 30 lights of lesser brightness were also procured. One was sold and the rest where shipped back.

ICECD sold around 700 SHS in the span of a year. Sewa also sold around 600 of these in the last two years. Sahjeevan, on the other hand, could sell 80 solar home light systems in the last one and half years and another 75 lanterns in the last 6 years in rural Kutch.

The volumes depend on various factors and low volumes must not be interpreted as the inability of the organization to take the technology to the customers.

Cost and sale price of the solar home lighting system

An important consideration is the price at which the system is procured from the technology collaborator and the price at which it is sold to the user. In the absence of MRP-like standards, a lot of price difference was noted. This was not due to profit making reasons, but because of attempts to recover the cost of making this system reach the users and get it installed. However, when the volumes are on the lower side, the unit cost increases making the system less affordable to the users. Let us see a few instances.

Dhara had two consignments. The first reached Barmer at INR 3250. This was sold to the users at INR 4000. The price difference of 750, i.e. 23 per cent, covered the cost of installations and also provided some margins (profit). The second lot came at INR 3750. This was sold to different users at different prices. The prices ranged from INR 4500 to 5000. Those which got sold on credit (30 of them) reached the users at INR 5000. The interesting point is that those users who could bargain got it

cheaper. Considering that the systems which were sold on credit should attract a marginal rate of interest (2 per cent per month) with some addition of loan processing fees and installation charges getting added to the same, the organization did make a margin of over INR. 535 per unit they sold out. To the customer the units came at a price escalation of 33 per cent, which is huge. (See table below)

Table 1
Showing costing of the product purchased

Shipment	Sale price	Purchase price	Price difference	Percentage difference
Shipment 1	4000	3250	750	23 %
Shipment 2				
On credit	5000	3750	1250	33 %
Cash sale	4500	3750	750	20 %
Cash sale	5000	3750	1250	33 %

SEWA Bank has a different arrangement with SELCO. SELCO is the technical partner and SEWA Bank the micro finance partner. Hence, cost of installation, repairs, services, etc. is all borne by SELCO including travel, food and logistics. SEWA Bank bears all expenses related to micro finance: paper work, systems for recovery, etc. The cost of the product is fixed for any system and the borrowings are supported by SEWA Bank. SEWA Bank charges interest and loan processing costs. SEWA bank also undertakes negotiations with SELCO to reduce the cost to the users when the product is sold.

Business Margins

At the time of the study there was a stock of one light to be given on credit and four lights to be sold for cash. Assuming they are all sold, the organization made a profit margin of INR. 26310.

Table 2
Profit earned

	Batch I	Batch II
Total sale	128000	442500
Total cost	121223	422967
Net Profit	6777	19533

The three models in operation

The Urja Samrudhhi project implemented by Dhara Sansthan in Barmer, Rajasthan initially proposed a revenue model which had two strategies, namely, the rental and the credit linked purchase model. The cost of the unit included the purchase price (inclusive of tax), the installation cost and an amount charged in advance for maintenance. The action research project initially suggested that both these models would be tried out in one village each. One of them would identify an entrepreneur who would carry out the project in each village for providing the solar light business. Sahjeevan also proceeded along the same lines. SEWA, on the other hand, worked on the direct purchase model which included the component of micro finance. Let us evaluate the learnings from these experiments:

a. Rental model

In the rental model proposed by Dhara, the household using the solar lamps would pay INR 10 per day towards hiring the solar light system. Though this was described in the proposal, it was never tried out in practice. It seems that when the organization discussed the benefits of the solar lamps in the villages, people came forward to own the unit rather than hire the same. Once a few units were installed in the villages, many others approached the agency and bought the systems. The first batch had only the purchase model whereas the second batch, despite having more of the purchase model, sold a few (30) units to users who took loans for installing the models.

The rental model was tried out by Sahjeevan in Gujarat, which gave both the lanterns and the solar home systems on rent. The monthly rent was INR 60/month for lanterns and INR 220/month for the home light. Penalties were also put in for late payments of the rents. Although the rental model helped in popularizing the technology, it had a flip side as well. Ownership not being theirs, the systems were not handled with care. Payments of rents also suffered due to recurrent faults in the technology. The other flip side was the high cost incurred by the organization in collecting the rent. In short, the flip sides made the organization decide to do away with renting and focus on the direct sale model.

b. Direct purchase model

A total of 98 SHS were sold by Dhara to households across 43 villages. The payments were made in cash and then the installations were done. They were sold at different prices. The price of the first 32 SHS was lower as it had fewer features whereas the second batch was sold at a range of 4500 to 5000.

