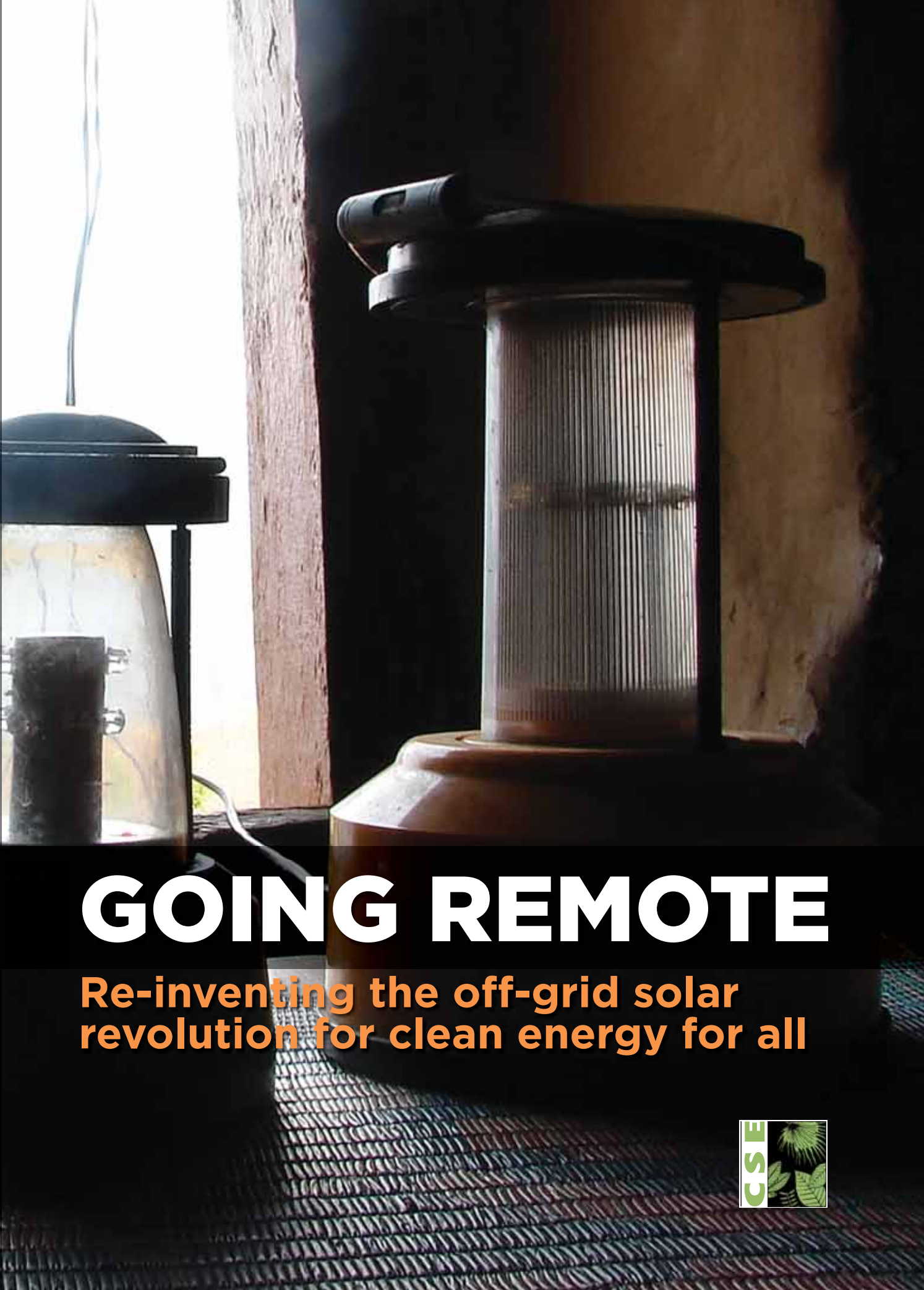

GOING REMOTE

Re-inventing the off-grid solar revolution for clean energy for all

CSE

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Re-inventing the off-grid solar revolution for clean energy for all

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Foreword

India suffers from chronic energy poverty. Even after 65 years of independence, one-third of its households have no access to grid power. In rural India, about 45 per cent of the households use largely kerosene to light their homes and shops. With no access to any sources of lighting, more than a million households go dark after sunset.

The problem is those who are connected to the grid, can't call themselves 'energy rich'. In many parts of the India, both rural and urban, the electricity supply is erratic and just for few hours. Very few cities in the country can claim to have 24x7 electricity supply. The country is paying huge developmental costs for this energy poverty – education, health and economic development is getting stymied because of this.

But India's energy poverty also provides an opportunity to design a new energy future for the world: those who are currently unconnected to the polluting fossil fuel grid can be leapfrogged to a clean and futuristic energy source. It could be the way the world solves its twin problems of energy poverty and climate change, in one stroke. The good news is that across India, small experiments are being conducted; some successfully some not so successfully; some with the support of the government and some without, to exactly chart this future.

From isolated houses in Chin hills in Mizoram to villages located in the Barnawapara Wildlife Sanctuary in Mahasamund district, Chhattisgarh, from remote villages in Pithoragarh district of Uttarakhand to houses and shops in Sagar island in Sunderbans in West Bengal, more than a million households use small-scale solar systems to light-up their homes and shops. Varied models are being implemented; from installation of solar housing systems to lights few bulbs to installation of few kilowatts mini-grids to supply electricity to few hundred households. Models include fully or partly government-subsidised systems to systems supplied by social entrepreneurs based on micro-credits to systems directly purchased by the consumers from the market.

The good news, as is documented in this report, is that these solar energy systems are changing the lives and the livelihoods of the unconnected. These systems are therefore, accepted and demanded. In fact, in many parts of rural India solar energy is preferred over grid-based power because of the unreliability of the grid. We came across villages connected to the grid where households have paid to set-up solar housing systems.

The bad news, so to say, is that the most distributed solar energy models beings implemented are designed to limit the usage and potential of the distributed solar energy.

Firstly, even the most successful experiments are built on limited opportunity models – such as the lantern or the solar panel with a few light-bulbs, which works when people are poor. It does not meet the needs or aspirations as people become richer or have more energy needs. In this way, existing solar energy systems have been designed only for the poor and only when they are poor.

Also, the model to up-scale these efforts is not available. Social entrepreneurs and NGOs give solutions as per the needs of the households and also have successful models to support after sales services – the most important component of the distributed solar power. But they have failed to upscale their programmes. Where the state has stepped in to upscale, the programmes have fallen apart due to lack of a well established and working delivery systems as well as apathy. The issue is made more difficult as

solar energy is still expensive and people who need it still poor. Therefore, the models demand some form of subsidies. The problem is that the government off-grid programme is built on assumption that the ultimate solution is to bring conventionally powered grid to the villages; distributed solar energy is a transitory solution and the design of the subsidy.

The real challenge is, how do we upscale the distributed energy systems to make them the real option in the real world.

From our year long research in which we have travelled to seven states of India – Assam, Uttar Pradesh, Chhattisgarh, Bihar, Uttrakhand, Karnataka and Haryana – to understand what is working and what is not, we are convinced that unless distributed energy systems can provide the same level of services as a fully function grid – energy when it is needed and in the required amount – it will remain a fringe and transitory solution. Distributed energy systems, therefore, require a radically different model that what is being widely implemented today. The good news is that we have such a model and with some improvements it could be made a winner.

We found the solar mini-grid projects being implemented by the Chhattisgarh government to be the most successful in terms of quality of services as well performance. However, the model is designed as an isolated grid for remote village electrification. And, a 100 per cent capital subsidy is provided by the state with users paying a small fee to meet only some parts of the operation and maintenance costs. The model is therefore not financially sustainable. However, what if we make this model grid-interactive and also financially viable?

Our proposal is simple: government needs to incentivise mini-grids with the same financial model as that of the grid-connected large solar power plants. We are proposing that the government come out with a major programme which allows entrepreneurs to set-up mini-grids across the country. Like grid-connected projects, these mini-grids projects should be provided with an assured feed-in-tariff. These mini-grids will meet the local energy needs and when the grid reaches the villages they could be made grid-interactive. That is, it can export power to the grid as well as import from it for growing needs or deficits. The difference is, instead of few big businesses setting-up megawatt scale solar power plants, we will be promoting thousands of small businesses and social entrepreneurs who will set up small power plants to serve the local population. They will create local jobs and help build the local economy. This model can also be used in urban areas for rooftop power producers.

If this concept is operationalised, it will revolutionise the way power is produced and consumed in India. This, we believe, is the way ahead.

– Chandra Bhushan

CHAPTER 1

The energy-poverty challenge

Census 2011 throws light on the darkness that exists across India today. Over 77 million households depend on kerosene for lighting; 1 million use wood and as much as 1.2 million households in India still remain completely in the dark. Interestingly, according to the Census, as many as 1 million households – the size of a small European country – use solar energy for lighting needs. The growth of solar is taking place in states where the electricity grid has not reached or even if the grid has reached, power has not. By 2011, West Bengal had over 0.24 million households using solar for lighting; Uttar Pradesh had another 0.16 million. This shows the opportunity and the challenge. The fact is that ministry of power of the government of India has been engaged with rural electrification since 1988; since 2005, the programme has the stated objective of meeting energy needs using renewable sources and decentralized solutions. But this has not taken off. On the other hand, the ministry of new and renewable energy (MNRE) also has a decade old programme to provide off-grid solutions. In 2010, it had an enhanced target under the prime minister's Climate Action Programme of 2000 MW of off-grid applications and 20 million solar lanterns by 2022. Therefore, India has an unmet need; it has the intent, programme and funds. The case for decentralized solar is clear and urgent.