The criteria adopted by the organization to sell out the home lights depended on the familiarity the NGO staff had with people hailing from these villages. The logic of

selling the sets across such a huge area in the district was to encourage demonstrations over as wide an area as possible, since the organization firmly believed that solar home lights are the answer to remote villages in the desert area where settlement pattern is scattered. However, with the NGO not going ahead with the programme, the demonstration effect of the same will not be further realized.

Sahjeevan experienced difficulties with the renting model and therefore is trying out with the direct purchase model. However, it has chosen to give some relaxation in making payment. The end users pay the total cost in 2 installments, 50 per cent as advance while booking the order, and the remaining 50 per cent later. This has reduced staff efforts on recovery. But the organization does realise the drawback of being able to reach out only to the middle segment of society, which can afford such level of capital investment. However, this system has been appreciated by the households as they do not have to make the entire payment at one go.

In case of SEWA, the direct purchase model is open to everyone. Anyone who gets motivated can enquire about the solar products and SEWA would put them in touch with SELCO after checking their house size, needs and giving them various options. The payment is done at SEWA (in case the purchaser is not a member). In case of members, payment can be made in one go or it can follow the installment model. The choice rests on the user.

C. Micro financing for solar home lights

We came across what was initially proposed and what was finally done. The credit model proposed by Dhara came at an installment of INR 200 per month. The number of installments was fixed at 15. In practice, it was seen that the household had to make a 20 per cent down payment of the sale price. This came to INR 1000. The remaining amount was paid in 11 installments of INR 350 and with a last installment of INR 150.

Sahjeevan, on the other hand, extended the lanterns on credit through the Ujas Mahila Sangathan, a rural women's collective in one of the Blocks, promoted by Kutchh Mahila Vikas Sangathan. Ujas gave lanterns at a monthly installment of INR 400-450. The users were expected to make a down payment of 10 per cent of the system cost. UJAS charged an interest of 18 per cent on the amount so borrowed. They also had the provision of penalties when delayed payments happened. This made the products affordable to the entire segment. The majority of the end users shifted from rental model to purchase model as it gave them ownership. However, recovery continues to be one of the hurdles. Irregular payments were accredited to faults in the technology. Due to persistent problems, the loan portfolio had to be closed.

Solar home lights were also provided on the credit model directly by Sahjeevan. Servicing and other facilities were included in the product agreement which made it easy for the direct linkages for end users. However, being from within the organization, it was difficult for staff members to recover the installments. It also made it unviable for the organization to incur travel costs. It also had a bearing on the time they took to get the amount recovered.

As regards to ICECD, it has adopted only the direct sale model.

SEWA had the solar products as one of their credit portfolio. SEWA Bank made this credit available only to its women members. The bank tied up with SHGs and Associations promoted by SEWA for solar products. With an interest rate of 10 per cent (since the solar products are quite expensive, the interest rate is kept lower), the members pay back the borrowed amount in 15 equated monthly installments.

The next section elaborates on specific aspects of the third model, i.e. the credit linked model. This aspect is important as agencies involved in promoting can make use of financial services to help the rural and urban poor access energy systems. Let us look at some of the key processes experienced by Dhara in particular and the other two organizations in general.

i. Criteria for choosing village for loan model

At Dhara, it was decided along with BASIX, that the three villages where sales would be made on credit must be in a cluster. This cluster of villages must be within 3-5 km from each other. The cluster was located at a distance of 175 km from Barmer and the nearest field office was at a distance of 75 km. The cluster of villages where solar home lights were given on credit, was totally new to Dhara. The logic for selecting these villages was that these were away from the villages which had been offered the 100% grant model earlier. The organization realized that the credit model would not be feasible in the existing villages. While experience of grain bank with part credit was successful, the organization did not want to take risk of changing the people's mentality overnight from grant-based interventions to credit-based interventions. Hence, while the villages chosen had some linkage of relatives from villages in which Dhara had worked earlier, they were as such totally new villages. However, this logic was defeated as it sold the other 98 SHS in the existing villages directly, without having to face any question on why no subsidy was being provided for procuring the system by those who took them.