The house of Saroj Kumar, a daily wager of Jagdeeshpur village in Vaishali district of Bihar is lit up by electricity generated through an off-grid 75-Watt (W) solar home lighting system. The grid has not reached this village yet. Kumar bought the panel in 2011 and the total cost of the system, including the battery, came to around Rs 7,000 which was about two and a half times his monthly income. Before he acquired this set, he used to pay Rs 100 per month to a private supplier, who used a diesel generator to supply electricity to households in the village. This allowed him to power a 10 W compact fluorescent lamp (CFL) for four hours a day and to charge his mobile phone.[1] He was, perhaps paying one of the highest power tariffs in the country, a whopping Rs 83 per unit. However, he had to bear this cost since he had no access to the grid or state-supplied electricity. But today he is a happy man with his own solar lighting set. This inaccessibility to the grid is probably one of the most important reasons for a thriving solar applications market in Bihar. Even the villages which are connected to the grid hardly get any power. A Greenpeace survey of electrified villages in Bihar found that at least 60 per cent respondents received less than an hour of power supply in a day forcing them to look for alternatives like solar home lighting systems.[2] Exhibition Road, a retail market for solar lighting systems in Patna is touted to be the biggest off-grid solar retail market in the world, reportedly making profits of Rs 500 crore annually.[3] Solar panels are today replacing diesel generator sets as a source of energy in this power-starved state with very

ANKUR PALIWAL / CSE

Solar lights are the alternative to a dark future in India's villages: Panels atop a house in Baunth village in Uttarakhand's Tehri district

little grid supply and the demand is purely market driven.

In remote rural areas off-grid systems are more feasible than extending the grid. In such areas electricity consumption is low and it is difficult to recoup the costs of transmission from these consumers. The capital costs are also high for grid extension.[4] In comparison, off-grid renewable energy-based systems generate electricity at the point of consumption. They are also capable of reduction in greenhouse gases by reducing kerosene consumption. Bihar is the second largest user of kerosene – about 15.6 million households – as a source of lighting in India.[5]

Deba is one of the 50 villages located in the Barnawapara Wildlife Sanctuary in Mahasamund district, Chhattisgarh that have no access to electricity owing to their remoteness and the terrain. But all the houses in Deba are lit up thanks to a 4-kilowatt (kW) solar power plant and a micro-grid which connects it to all households. The plant generates 28 units of electricity each day, enough to light all houses and lanes of Deba with CFLs for seven hours a day, without fail: from 4 to 6 am and 6 to 11 pm. Earlier, the villagers had to depend on kerosene, which they said provided very poor light.[6] The Chhattisgarh Renewable Energy Development Agency (CREDA) installed the first micro-grid in 2004 and by May 2012, 1,439 remote villages in the state had been electrified through micro-grids, with a total capacity of 3,500 kW lighting up 58,000 families in remote villages. Some of this work has been done under the centrally-sponsored Remote Village Electrification Programme (RVEP).[7] Research has proven the feasibility of such decentralised systems for villages located away from the grid.[8]

Solar home lighting systems have proved to be a boon for un-electrified remote villages of Uttarakhand. Avani, a non-governmental organisation based in Tripuradevi, Pithoragarh district of Uttarakhand has not only provided solar home lighting systems to around 2,500 families in more than 254 villages in the Kumaon region of Uttarakhand, but also trained village youth to install, repair and maintain such systems.[9] Social

enterprises such as Avani have played a big role in popularising solar-energy based products in several parts of the country and in remote villages with no access to electricity.

As of November 2011, there were about 10,000 remote villages in India that were completely un-electrified.[10] Located far away in areas where the power grid may never reach, these villages depend on either kerosene or biomass for their basic lighting needs. The 2011 Census of India has some telling figures: about 77.5 million households still depend on kerosene for their basic lighting needs. Another million use other oil or wood while 1.2 million households have no access to any form of lighting sources.[11]

The 2011 Census: a case for solar

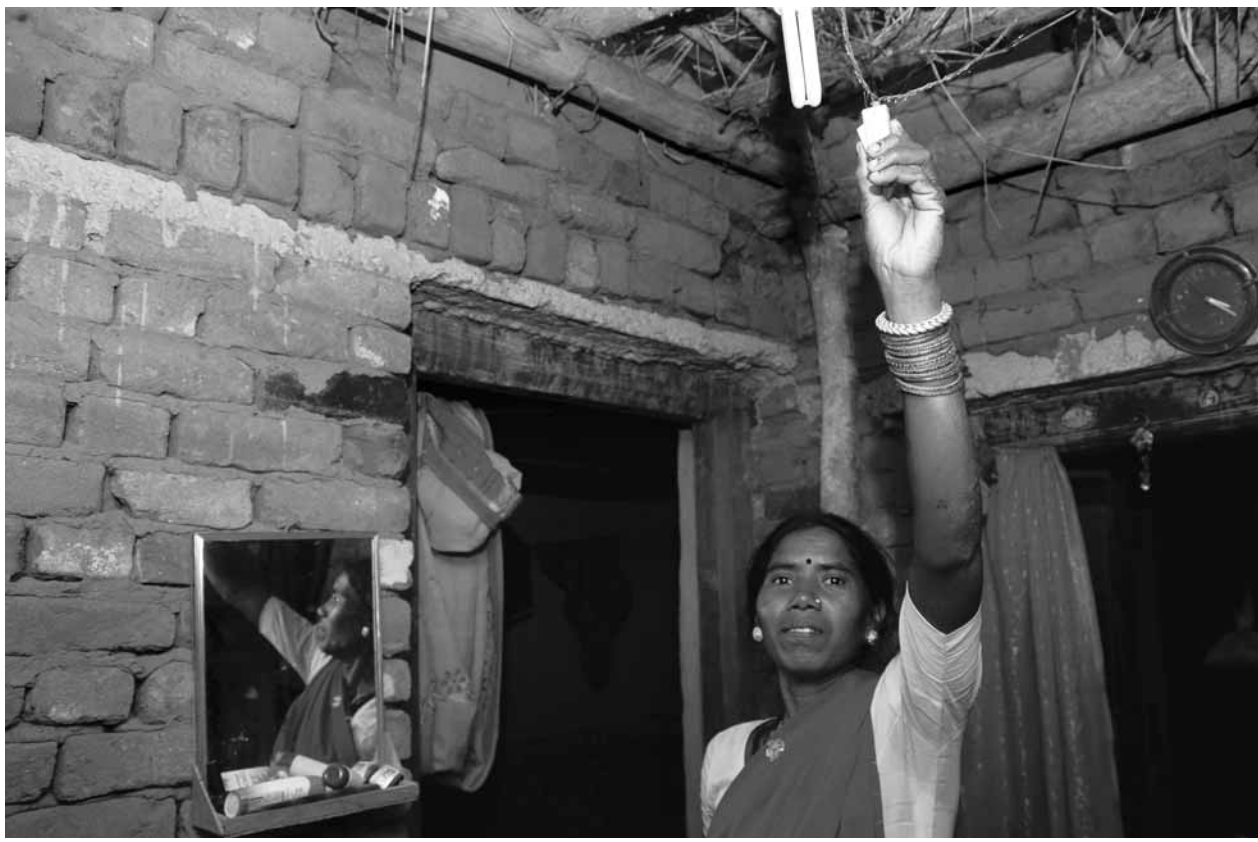
The Census of 2011 has thrown up data which have a bearing on planning for solar. It records that there were 246,692,667 residential households in the country. Out of these, 67.3 per cent (165,897,294) had access to grid power, 31.4 per cent (77,545,034) used kerosene and only 0.4 per cent (1,086,893) used solar lighting systems for lighting. Overall, 0.5 per cent (1,164,584) had no access to any energy sources for lighting.[12]

If we take a closer look at the scenario, 92.7 per cent (73,089,256) of urban households had access to grid power, only 6.5 per cent (5,109,731) used kerosene and few used solar systems, which is about 0.2 per cent (170,690) of the urban households. About 0.3 per cent (229,436) used wood and other oils. Those without access to electricity stood at 0.3 per cent, or 266,824 households.[13]

In the case of rural households, access to grid power stood at 55.3 per cent (92,808,038). There was a substantial usage of kerosene – 43.2 per cent (72,435,303). Just about 0.5 per cent (916,203) households used solar home lighting systems and 0.5 per cent (897,760) had no access to energy. About 0.4 per cent (769,426) used wood and other oils[14] (see Tables 1.1 and 1.2: *Number of households using various sources of lighting, 2001 and 2011*).