Another reason for choosing these remote villages was the strategy that the organization normally adopts, of reaching out to the remotest villages where normally others don't reach out. These villages are about 15 km from the Pakistan border, and have no access to the national electricity grid due to their remoteness. These are also desert villages where living conditions are extremely harsh during both summer and winter.

ii. Loan qualification criteria

The initial contact point for Dhara was the presence of some known people who were relatives of the people in the existing area of intervention. Loan was, however, given to all those who were willing to take loan after paying upfront amount of INR 1000. The basic underline was the organization's trust in the people.

At SEWA Bank, one has to be a member of the bank to be eligible for a loan. If a non-member woman wants to avail of micro finance service for solar products, she has to first become a member and has to have a minimum savings of INR 1500-2000 in her bank account. Guarantee has to be extended by the SHG leader of the village or the Bank Saathi. It is only then that the new member can avail of the credit.

iii. Fixing of the recovery schedule

Dhara sought an upfront amount of INR 1000 from the total cost of INR 5000. The remaining amount was paid in 11 installments of INR 350 and a last installment of INR. 150.

In case of SEWA, the installments have to be paid in 15 months. The customers are aware of their monthly installment, but also enjoy flexibility in payment. The rural borrowers can pay the amount in seasonal installments as well. Daily labourers and vegetable vendors who save INR 10 per day, pay an amount of INR 300 a month and sometimes make payment every fortnight. By keeping the payment schedule flexible, SEWA has been able to reach out to customers from different economic classes. This sort of arrangement is also a women- friendly arrangement, as a woman doesn't get a fixed amount every month from her husband and it is her flexible savings which she uses to pay for the solar products.

iv. Loan recovery mechanism

The cluster of three villages is managed by the field office of Dhara from Guddha road (75 km from the cluster villages). One staff member is responsible for collection of the installment and he travels by bus. The staff member is also in charge of other projects and gives two days every month for the collection. People know the collection date, which makes things easier for him. If any one misses the date for repayment, he is supposed to pay the next month. The organization is thus not very rigid about payment.

The recovery mechanism of SEWA Bank has four field workers for solar products going for recovery during the first to tenth of every month. Recovery can be given to the Bank Saathis or deposited personally at the Bank office.

v. Regularity in loan repayment

Installment of INR 350 per month flowed in regularly from all the 29 customers of the solar light system from April to November 2008, i.e., for eight months. In December, however, the staff member could not make it to the villages and hence the customers skipped the installment. Since then irregularity in the repayment schedule has become visible. While many people did make double installments in January, some defaulted. At the time of the study, in mid-March, the February installment had not been collected. As on March 10, 11 customers had not paid installment for one month (barring the one for February); 2 had not paid for 1.5 months; 3 had not paid for 2 months and 1 had not paid INR 100. Thus, out of the total 29 customers, recovery was irregular for at least 17 individuals. In case of SEWA, the recovery rate is as high as 85%.

To conclude, the models and the operational guidelines of each of the intervention had its own positives and negatives. They hold for the practicing community a lot of latent knowledge.

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CHAPTER 5
Lessons learnt

The practising community, for whom this work has been undertaken, can acquire the following set of lessons. The purpose of enumerating the lessons is to make the practising community aware of the issues it may encounter while doing interventions in the field of solar energy. Awareness of these issues will enhance efficiency and effectivity. Some of the inherent learnings are:

a. Need assessment is a prerequisite before launching products

The experiences of Dhara as against Sahjeevan and SEWA aptly bring out the need for a structured need assessment that the practising organization needs to do. This will not only enable the company and the NGO to look at the design of the product, but also understand the varying needs of the community and address them while developing products. The need assessment will also provide a clue to the design of the intervention. The differing repayment schedule based on affordability can be assessed and incorporated into the design of the micro finance product. The need assessment survey will highlight problems of existing energy sources along with the time and money spent on accessing the same, which again can be used during promotional campaigns.

b. Proactive promotional efforts enable penetration of solar lights in remote areas

Sahjeevan and SEWA's examples have shown that disseminating basic information along with putting the solar products in perspective, highlighting the advantages of solar lights and disadvantages of kerosene or other sources of energy from health, monetary and other angles, often help in enhancing the acceptability of the solar products. Taking up promotional efforts in an intensive campaign mode in the local language also helps in accentuating acceptance.

c. Educational awareness on dos and don'ts of solar light system a must

While training of end users has been done, it is important that focus does not remain only on care of solar panels. Awareness of each end user should be created as to how to put the system to use, why tape or radio should not be charged from the main unit and why wires within the main unit should not be tampered with, and the like. Emphasis should be laid on explaining the logic, rather than just making a statement of the rules. The logic should be clear to the people as a part of the capacity building of the end users. This will ensure less tampering with the product,

thus reducing cases of damage to solar home light systems. The working of the product will improve, thus increasing its popularity.