Five states – Uttar Pradesh, Bihar, Odisha, Madhya Pradesh and Assam – constitute 63.2 per cent of the total households without any access to grid power in the country. In these electricity-

The large potential for off-grid solar applications has activated the interests of social businesses, financial institutions and NGOs



SURYA SEN / CSE

Table 1.1: Number of households using various sources of lighting, 2001

Item No.	Source of lighting (2001)	Absolute number			Percentage		
		Total	Rural	Urban	Total	Rural	Urban
a	Total households	191,963,935	138,271,559	53,692,376	100	100	100
b	Electricity	107,209,054	60,180,685	47,028,369	55.8	43.5	87.6
c	Kerosene	83,127,739	76,896,701	6,231,038	43.3	55.6	11.6
d	Solar energy	522,561	394,425	128,136	0.3	0.3	0.2
e	Other oil	184,424	146,165	38,259	0.1	0.1	0.1
f	Any other	305,308	227,210	78,098	0.2	0.2	0.1
g	No lighting	614,849	426,373	188,476	0.3	0.3	0.4

Source: Census of India, 2001

Table 1.2: Number of households using various sources of lighting, 2011

Item No.	Source of lighting (2011)	Absolute number			Percentage		
		Total	Rural	Urban	Total	Rural	Urban
a	Total households	246,692,667	167,826,730	78,865,937	100.0	100.0	100.0
b	Electricity	165,897,294	92,808,038	73,089,256	67.2	55.3	92.7
c	Kerosene	77,545,034	72,435,303	5,109,731	31.4	43.2	6.5
d	Solar	1,086,893	916,203	170,690	0.4	0.5	0.2
e	Other oil	505,571	407,919	97,652	0.2	0.2	0.1
f	Any other	493,291	361,507	131,784	0.2	0.2	0.2
g	No lighting	1,164,584	897,760	266,824	0.5	0.5	0.3

Source: Census of India, 2011

starved states, solar has started to slowly replace kerosene as a lighting source: Uttar Pradesh and Bihar are the largest users of solar lighting systems. Maharashtra ranks at the top of the list of states with households that have no access to lighting. Gujarat, the state with highest grid-connected solar power in India, has the second largest number of households without access to any forms of lighting (see Box: *Five states: the energy sources*).

If one compares data from the 2001 and 2011 Census, in 2011, 1,086,893 households used solar lighting systems: nearly twice the number of households – 522,561 – as identified by Census 2001.[15] This increase cannot be attributed only to government programmes. Social businesses, financial institutions and non-governmental organisations have also been instrumental in the deployment of off-grid solar home lighting systems to energy-deprived poor. The large potential for off-grid solar applications attracted these sectors. Certain successful business models have been exhibited by these sectors in this field, although these models have been unable to scale up to the national level.

In the decade of 2001-2012, 58.8 million households have gained access to lighting through electricity. Under the Rajiv Gandhi Vidyutikaran Yojana (RGGVY), a total of Rs 25,913 crore has been spent until 2011. Although the entire 58.8 million households need not have gained electrification through the extension of the grid

FIVE STATES: THE ENERGY SOURCES

The energy profile of states provides a clear direction on the need for focus – states that remain un-reached by power and electricity provide the opportunity for the future

Access to the grid

- Uttar Pradesh, among all states in India, has the largest number of households [32,924,266] to begin with. The state also has the largest number of households [20,808,136] without access to grid power. This is about 8.5 per cent of the total number of households [246,692,667] in the entire country. Only 36.8 per cent of the households in UP [12,116,130] have access to electricity.
- Bihar has slightly more than half the number of households in UP [18,940,629]. However, it is close to UP in terms of those that lack access to grid power [15,834,366]. This is about 83.6 per cent of the total number of households in the state.
- UP and Bihar are followed by Odisha [5,506,819], Madhya Pradesh [4,924,339] and Assam [4,005,029] in terms of the number of households in each state without access to grid power. These five states together constitute 36.8 per cent of all the households in the country. However, 63.2 per cent of the households that lack access to grid power also lie in these five states.

Kerosene usage

- 97.9 per cent of households in UP that lack access to grid power [20,808,136] use kerosene [20,380,121] for their lighting purposes. This observation is similar in the other states as well – Bihar (98.6 per cent), Odisha (97 per cent), Madhya Pradesh (97.6 per cent) and Assam (98.3 per cent).
- In southern India, at least a million households in each state including Tamil Nadu, Karnataka and Andhra Pradesh still depend on kerosene as their basic source of lighting.
- 95.9 per cent of all the households in the country without access to grid power [77,545,034] depend on kerosene as their source of light. This comes to 31.4 per cent of all the households in the country [246,692,667].

Lighting through solar

- In 2011, West Bengal was the highest user of solar lighting systems [240,807 households] for its basic lighting needs. This is 2.6 per cent of all the households without access to grid power in West Bengal. However, 95.6 per cent of the state's households without access to grid power still depend on kerosene for their lighting needs.
- Uttar Pradesh is the second largest user of solar energy [164,621 households] as a source for lighting needs, which accounts for only 0.8 per cent of the households without access to grid power. This is followed by Bihar where 0.7 per cent of the households without access to grid power [113,644] depend on solar lighting systems. Again, in each of these two states, at least 98 per cent of the households without access to grid power depend on kerosene for their lighting needs.

No access to electricity

- The Census also reveals figures on households that have no access to lighting whatsoever, be it kerosene, solar or any other oils. Maharashtra has the highest number of households [214,475] that have absolutely no access to any sources of lighting.
- Gujarat has the second highest number of households [121,817] in this category followed by Odisha [106,271], Rajasthan [100,650] and West Bengal [100,336].

[Also see Annexure 2A: Distribution of lighting in households across Indian states, 2011]

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About 1.2 million households have no access to any lighting. The decadal increase of un-electrified households stands at 618,614. They present an immense challenge as well as potential for the solar power sector

under RGGVY, it would be safe to assume that a majority were electrified under this Central government scheme. Out of this, 16.47 million connections are for BPL (below poverty line) households covered under the RGGVY.[16]

In the same period, the Union ministry of new and renewable energy (MNRE) spent Rs 634.19 crore under RVEP to provide basic lighting facilities using SPV applications. Around 8,500 villages and 1,400 hamlets received solar power during this period.[17] These efforts to increase access to energy for remote households have helped in decreasing the usage of kerosene. At least 5.6 million (5,582,705) households have withdrawn their usage of kerosene for lighting purposes over the decade. Besides, 5.3 million households have also withdrawn their usage of kerosene for cooking purposes over the decade.[18]

This has led to a reduction in the allotment of kerosene under the public distribution system by 16.87 per cent from an allotment of 10,490,199 tonnes for the year 2000-01 to 8,719,546 tonnes for the year 2010-11.[19] This is, in effect, a reduction of 1,770,653 tonnes which amounts to a huge 2.254 billion litres of kerosene saved, a tonne of kerosene being equivalent to 1,273 litres. According to a World Bank report, a litre of kerosene emits 2.45 kg of carbon dioxide into the atmosphere.[20] Therefore, keeping in mind just kerosene consumption, India has reduced its carbon emissions by 5.5 million tonnes by 2011 (as compared to 2001 figures).

Despite this, about 1.2 million households still live in darkness as they have no access to any form of lighting. This is twice the number of households as compared to the Census count in 2001: 0.61 million.

The total number of residential households during the decade (2001-2011) increased by about 54.7 million in India, from 191,963,935 in 2001 to 246,692,667 in 2011. Going by the fact that 58.8 million households had gained electrification in the same decade, the rate of electrification of households in India is greater than the rate at which new households are being built. This fast pace can be attributed to the goal that was set to electrify all households by 2012 by the Union ministry of power (MoP) through the Rural

Electrification Policy (2006). However, India is still way short from achieving this goal. The number of un-electrified households has doubled during this period – from 614,849 in 2001 to 1,233,463 in 2011. The question is if the solar 'off-grid' model for rural electrification can be adopted in these un-reached villages.

Lighting up rural India: a status check

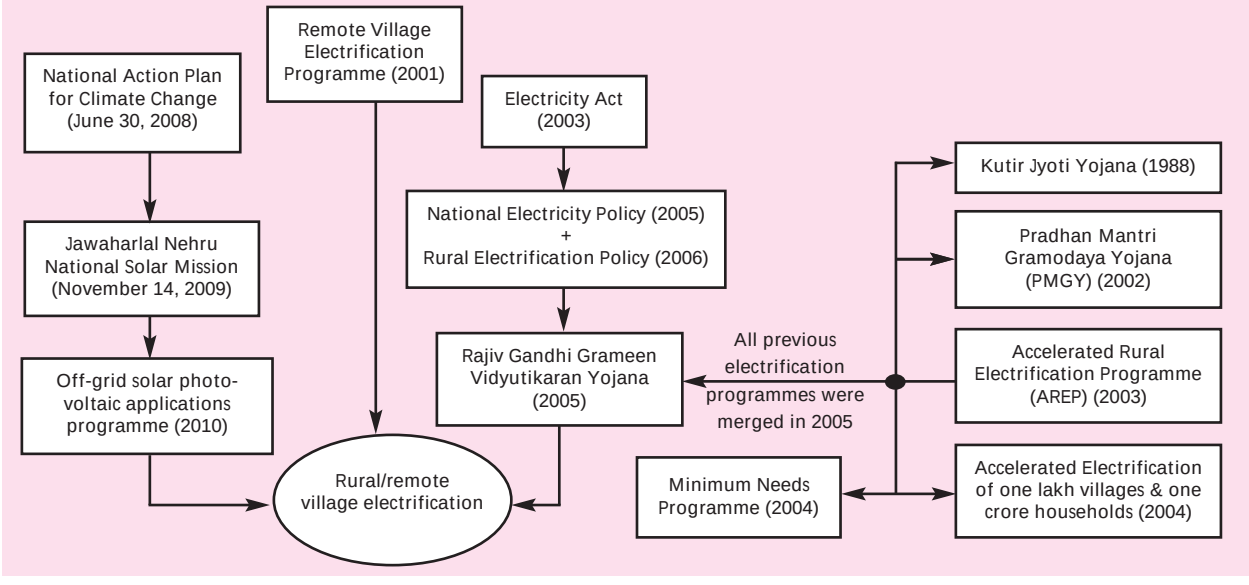
The Kutir Jyoti scheme launched in 1988 by the Union ministry of power (MoP) was one of the earliest programmes that initiated the task for rural electrification in India (see Figure 1.1: *Evolution of electrification programmes for rural areas*). It had a basic objective – to extend single-point light connections to the rural poor living below the poverty line, with special quotas for scheduled castes and tribes. However, the scheme attracted some criticism. On one hand, the increasing transmission and distribution losses as the grid was being extended to serve rural areas came in for criticism.[21] There were also reports of widespread misuse of the programme. A 2003 World Bank report suggests that the scheme "would be more effective and efficient in providing the poor with grid access if there were better identification of the targeted population and beneficiaries served."[22] In May 2004, this scheme was incorporated within a new programme under the MoP – the 'Accelerated electrification of one lakh villages and one crore households programme'.[23]

In the same year, the Planning Commission also introduced the Minimum Needs Programme as part of the Fifth Five Year Plan. It was designed to establish a network of basic services and facilities of social consumption with rural electrification being one of the key elements.[24] Two other programmes under the MoP were also operational around this time. The Accelerated Rural Electrification Programme (2003) provided assistance for electrification via conventional and non-conventional sources of energy. The Pradhan Mantri Gramodaya Yojana (2002) had six components which included rural electrification.[25]

Thus, at this point in time, the MoP was primarily focussed on extending the grid connection to households. It had not really opened up to decentralised solutions for electrification. In fact, the definition of 'electrification' then current with the ministry had a very general contour: "A village will be deemed to be electrified if the electricity is used in the inhabited locality, within the revenue boundary of the village for any purpose whatsoever".[26]

In April 2004, the MoP brought forth a more specific definition of 'electrification' which laid emphasis on providing electrification infra-structure to a certain percentage of the households and all the public places in the village.

Figure 1.1: Evolution of electrification programmes for rural areas



Source: Centre for Science and Environment (CSE), 2011

ELECTRIFICATION ACCORDING TO POWER MINISTRY: UNDERMINING SOLAR SYSTEMS

A village would be classified as electrified based on a certificate issued by the *gram panchayat* certifying that:

(a) Basic infrastructure such as distribution transformers and distribution lines are provided in the inhabited locality as well as one dalit basti/hamlet where it exists,

(b) Electricity is provided in public places like schools, panchayat office, health centres, dispensaries, community centres, etc and

(c) The number of households electrified are at least 10 per cent of the total number of households in the village.[1]

The MNRE does not provide basic infrastructure like transformers for distribution and power lines because they are not needed for applications like solar home lighting systems and street lanterns. This makes these villages still 'un-electrified' as per the power ministry's definition even after providing solar home lighting systems. The MNRE's programme has been considered a temporary measure until the grid reaches the village in the as yet indefinite future. By providing home lighting systems, every household would receive at least 3-5 hours of lighting every day. However those villages that are connected to grid power receive poor quality of electricity. These villages sometimes receive electricity only once in three days and at other times very intermittently. Still, villages receiving power from the grid, would be considered 'electrified' as against the villages that were provided longer hours of lighting through solar home lighting systems. The new definition, has undermined the usage of stand-alone renewable energy systems.

However, the definition mainly laid emphasis on conventional sources for generating electricity, as solar home lights and street lights did not come up with basic transmission and distribution infrastructure (see Box: *Electrification according to ministry of power: undermining solar systems*). In 2005, the National Electricity Policy and in 2006, the Rural Electrification Policy, direct outcomes of the Electricity Act of 2003 (see Box: *Electricity Act, 2003: the legal and policy framework for renewables*), laid emphasis on this new definition and also addressed the need for renewable energy sources for off-grid and decentralised projects.

In 2005, all the previous schemes under the MoP aimed at rural electrification were merged to form the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY), a flagship programme. The RGGVY initiated the use of stand-alone renewable energy systems as an option for provision of electricity to poor households to which grid extension was not possible. Under this programme, there is also an option to set up community power plants (independent of the grid) as part of a decentralised distributed generation (DDG) scheme. The scheme allows for the use of mini-grids powered by conventional and non-conventional energy sources or a combination of

ELECTRICITY ACT, 2003: THE LEGAL AND POLICY FRAMEWORK FOR RENEWABLES

The first steps towards a framework for creating policies aimed at rural electrification which incorporate the use of renewable energy systems can be found in Sections 4 and 5 of the Electricity Act, 2003.

Section 4: (National policy on stand-alone systems for rural areas and non-conventional energy systems): The Central government shall, after consultation with the state governments, prepare and notify a national policy, permitting stand-alone systems (including those based on renewable sources of energy and other non-conventional sources of energy) for rural areas.

Section 5: (National policy on electrification and local distribution in rural areas): The Central government shall also formulate a national policy, in consultation with the state governments and the state commissions, for rural electrification and for bulk purchase of power and management of local distribution in rural areas through panchayat institutions, users' associations, co-operative societies, non-governmental organisations or franchisees.[1]

both. Although funds have been sanctioned for these projects by the power ministry, none of them have been commissioned yet (see Box: *Decentralised distributed generation*). This is what needs to be understood.

The MNRE and off-grid solar

On the solar energy front, however, the country has had an active programme in the field of stand-alone SPV applications for more than a decade. From 2001 onwards, the MNRE started installing

DECENTRALISED DISTRIBUTED GENERATION

Under the DDG scheme of the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY), there is significant potential to deploy off-grid renewable energy systems. Projects have been sanctioned for 220 villages, but none have been commissioned. A Right to Information (RTI) response received in February 2012 from the Rural Electrification Corporation (REC) – the nodal agency for electrification projects under the power ministry – claimed that no funds had been utilised. Therefore, the number of villages electrified under the DDG scheme can be considered nil. On the other hand, as of August 2012, 104,456 villages have been covered under RGGVY for grid extension. Hence, under the power ministry, grid extension to villages remains the prime focus.

Table: Status of decentralised distributed generation programmes

State	Type of project	Sanctioned amount (Rs crore)	Total capacity of projects (kW)	Number of villages/ hamlets proposed to be electrified
Uttarakhand	**Micro-hydel**	**27.05**	**200**	**2**
West Bengal	Hybrid (bio-diesel + SPV)	69.92	600	1
	Hybrid (bio-diesel + SPV)	67.20	500	2
	Biomass briquettes fired boilers TG sets	217.25	1,500	7
	Biomass briquettes fired boilers TG sets	216.58	1,500	8
	Hybrid (biomass gasifier + SPV)	130.83	880	5
	Hybrid (biomass gasifier + SPV)	105.31	705	7
	Hybrid (biomass gasifier + SPV)	52.44	300	2
	Hybrid (biomass gasifier + SPV)	74.39	590	3
	Hybrid (bio-diesel + SPV)	59.48	500	4
Total (West Bengal)		**993.44**	**7,075**	**39**
Chhattisgarh	SPV (9 projects)	29.43	56	9
	SPV (10 projects)	75.83	177	10
Total (Chhattisgarh)		**105.26**	**233**	**19**
Andhra Pradesh	**SPV (57 projects)**	**169.42**	**365**	**57**
Uttar Pradesh	SPV (7 projects)	32.37	79	103
	SPV (14 projects)	373.39	973	
	SPV (41 projects)	235.19	588	
Total (Uttar Pradesh)		**640.96**	**1,640**	**103**
	148 projects	**1,936.15**	**9,513**	**220**

Note: The funds utilised for the projects so far is nil
Source: RTI No. REC/RTI/390/11-12/, received by CSE on February 30, 2012

solar home lighting systems and street lighting systems on a large scale across India through two key policy vehicles which had been in existence for some years – the solar photo-voltaic (demonstration and utilisation) programme and the solar photo-voltaic water pumping programme (see Box: *Solar photo-voltaic programmes*).

After the 2001 Census, the MNRE initiated the Rural Village Electrification Programme (RVEP), after identifying 18,000 remote un-electrified villages. The programme was to provide basic lighting systems using SPV applications. It was proposed that all the identified villages be provided lighting systems by the end of 2012. But as per data from March 2012, the ministry has managed to complete electrification of only about 9,009 villages.[27]

During the early stages of the RVEP, in a notable project, 39 remote villages in Leh district and 18 villages and 27 hamlets in Kargil district of Ladakh were electrified. The project was sanctioned to the Jammu and Kashmir government and implemented by the Ladakh Autonomous Hill Development Council. A target to provide 10,000 solar home lighting systems and 6,000 solar lanterns to these villages was set. The project cost was estimated at Rs 20 crore of which 90 per cent was subsidised by the MNRE. At least 60 per cent of the households in a village would have to be provided SHS for the village to be considered electrified. The project was completed in 2003.[28] By March 30, 2010 close to 800,000 million street lighting systems and a little over 600,000 million

JOEL KUMAR / CSE

Solar street lighting systems were rolled out by MNRE from 2001

SOLAR PHOTO-VOLTAIC PROGRAMMES

The first solar photo-voltaic (SPV) programme was started in 1976 by the Department of Science, Government of India. This was a research and development programme focused on development of solar cell technology. The 'solar photo-voltaic (demonstration and utilisation) programme' was initiated in 1980. Under this programme, commercial establishment of solar applications was the focus. A range of SPV applications were tested and developed. They included home lighting systems, railway signals powered by solar, small power plants, water pumping sets, etc. During these stages, the Centre subsidised 50 per cent of the capital cost and the beneficiary would pay the rest. Many government organisations and agencies put up SPV plants in their buildings to test the viability of the new technology. This programme was later called the solar photo-voltaic programme and helped in the deployment of various SPV applications across the country.

Water pumps powered by solar energy were one of the first SPV applications to be developed in India. In 1993, the Central government came up with the 'solar photo-voltaic water pumping programme' that provided soft loans for 90 per cent of the cost of the systems after including a 10 per cent capital subsidy.