d. Offering range of products customized to meet diversified needs of people helps

A range of products offered to people may be a better option than having a single standard one. This is important as families today have diversified needs and these vary as per the class of people, size of family and other variables. Some relatively affluent families in one of the villages have gone for the more expensive Tata solar lights, which, despite being expensive, can meet their requirement of TV, Kisan torch and more. Again, one of the products of REIL is more in demand because it can charge mobile phones and Kisan torch. The cost is also on the lower side. Offering a combination of such products may help reach out to a range of people. This has been aptly done by Sahjeevan in Kachchh.

While these are options for lighting in general, even within the home lighting system, there may be options. One sees an example of this in the SEWA-SELCO intervention, where the customers choose the model based on their differing needs and affordability.

e. Centralised service centre approach is a working model, but one also needs to appreciate the decentralized model

Tata BP and SEWA-SELCO have their own service centres. These centralized centres provide after sales services. On the other hand, Sahjeevan and ICECD have tried to train local youths to provide the needed repairs and maintenance. Though they can't provide the full range of repair services, this decentralized approach definitely enables people to meet certain basic needs of maintenance locally as also helps generate income by creating businesses for the local youth. This approach has an inherent strength. It provides for additional livelihoods and also helps upgrade skills of the youth and, in the long run, empowers them as well.

f. Back-up support needs to be made available to the local para-technicians

While the experience of training local youth as entrepreneurs and technicians has proved successful to a significant extent, it has also been seen that these para-technicians can generally manage the basic level of repairs. Circuit related work has to be done at other places. In case of Dhara, any problem related to the non-functioning of the system is dealt with by dispatching the batteries to the company for repairs. In case of Sahjeevan and ICECD, the organizational technician helps repair the battery at the central level. Thus, back-up support to the local technicians helps in promptness of services. A tie-up with some electronic service outlet can

also be designed as part of the strategy. The circuit inside the main unit is not any rocket science that the local person cannot address.

g. Training of technicians must be decentralized

The strategy of training local entrepreneurs has been tried out with significant success at Sahjeevan and ICECD. Dhara, on the other hand, has chosen to do differently. Sahjeevan and ICECD took the company staff to the field to get the local staff trained. The field level issues can be discussed well if the training is done at centres near the field.

h. Setting up independent distributional channels is a better choice

Although one may like to argue that NGOs must get involved in installation of the solar products so as get a 'feel' of the issue, it can be also argued that rural people can do this on their own as well. In fact, REIL has been selling its solar light products through distribution dealers for quite some time. The installations are done by the people and not by the distribution dealers.

Installation implies costs. Dhara has marked up the price of its first consignment by INR 750 to cover this cost. SEWA has not got into playing this role. The technology partner does it. The cost is built into the price at which the product is offered to the users. Off late, Sahjeevan is also doing something similar. With distances in desert locations being huge, installation and after sales costs are always on the higher side. While reaching out to the remote villages is well appreciated, after establishing the product in the market to a certain degree, the NGO can restrict its role to promotional efforts, capacity building, micro financing and setting up of distribution and service outlets.

i. Scale is important to make business sense

The costs of travel, dedicated human resources, installations, maintenance and repairs will have to be recovered. It can be done if more units are sold in any geographical area. Even the cost of door to door collection of installments requires scale. Though the solar product has a promise within, the scale will always be a bothersome issue. Perhaps time will sort out this issue and ensure that the proposition makes business sense.

j. Apt recovery mechanism will make micro financing succeed

Micro finance is an essential strategy to help poor households obtain the solar lighting systems. The initial cost of the system is high and the product is still considered to be a luxury. So if micro finance is to be successful, the recovery

mechanism must be in place. In case of Dhara, the entire micro finance runs on trust. This may work as the organization has a good grip on the area. However, one can question replicability of the same in other areas. Even with Dhara it has been seen that one irregularity in obtaining one installment can make many others become irregular. SEWA Bank's experience of strong recovery mechanism through SHGs indicates that SHGs can help, though this will be conditional to the fact that SHGs are really strong in ensuring member discipline.

k. Flexibility in the repayment schedule may be a useful strategy to have a wider outreach to economically weaker sections and women

SEWA has not gone for a fixed monthly repayment schedule. It has put in place a weekly and in some case even a seasonal schedule. According to the organization, this has increased access of economically weaker section and women to this technology. Poor people may have smaller, but frequent amounts which they can pay as installments rather than the larger monthly amounts. While this may increase the recovery cost, it may be able to even out with increased customer reach.