These programmes were implemented up to 2010, when the Jawaharlal Nehru National Solar Mission superseded them.

Table 1.3: Off-grid applications, March 30, 2010

Type of application	Installed till date
Street lighting system	797,344
Home lighting system	603,307
Solar lanterns	119,634
Power plants (kWp)	2,922
Solar PV pumps (nos)	7,334

Source: March 2010, Union ministry of new and renewable energy, Government of India

home lighting systems had been installed in the country (see Table 1.3 *for March 2010 data*).

The Solar Mission: 2010

In 2008 the National Action Plan for Climate Change (NAPCC) issued by the Prime Minister's Council for Climate Change put forth an agenda to rapidly upscale the use of solar energy technologies in the energy mix of the country. The Jawaharlal Nehru National Solar Mission (JNNSM) was established in 2010 as a direct result of the NAPCC mission statement. It notes: "A National Solar Mission will be launched to significantly increase the share of solar energy in the total energy mix while recognising the need to expand the scope of other renewable and non-fossil options such as nuclear energy, wind energy and biomass. Solar energy, therefore, has great potential as a future energy source. It also has the advantage of permitting a decentralised distribution of energy, thereby empowering people at the grassroots level. Photo-voltaic cells are becoming cheaper with new technology."[29]

The JNNSM superseded all the previous solar schemes (both rural and urban applications) with new targets of 2,000 megawatt (MW) for off-grid

Way to go: why are our solar energy schemes failing to provide energy access to the millions still outside the grid?

ANKUR PALIWAL / CSE

SPV applications and 20 million solar lanterns by 2022. The JNNSM policy document notes: "The immediate aim of the Mission is to focus on setting up an enabling environment for solar technology penetration in the country both at a centralised and decentralised level. The first phase (up to 2013) will focus on capturing the low hanging options in solar thermal, on promoting off-grid systems to serve populations without access to commercial energy and modest capacity addition in grid-based systems".[30]

In the first phase of JNNSM till 2013, a target of 200 MW in terms of aggregate off-grid SPV capacity has been set. According to the MNRE, 40.648 MW of projects have been installed in 2010-11 using off-grid SPV applications as against a target of 40 MW.[31]

As of today, the Central government's flagship schemes to reach electricity to remote locations are the MNRE's RVEP and JNNSM and the power ministry's RGGVY. The question is why these schemes are failing in providing energy access to the millions still outside the grid. The question is how these schemes and funds can be used to bring the lights of solar to these homes. What is working and how can experiences be upscaled to make a difference?

CHAPTER 2

Remote Village Electrification Programme

RVEP, as this programme is called, was started over a decade ago: the aim was to reach the energy un-reached villages in remote regions. It has an elaborately designed system to identify villages, plan, bid out the project and implement the programme. It even has a system for periodic reporting. Despite this, the programme has been unsuccessful. Why? CSE reporters visited villages in three states – Uttarakhand; Assam and Chhattisgarh – and stumbled upon a story of opportunity and challenge. First, the good news: in all these villages, solar household energy systems are accepted and demanded. In fact, solar energy is preferred over grid-based power, which is either unreliable or too expensive. But solar energy programmes as designed currently limit their outreach and usage. People want systems that are capable of meeting their growing energy needs. In other words, it is imperative that solar energy systems for poor must not be seen as transitory solutions – till the grid energy takes over. Solar energy systems must be designed to make the poor rich.

What is also clear – and this is the bad news – is that household solar energy systems suffer from fundamental manufacture defects – not in the solar module, but in the CFL bulbs or the battery supplied in the package. Also, the system of distributing subsidized solar household packages is riddled with corruption and bad practices. It is not clear if the government has the capacity or governance abilities to launch an individual household distributed energy system that will actually work. Instead, the answers are coming from Chhattisgarh's mini-grid system where households are supplied energy on payment. The draft revision of the RVEP learns from this experience. But will it go far enough?

In 2001, the Union ministry of new and renewable energy (MNRE) formulated the Remote Village Electrification Programme (RVEP) in order to electrify all un-electrified remote Census villages and hamlets identified by the Census, by 2012. The following renewable resources could be used in order of preference: small/micro hydro power, biomass gasification, biogas engines or community solar power plants.

However, in villages where such decentralised distributed generation (DDG) was not feasible due to lack of sustainable resources, basic solar home lighting systems (SHS) using solar photo-voltaic (SPV) technology would be encouraged.

Such a village would be deemed to be electrified if at least 60 per cent of the proposed households were provided with SHS by the implementing agencies.[2] This was later changed adhering to the provisions of the new definition of an 'electrified village' as per the Union ministry of power (MoP).[3] Under this definition, a village would be considered 'electrified' if 10 per cent of its households are connected. But there is a catch: the definition includes the provision of basic

infrastructure like distribution transformers. But as solar energy systems do not require this paraphernalia, the village -- even if 60 per cent households are reached -- is not considered to be 'electrified'. In this way, off-grid solar energy has been typecast as an intermediate solution, till grid-based energy reaches the village.

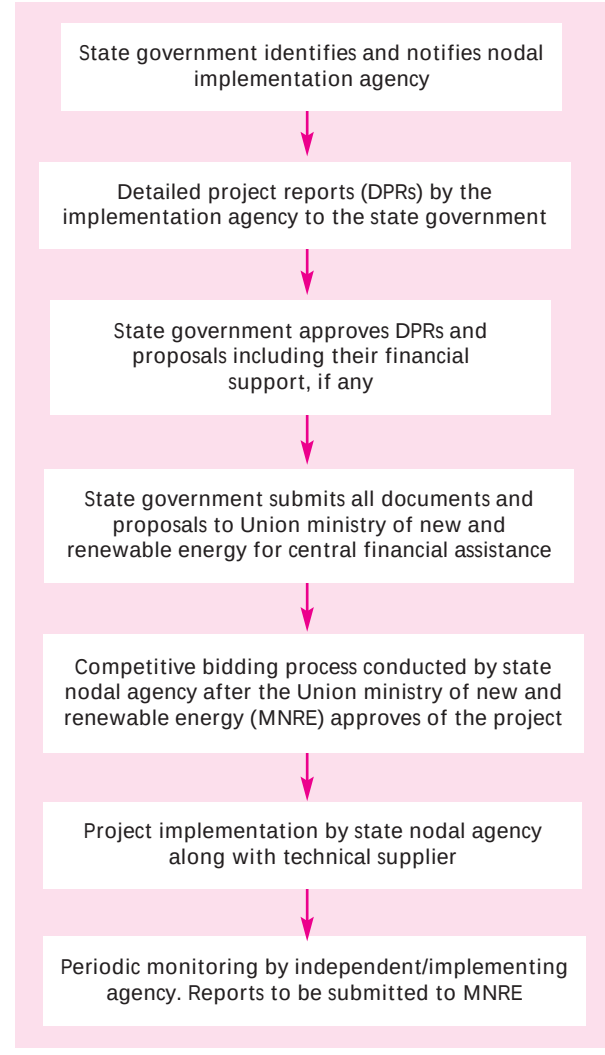
RVEP: Status of implementation

Electricity is a concurrent subject between the Central and state governments. Every state has a state nodal agency which implements the programme on behalf of the MNRE. State electricity boards first identify the remote villages that cannot be electrified through conventional grid power (see Box: *Identifying a remote village for electrification*). A list of identified villages that require electrification under RVEP is sent to the agency which forwards it to the MNRE for clearance (see Figure 2.1: *Modality of RVEP*).

Since the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) under the Union ministry of power is also active in extending the power grid to rural un-electrified areas, its implementing agency, the Rural Electrification Corporation (REC) identifies if a village is already listed for electrification.

Once the REC approves the villages to be considered by MNRE, the state nodal agencies prepare a detailed project report (DPR). It includes information on available energy resources in the villages, technical details such as the number of systems and size of power plant required, cost of installation, population and the households proposed for installation.

Figure 2.1: Modality of RVEP



Source: Centre for Science and Environment (CSE), 2011

IDENTIFYING A REMOTE VILLAGE FOR ELECTRIFICATION

There is no definition of a remote village by the Union ministry of new and renewable energy (MNRE) in terms of the distance from the nearest sub-station. Some other parameters have been used to narrow down the concept of a remote village. The villages to be taken up for electrification under the Remote Village Electrification Programme (RVEP) should come under the following categories:

- Un-electrifed villages where grid penetration is not feasible due to geographical constraints which are identified by state electrification boards,
- Un-electrifed villages with a population not greater than 300,
- Un-electrifed villages which have not been considered for electrification by the Union ministry of Power under the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY), and
- Un-electrified hamlets with a population not greater than 100.

Furthermore, renewable energy systems need to be feasible in terms of costs, specifically in a situation where it can be compared to the costs of grid-extension to the village.[1]

Table 2.1: How monitoring is done: Data from Raisen district, Madhya Pradesh

Particulars	Details
No of villages (Raisen district, Madhya Pradesh)	16
Project sanction number	MPUVN/RVE-137/2009-10/1982
Dated	September 25, 2009
Solar home lighting systems (SHS) installed	1,528
Number of SHS not working	317
Percentage of SHS not working	20.75
Solar street lighting systems (SLS) installed	155
Number of SLS not working	20
Per cent of SLS not working	12.90

Note: The report includes a signature of the beneficiary acknowledging receipt of the system in good condition.
Source: Anon 2009, 'Third party verification of SPV Home Light (MPDEL-I) and street lighting system installed and commenced under Remote Village Electrification Programme of MNRE in District - Raisen (16 villages)', compiled by MPCON Ltd for MP Urja Vikas Nigam, September 25

The MNRE scrutinises the DPR and on its approval sends a sanction letter to the relevant state nodal agency to proceed further. At least 70 per cent of the assured funds from MNRE are released to the state nodal agency at this point. These funds are used till the project is commissioned, when the rest of the finances are disbursed by the ministry. For release of the final tranche, two levels of clearance is needed. An authorisation certificate comes from the village/district level bodies, stating that work has been carried out as per the sanction order. The ministry also scrutinises a third party monitoring report after the completion of the project. It is commissioned by the ministry itself and the data generated is crucial to track the implementation during the last lap (see Table 2.1: *How monitoring is done*).

Under RVEP, the Union ministry provides a 90 per cent capital subsidy.[4] The rest 10 per cent of the cost can be contributed by the states, the end user or shared between the two.

The household solar package: A supplier for the solar household system (SHS) is identified through a tender in local media issued by the state nodal agency. The winning bidder handles the supply of systems, installation and commissioning. It also comes with a five-year maintenance contract.

Under RVEP, the supplier is identified through a competitive bidding process. Sometimes, if the lowest bidder cannot provide the required systems, the next lowest bidder also wins a share of the supply. This way, more than one supplier can be involved with a project. Systems are procured only from bidders holding MNRE-authorised test certificates.

Usually, a standard SHS, the Model-II comprising two CFL (compact fluorescent lamp) lights, 37 Watt-peak (Wp) module is handed out under RVEP. "Households of BPL families who cannot afford the system, sometimes receive the single light, 18 Wp module. Similarly, most solar street lighting uses the 74 Wp module which comes with a 11 Watt (W) CFL lamp," according to Anindya Parira, scientist, MNRE (see Table 2.2: *Central financial assistance for photo-voltaic applications, 2010-11*).[5]

On the other hand, energy service-providing companies independent of government subsidies, tend to use LED (light-emitting diode) lights. These are very luminous and economical when compared to CFLs since they require lesser power (see Box: *The economics of LEDs*).

Report card: As of November 2011, 8,794 villages have been provided with renewable energy systems under the RVEP, as of November 2011.[6] The REC states that there are 10,677 un-electrified remote Census villages in India, as of January 2011.[7] Thus, as of November 2011, electrification in at least 45 per cent of these remote villages has been completed.

Out of the un-electrified villages, 21 per cent are in Assam, 15 per cent in Odisha and 9.5 per cent in Jammu & Kashmir. These states need to be

Table 2.2: Central financial assistance for photo-voltaic applications, 2010-11

Application	Specification	Subsidy (Rs)	Benchmark costs (Rs)
Solar home lighting system	18 Wp module; 1 CFL light	5,895	6,550
	37 Wp module; 2 CFL lights	11,250	12,500
Solar street lighting system	74 Wp module; 11 W CFL lamp	19,602	21,780
Community solar power plant	Solar photo-voltaic power plant with battery	315,000 (per kW)	–

Source: Anon 2009, 'Programme for electrification/lighting of remote un-electrified Census villages and remote un-electrified hamlets of electrified Census villages through renewable energy sources – administrative approval for the year 2009-10 – regarding', administrative order No. 15/1/2009-10-RVE, July 14, Union ministry of new and renewable energy, Government of India, New Delhi

prioritised under the RVEP in future (see Table 2.3: *Status of remote village electrification programme*).

The RVEP villages are either provided SHS or electrified through a community power plant. According to Rajesh Dube, scientist, MNRE, "the ministry has provided SHS to at least 95 per cent of the villages under RVEP." Thus, less than 5 per cent of the projects are community power plants. However, there is no specific information on the number of these plants installed and the funds utilised for 'electrification', as per the terms of the new definition. According to an RTI response received by CSE: "The MNRE does not maintain the list of villages that have been electrified using community power plants based on small-hydro, biomass and solar under this programme."[8] Since

THE ECONOMICS OF LEDS: THE FUTURE OPTION

Llight-emitting diodes (LEDs) are now being considered for use to replace compact fluorescent light (CFL) bulbs. This is because in terms of life cycle energy cost, LEDs score over other types of bulbs. Tested LED products claim to have a life span of 50,000 to 100,000 hours unlike CFLs which have a life span of 10,000 hours and incandescent bulbs with just 1,200 hours. LEDs have more lumens per Watt as compared to CFL's and therefore conserve more energy. Their visibility per lumen is also superior compared to the other technologies readily available in the market.

Since LEDs provide more light for lesser power they require much smaller capacity panels than the current 37 Wp required by two CFLs. The cost of the entire system would go down if two LEDs instead of two CFLs are used. However, the Union ministry of new and renewable energy (MNRE) is yet to revamp its technical specifications to accommodate the usage of LEDs.

Table: Estimate of cost comparison between LEDs, CFLs and incandescent light bulbs

	LED	CFL	Incandescent
Projected lifespan of light bulb	50,000 hours	10,000 hours	1,200 hours
Watts per bulb (equivalent 60 W incandescent bulb)	6	14	60
Cost per bulb (Rs)	1,000	220	20
Electricity used over 50,000 hours (kWh)	300	700	3,000
Cost of electricity (@ Rs 4.17 per kWh)	1,251	2,919	12,510
Bulbs needed for 50,000 hours of use	1	5	42
Equivalent 50,000 hours bulb expense (Rs)	1,000	1,100	2,520
Total cost for 50,000 hours (Rs)	1,351	4,019	15,030

Source: http://www.dredo.org/comparison_between_led__cfl_bulb, as viewed in March 2012

Table 2.3: Status of remote village electrification programme

State	Total funds utilised (Rs lakh) (November 2011*)	No. of villages electrified under RVEP (November 2011*)	No. of un-electrified remote villages (January 2011*)	Percentage electrified (November 2011)	Total remote Census villages
Andhra Pradesh	146.94	13	112	10.40	125
Arunachal Pradesh	1,584.08	305	145	67.78	450
Assam	11,540.08	1766	2,232	44.17	3,998
Bihar	0	0	80	0.00	80
Chhattisgarh	3,435.97	658	1,112	37.18	1,770
Delhi	24.96	0	0	NA	0
Goa	10.24	0	0	NA	0
Gujarat	53.61	38	49	43.68	87
Haryana	276.42	286	149	65.75	435
Himachal Pradesh	251.88	21	1	95.45	22
Jammu and Kashmir	7,819.99	160	1,011	13.66	1,171
Jharkhand	6,877.2	449	703	38.98	1,152
Karnataka	174.98	30	173	14.78	203
Kerala	340.65	49	73	40.16	122
Madhya Pradesh	3,106.6	381	972	28.16	1,353
Maharashtra	3,629.697	338	362	48.29	700
Manipur	2,329.19	191	166	53.50	357
Meghalaya	863.85	149	158	48.53	307
Mizoram	144.75	20	0	100.00	20
Nagaland	100.817	11	11	50.00	22
Odisha	5,423.1	620	1,581	28.17	2,201
Punjab	0	0	0	NA	0
Rajasthan	2,786.72	292	507	36.55	799
Sikkim	16.64	13	0	100.00	13
Tamil Nadu	433.76	0	73	0.00	73
Tiripura	4,544.54	790	483	62.06	1,273
Uttarakhand	2393.238	472	230	67.24	702
Uttar Pradesh	3,508.86	184	201	47.79	385
West Bengal	8,072.5	1558	93	94.37	1,651
Total	**69,891.292**	**8,794**	**10,677**	**45.16**	**19,471**

Sources: *RTI No: 13/1/2010-11/RVE, Dated: 26/12/2011, received from MNRE
**Lok Sabha starred question No. 64, February 25, 2011, http://www.indiastat.com/table/power/26/electrification/84/526675/data.aspx

providing SHS cannot be considered as electrification as per the new definition, the programme has often been called the remote village lighting programme.[9]

Since the MNRE subsidises the programme by 90 per cent of the capital costs, it could claim ownership of these systems. Yet, the ministry does not keep an account of the suppliers.[10] The field visits by Centre for Science and Environment (CSE) and third party reports have shown the negligible maintenance support provided by these suppliers, a serious problem during implementation.

From all the above facts it can be inferred that the ministry neglects the information brought to it by these third party audits, and has never looked back on how the funds provided by it has been utilised so far.

State implementation models: The states adapt the guidelines developed by the Central government according to the situation on the ground. Certain states have been successful while applying these guidelines where others have not.

The MNRE commissioned the National Council of Applied Economic Research (NCAER) to conduct a third-party evaluation of the programme across Odisha, Madhya Pradesh and Chhattisgarh. The 2011 report found that the state had different success rates based on their approach, eventually (see Table 2.4: *Modality of RVEP implementation in various states*).[11]

Although Central financial assistance (CFA) is the same for every state under RVEP, some states have given more importance to certain processes as compared to the others. Some have given importance to setting up energy committees at the village level to build a firm foundation for energy-related activities in these rural areas as they develop. Others have given importance to providing good after sales services with the aid of the manufacturers and local technicians. Some states have given importance to the electrification processes by setting up district-wise targets.