Flexible payment schedule also facilitates reaching out to women. On one hand, women have more direct and intensive relation with domestic energy due to their social roles and, on the other, they do not have control over money to decide to invest in a product like solar light. Micro finance can help them in this situation. However, since women may not have large sums of money at one go, it may be wiser to give them longer repayment schedules with higher flexibility for repayments.

l. Bringing gender dimension to the domestic solar products will bring in efficiency and sustainability as well as contribute to empowerment of women

In India, like in many developing countries, the existing social divisions of labour make women the primary managers of energy for their households, as large quantities of energy are required for their daily subsistence and productive activities. Light is needed, for example, for early morning chores, visits to the toilet after dark, and preparing evening meals. Thus there is a strong case for involving women in interventions related to solar home systems: be it women's involvement in need assessment, since they have different types of multiple needs for the domestic roles they have to play; or in capacity building of the end users, as while women and men both may be involved in outdoor income generating tasks, it is women who spend more time with energy at home. So if she knows the use of the systems properly, it would lead to more efficiency of the system use, also leading to sustainability of the product. SEWA, for instance, has attempted to ensure this. The solar home light product is in the name of women, for whom “having an asset in their

own name" is itself empowering. There is also scope for women entrepreneurs like the one promoted by SEWA to take the opportunity to break gender stereotypes.

Conclusion

We assume that this monograph has made attempts to capture the field level details and the interface between technology and its users. The purpose of this monograph is to help livelihood promotion agents understand the processes they need to adopt so as to help the rural poor access a technology that may help in augmenting livelihoods and contribute to enhanced well being. It is assumed that practitioners will find the readings suited to their grass roots requirements and useful to their context as well.

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18. Annexure 2, 3 and 4 for Products being used by the agencies involved.
19. Semiconductor Company based in Ahmedabad, manufacturing solar home lights since 2008
20. Fishermen and salt pan workers migrate to shores and salt pans for eight months, living in temporary shelters. They encounter extreme conditions of living without any basic amenities
21. Vandhs are locations amidst the salt pans where the workers stay with their families.
22. Conversation with Mr. Jasjeet Singh Chaddah, CEO, Grameen Surya Bijlee Foundation, Mumbai
23. Conversation with representative of Sahjeevan
24. Conversation with Mr. Jasjeet Singh Chaddah, CEO, Grameen Surya Bijlee Foundation, Mumbai
25. Personal communication with representative of ICECD in Uttarlai, Barmer

Annexure- 1

Schemes of Rajasthan Rural Electricity Corporation, Rajasthan

1. Remote Village Electrification (RVE) Programme 2005-06

Remote Village Electrification Programme is very ambitious and attractive scheme of Ministry of New & Renewable Energy (MNRE) New Delhi. Under this programme, un-electrified Remote Census villages and un-electrified dhanis of electrified villages are to be electrified through Solar Photo Voltaic Domestic Lighting System (Model II 37 W). Such villages and dhanis should be:

- Remote
- Revenue
- Where supply of electricity through Grid is not possible.

Financial assistance

- MNRE will provide 90% of the bench mark cost (INR 12500/- per DLS) i.e. INR 11250/-.
- Operation & Maintenance cost for 5 years is included in the bench mark cost.
- Balance 10% cost is to be borne by State Government (INR 3335/-) and beneficiary (INR1500/-) against the total cost of INR 16085

Order for supply, installation and commissioning of 3973 Domestic Lighting Systems (DLS) in 230 villages of 13 Nos districts in Rajasthan State.

2. Remote Village Electrification Programme 2006-07

Sanction for installation of 7618 Nos of Domestic Lighting Systems (DLS) in 73 villages has been issued by MNRE.