Table 2.4: Modality of RVEP implementation in various states

Process	Odisha	Madhya Pradesh	Chhattisgarh
Installation charges	Rs 100 is collected from the beneficiary households at the time of installation	Rs 100 is collected from BPL households and Rs 200 is collected from APL households	Rs 100 is collected from BPL households and Rs 200 is collected from APL households
Comprehensive maintenance contract (CMC)	Responsibility of the supplier	Responsibility of the supplier	CREDA organises maintenance of the systems without help from the supplier
Maintenance model	OREDA has appointed 153 technicians who regularly visit the village. In case of repairs that cannot be handled by them, they inform the supplier who is supposed to send another technician within a week	Although the CMC exists in paper with a prescribed format for the supplier, no service centre has been set up here, yet. The village energy committees (VECs) are also only on paper	O&M centres are set up by CREDA for every 12-16 villages. There is one trained operator for every village these centres. They are equipped with spare parts and tools. They wear uniforms for easy identification. The VEC or a beneficiary can call for his services
Maintenance costs	Responsibilty of the supplier. Covered in the capital costs. Rs 20-30 is collected from each beneficiary per month after installation. This forms a corpus fund that is used for replacing batteries in the future	Nil	CREDA takes full charge of maintenance, and pays Rs 2,000 a month to technicians, Rs 1,000 to helpers, Rs 400 to operators. The latter also get Rs 5 per month from each beneficiary. CREDA gets Rs 25 per beneficiary from the state government

Note: OREDA: Odisha Renewable Energy Development Agency; CREDA: Chhattisgarh Renewable Energy Development Agency, O&M: Operations and maintenance, BPL: below poverty line, APL: above poverty line
Source: 'Third party evaluation study – Odisha, Madhya Pradesh & Chhattisgarh', conducted by National Council for Applied Economic Research, April 2011, New Delhi (submitted to the MNRE in April 2011)

GROUND TRUTHS: REPORTS FROM THE FIELD

Uttarakhand

The Uttarakhand Renewable Energy Development Agency (UREDA) took up the implementation of RVEP in this hilly state in 2003-04. The agency had distributed 6,127 SHS in 307 villages by 2010, while work towards distributing 2,130 more is underway. It provides the MNRE-standard 37 Wp system with two CFL lamps. However, no community solar power plants have been set up. CP Agrawal, deputy chief project officer, UREDA said that the agency has had a very bad experience with community plants. "Nobody in the village wants to take the ownership. They expect the government to do everything from cleaning the solar panels to small repairs and collection of money," said Agrawal. "With individual systems, at least they have a sense of ownership," he added.[12]

After the beneficiaries have been identified by UREDA, they have to submit the deposit for replacement of the battery in advance, which is decided on its prevailing market cost. If the beneficiaries cannot pay the entire amount, they are asked to submit half of it. The money is placed with UREDA as a fixed deposit in the name of the beneficiary. There is also a two-year warranty within which period the battery is replaced by UREDA free of charge. However, this process has its problems. The village *pradhan* or head is supposed to collect the deposit, but some of them in villages that CSE visited were clueless on why it was collected, and what they could do with it.

CSE randomly chose three districts in Uttarakhand for the case study – Pithoragarh, Almora, and Tehri. The CSE team visited two villages each in Pithoragarh and Almora which were using off-grid systems from UREDA. It also visited a village in Tehri which was off-grid when the SHS were distributed, but had later been connected to the grid under RGGVY. This was useful to compare the benefits of using an SHS against grid power.

Pithoragarh district

Two villages, Galagat and Bung Bung in Dharchula block were cosen for the study, since the maximum number of SHS were distributed there in 2009-10. The nearest electrified village is about 6 km below a hill called Garbadar, while the nearest sub-station is about 32 km away in a town called Tawaghat. There are plans to extend the grid lines to the two villages and others that lie further north. The power lines have not reached these places due to the lack of motorable roads and undulating hills. The Border Roads Organisation is currently laying roads in the block.

The SHS have been welcomed by the residents, since it has lessened their dependence on kerosene. The use of oil is expensive compared to solar power and gives only dim localised light. Most residents had to buy kerosene from the black market because it was not available at the local fair price shop. One litre of kerosene would cost them Rs 25. Average kerosene consumption per household per month was between 8-10 litres. After the introduction of SHS, the consumption of kerosene came down to 3-4 litres per month, used mainly in cooking stoves.

Galagat village: Indira Devi of Galagat is a daily wage earner, barely making Rs 3,000 per month. Yet, she spent Rs 3,000 to get her SHS in 2010. Of this, Rs 2,200 was deposited with UREDA. Another Rs 800 was spent to transport the SHS to the village from UREDA office in Pithoragarh. The taxi hired for the purpose cost around Rs 600, including the return trip. But the taxi could only reach Garbadar after which the SHS had to be transported some 4 km on a mule to the village. The ride cost Rs 200.

She is happy with the system. The solar light has made a great difference in the life of her family -- four children and a handicapped husband. Her children can study and she can finish house chores till late.

The only worry: what to do when the system

ANKUR PALIWAL / CSE

Villagers in Galagat are not aware of the 1-year warranty on CFLs

breaks down? Says Devi: "Though solar light is cheaper than kerosene, the lack of service support, makes it difficult to maintain the system."

UREDA had distributed 100 SHS in the village between 2009 and 2010. The two CFLs provided to Indira Devi stopped functioning in less than six months. The CFL has a year's warranty, but she had not been informed of it. Nor had she been told whom to contact for service and support.

Under RVEP, the manufacturer of the equipment is supposed to provide after sales service for five years. The systems were provided by the Ghaziabad-based Central Electronics Limited (CEL). In two years, not a single person from CEL or UREDA has visited the village. Neither is there any trained technician on hand.

According to UREDA, it has trained around 128 para-technicians so far with 88 more to go. Two para-technicians are placed in each block, but they are not paid any salary. "All the *pradhans* have phone numbers of the technicians, who also charge fees, and can be paid accordingly," said C P Agrawal of UREDA.

But none of the villagers and even the *pradhan* know anything about any technicians. "It would have been better if we had a technician in the village or one who visited the village at least once a month," said Hema Bisht, the village *pradhan*. At her residence, the SHS is in working condition. She says UREDA had assured that a technician would visit the village regularly. "No resident has been trained as a technician, either," she adds.

Bisht complains that for small technical faults, villagers have to rush to Dharchula, 40 km away, which is expensive. The service station of UREDA is located in Pithoragarh town, roughly 80 km from Galagat. It takes an entire day to travel to Pithoragarh and back.

Indira Devi had to visit Dharchula to buy new CFLs. "I was told that CFLs cannot be repaired and that I would have to buy new ones. I bought two, each costing Rs 100," says Devi. In the last two years, she has bought four CFLs. A round trip each time has cost her Rs 400. She has also purchased a battery-run lantern for Rs 375 from Dharchula. She uses it on cloudy days when the sunlight is not strong enough to charge the system or when the SHS malfunctions. The lantern's battery life is three months.

Diwan Singh and Urmila Devi, who also received the SHS in 2010, faced similar problems. The battery is in working condition, but their CFLs fused within six-seven months. They too did not know about the one-year warranty on the CFLs, and had to buy CFLs from Dharchula. They too were clueless regarding the technician. In case their battery too stops working, they do not know how to rectify the problem. Arranging money for a new battery is very difficult. But, they do not seem to know that they can approach UREDA, since money deposited with the agency was meant for battery replacement.

Even village pradhan Bisht is not completely aware. "We were told that the Rs 2,200 deposited would be used if any problem occurs in our system, including replacement of battery," says Bisht. But she does not know that this money is being held in a fixed deposit and villagers will have to pay the balance if the amount of the matured deposit is not sufficient to pay for the battery replacement at current rates.

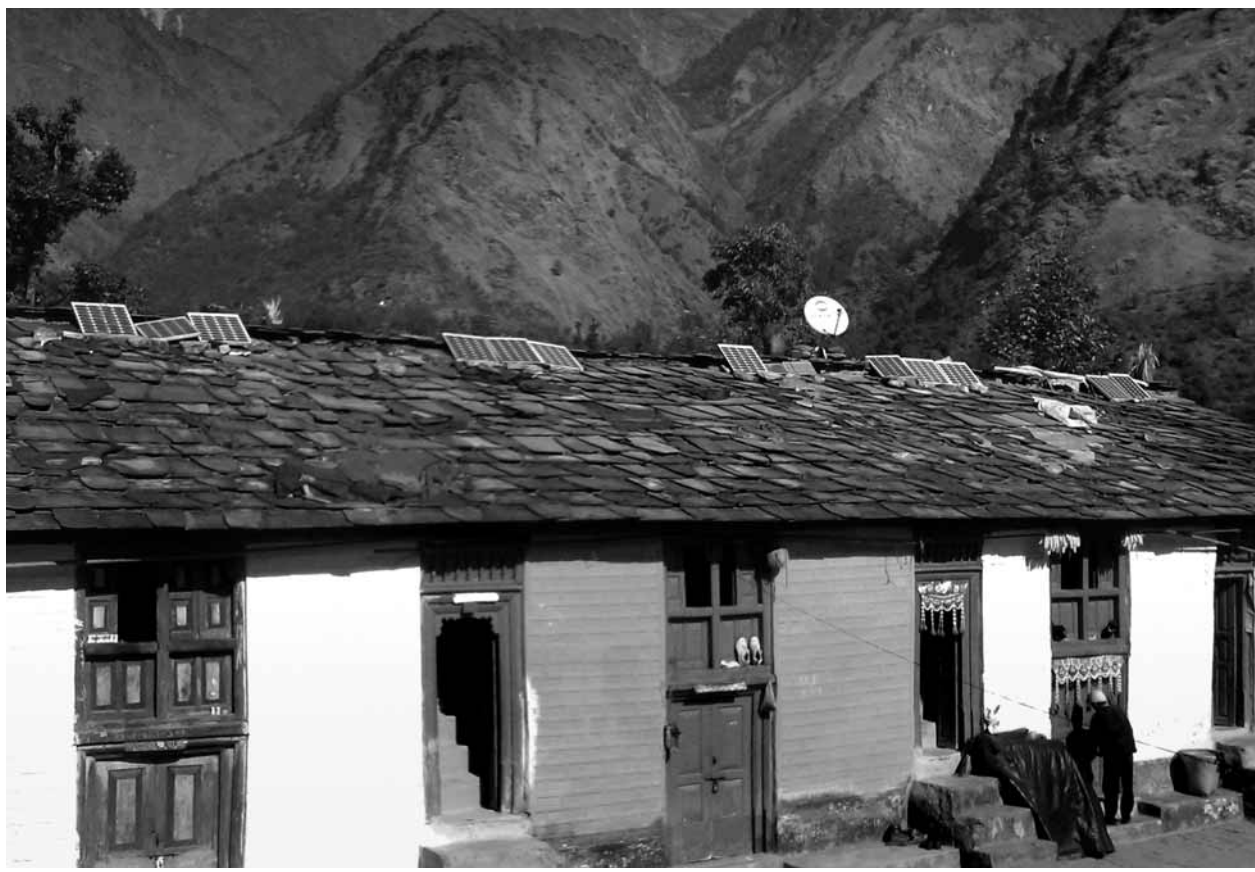
The information gap prevails. There is no village electrification committee, as is mandated under the RVEP, to hold regular meetings to discuss issues around the SHS. The usefulness of the SHS is not in doubt, however. Indira Devi and other residents of Galagat want more SHS with higher capacity to enable them to use electronic appliances with greater load. Of common interest: they want to be able to watch TV.