3. Rural Electrification Programme

RREC is implementing Programme of installation of SPV Domestic Lighting Systems (SPV Home Lighting Systems) with financial assistance from MNRE, GOI and State Government to rural beneficiaries in Rajasthan. Govt. of India through Ministry of New & Renewable Energy (MNRE) and Govt. of Rajasthan provides subsidy on SPV Domestic Lighting Systems, Street Lighting Systems and SPV Water Pumping Systems. The details of SPV domestic Lighting Systems are as under:

RREC is providing SPV DLS (Model-2, 37 Wp SPV Module with 2 Light Points of 9W CFL) under Rural Electrification Programme in Rural Rajasthan. Details of approved prices under programme 2006-07 which is extended upto 31/10/2008 are as under :

* Unit Cos	:	INR. 15075/-
* Subsidy (By GOI / GOR)	:	INR. 4550/-
* Beneficiary Share	:	INR. 10525/-

Scope of Work for supplier : The selected manufacturers / authorised suppliers shall identify beneficiaries to supply, install, commission systems and provide maintenance services for 2 years free of charge and for next three years at the fixed AMC charges (INR 300/- per year per Domestic Lighting System) to be charged from beneficiaries. Replacement of CFL is not included in this AMC.

Eligible Beneficiary for SPV Home Lighting Systems(SPV HLS/DLS)

Every resident of rural area (village) whether electrified or un-electrified is eligible for getting subsidy on SPV Domestic Lighting System.

Annexure- 2

Profile of product offered by Dhara to rural villagers

- Grameen Surya Bijli Foundation:
    - Technical Specification: 2 LED lamp-working for 3-4 hours, 1 night lamp working for 3 hours, mobile charger socket
    - Solar module:10 watt, 12 v thin film
    - Battery:12v, 7Ah SMF battery
    - System warranty: 1 year
    - Price: INR.4500-Rs.5000

Annexure- 3

Profile of products offered by Sahjeevan to rural villagers

1. Home Lighting system: Flexitron, Grameen Surya Bijli Foundation

- Flexitron:
    - Technical Specification: 1 LED lamp-working for 6 hours, mobile charger socket
    - Solar module:3 watt thin film
    - Battery:6v, 4Ah SMF battery
    - System warranty: 1 year
    - Price: INR 2600
- Grameen Surya Bijli Foundation:
    - Technical Specification: 2 LED lamp-working for 3 hours, 1 night lamp working for 3 hours, mobile charger socket
    - Solar module:10 watt, 12 v thin film
    - Battery:12v, 7Ah SMF battery
    - System warranty: 1 year
    - Price: INR 4900

2. Lantern:
    - It has 4 small LEDs, in front and back
    - It can work in 3 different modes: medium light, focus light, night model, full brightness
    - It has 3 different charging options: it can be charged through electricity, can be charged through solar panel generating 12v power
    - It can be effectively charged through hand cranking the rotations
    - Once cranked for 20 minutes, it works for 2-2.5 hours
    - It has one year guarantee from supplier
    - Price: INR 800

3. Torch:
    - It has single LED lamp focusing things
    - It also has similar charging options as lantern and can be charged through hand cranking
    - It can focus up to 125 ft.
    - It carries one year guarantee from supplier
    - Price: INR 750

Annexure-4

Profile of product offered by ICECD to rural villagers

- Grameen Surya Bijli Foundation

    - Technical Specification: 2 LED lamp-working for 3-4 hours, 1 night lamp working for 3 hours, mobile charger socket
    - Solar module:10 watt, 12 v thin film
    - Battery:12v, 7Ah SMF battery
    - System warranty: 1 year
    - Price: INR 4900

Abbreviations

Ah	*Amp- Hours*
AMC	*Annual Maintenance Contract*
AuroRe	*Auroville Renewable Energy*
CFL	*Compact Fluorescent Lamps*
DC	*Direct Current*
GOI	*Government of India*
GOR	*Government of Rajasthan*
GSBF	*Grameen Surya Bijli Foundation*
ICECD	*International Centre for Entrepreneurship Community Development*
INR	*Indian Rupee*
IREDA	*Indian Renewal Energy Development Agency*
LED	*Light Emitting Diode*
LTF	*Livelihood Triad Fund*
LVD	*Low Voltage Disconnect*
MNRE	*Ministry of New and Renewable Energy*
MW	*Million Watt*
NGO	*Non Governmental Organization*
PDS	*Public Distribution System*
PV	*Photo Voltaic*
R&D	*Research and Development*
REIL	*Remy Electrical India Limited*
RGGV	*Rajiv Gandhi Grameen Vidyutikaran Yojana*
RREC	*Rajasthan Renewable Energy Corporation*
SDC	*Swiss Development Corporation*
SEWA	*Self Employed Womens Association*
SHS	*Solar Home Lighting System*
US	*United States*