But officials in UREDA believe otherwise. They feel that the present SHS is enough for a household. "Based on our calculation, the energy requirement in these villages is not much. As they live on hills, they don't need power intensive appliances like a refrigerator. As most of them are engaged in agriculture and daily wage work, they do not stay at home. So, when do they watch TV, anyway? Two lights provided with the system are enough to light two rooms. They can charge their mobile phones. A small black and white TV can run on the SHS for two-three hours," said C P Agrawal of UREDA.

Bung Bung village: Residents of Bung Bung, 3-km further north from Galagat, received 116 SHS from UREDA in 2010. "Now I can work even at night," says Jaya Ram Navyali, a tailor in the village. "I could not do it with a kerosene lamp as the light thrown by its flame is localised." His children can also study for longer hours. But, what if any problem occurs in the system?

Most residents have had to purchase new CFLs from Dharchula even when the lamps fused within the warranty period of one year. This shows that the CFLs were of poor quality. "We had no information about the one-year warranty and had to shell out money to buy CFLs," said Kundan Singh Bodhiyal, a 52-year old tea-stall owner in the village. "Nobody told us anything about the maintenance regime when we went pick up the systems from the UREDA office in Pithoragarh," he adds. The villagers were not even schooled in the basics of maintenance such as when to put distilled water in the battery. There is no village electrification committee and

Villages such as Bung Bung in Uttarakhand find solar light affordable, especially when compared with kerosene, but complain about the lack of after-sales service



JOEL KUMAR / CSE

no technician.

Kundan Singh Bhandari, *pradhan* of the village, has not held any meeting in two years to discuss problems related to the SHS. Like Galagat, villagers do not know that they have paid for the battery replacement and can exchange it if any problem occurs within the two-year warranty period. "We were told that it is meant for repairing the SHS and that it would also be utilised for battery replacement," says Bhandari, when asked about the money deposited in the UREDA. However, he did not know the procedure, or that the money was being held in a fixed deposit.

Though the grid is expected to reach Bung Bung and Galagat soon, villagers prefer solar systems. "We hear from villages connected to the grid that they get power for four to five hours a day and that electricity bills are enormous," said Roop Singh Bisht, a resident of Bung Bung. "Besides, it takes weeks to get the power lines repaired as most villages are very remote and the electricity poles are situated on undulating hills," he added. In Bisht's house, the SHS was in working condition. His only worry: "I am lucky that nothing has happened so far. But, in case of a fault, I don't know whom to get in touch with.

THIRD PARTY EVALUATION FOR UTTARAKHAND

In 2006, the National Productivity Council (NPC) evaluated two states – Uttarakhand and West Bengal – on the implementation of the Remote Village Electrification Programme (RVEP). At the time of the study, the ministry had completed electrification of around 1,950 remote villages and 600 remote hamlets under this programme.

Modules not working

In Uttarakhand, 231 villages and 34 hamlets in 11 districts had been electrified. About 59 villages and 9 hamlets were surveyed by the field officers. Among the surveyed villages, 5,901 households have been provided with home lighting systems. Out of these 1,818 households were surveyed. From the data, it can be observed that a large share of the systems that were 'not working' came from the remote hamlets. But, as can be seen, very few of the systems were 'not working' completely. In the districts of Pithoragarh and Almora a large share of systems were functioning partially (see Table: *System performance in the surveyed villages, district-wise*).

Table: System performance in the surveyed villages, district-wise

District	Number of systems		
	Working	Partly working	Not working
Uttarkashi	67	7	0
Pauri	127	29	0
Tehri	171	38	6
Nainital	134	10	0
Chamoli	90	0	0
Rudraprayag	161	6	0
Almora	159	42	2
Bageshwar	62	13	0
Haridwar	53	19	1
Pithoragarh	134	35	0
Champawat	265	14	0
Hamlets	115	48	10
Total	1,538	261	19

The cause for failures was also analysed. It was found that when systems that were 'not working' completely the biggest share of the problem came from the modules. If it was not the modules, then it was usually the charge controller and the battery that had a fault. However, in a partially working system, the problem with the module was negligible. This leads to the conclusion that once the module stopped functioning, the entire system broke down. For partially working systems, the charge controller or the battery were identified as the trouble spots (see Table: *Reasons for complete failure of systems*).

Once the charge controller fails, the user tends to by-pass and directly connect it to the battery, which in turn overloads the battery. Therefore, one problem leads to another. This calls for prompt maintenance support from the suppliers. Non-availability of spare parts in these remote areas compromise the durability of these systems, and compound the problems of the beneficiaries. The user has to move at least 10-15 km to find a service centre with spare parts.

Taking the entire system for repair to Dharchula or Pithoragarh would be difficult and cost a lot," he added.

Bhandari wants solar street lights installed in the village. It is very difficult to walk around at night. Villagers need portable solar lanterns to go to their fields at night. "SHS lights are fixed. We have to use battery run torches in the night if we have to go anywhere," said Virendra Singh. "We generally light pine wood to light our way to the field," he adds. The SHS in Singh's house was in working condition. Bhandari says that the grid is useful for running a small flour mill. "If these works can be done by a small solar power plant, we would prefer that over the grid," he stressed.

The villagers in Bung Bung definitely need more power. Most of them are traditional weavers. They want a small cottage industry to be set up in the village so that they can be employed. A solar light will help them work in the evening. This will also help them pay when they have to buy a new battery.

Interestingly, the villagers are clear about their choice. Given an option between the capacity of the SHS being increased or being connected to the grid, they prefer high capacity SHS.

The report also suggested that these projects did not receive any maintenance support from the suppliers. There was also no warranty associated with the system which could have helped users with problems associated with charge controllers and module.

It is recorded in the evaluation report that more than 85 per cent of the systems were provided by Central Electronics Limited (CEL), Ghaziabad. The other suppliers include Bharat Heavy Electrical Ltd, Ritika System Pvt Ltd and Flexitron Pvt Ltd.

A key finding in the report mentions that beneficiaries having grid connectivity preferred solar lighting systems over grid power for its reliability. Most beneficiaries suggest that they want higher capacity solar systems in order to add more useful electronic gadgets to their load. If we take a look at the grid connectivity scenario of the surveyed villages, the report states that 10 of the surveyed villages were found to be connected to the grid at the time of inspection. A majority of the villages were found to be within a 5-km radius from the nearest grid powered village (see Table: *Grid connectivity of surveyed villages*).

Table: Reasons for complete failure of systems

Reasons for failure	Percentage of failure
Module	36.8
Battery	26.3
Wiring problem	5.3
Charge controller & battery	31.6

Table: Grid connectivity of surveyed villages

Grid connectivity	Number of villages
Grid available	10
Less than 5 km	27
5-10 km	21
10-15 km	6
More than 15 km	4

Recommendations by National Productivity Council

- The annual maintenance contract (AMC) needs to be established and has to be active for the programme to achieve its objectives.
- Replacement warranty for certain parts like the module and charge controller needs to be infused in the product. A three-year replacement warranty was recommended by the evaluators.
- Awareness programmes should be conducted to familiarise the user with the applications. This will encourage the user to diagnose basic repairs. Also, the evaluators suggest that if spare parts like fuse and lamps are provided the user could take care of most of the associated problems himself.
- Distilled water machines could be provided for each village, since the quality of the distilled water available to them from nearby towns was very poor. This could also encourage them to change the water more regularly.

Source: 'Evaluation survey of the remote villages electrified under the RVE Program', submitted to the MNRE by the National Productivity Council, Lodhi Road, New Delhi (The report was received from Uttarakhand Renewable Energy Development Agency), 2006

Almora district

Two villages, Batuliya and Bhetuli, were randomly selected for a field visit. UREDA had provided SHS in these villages in 2008-09. While the maintenance concerns echo those witnessed in Pithoragarh, Batuliya and Bhetuli also bring in new perspectives. Batuliya has not been connected to the grid since it is located at the edge of the Binsar wildlife sanctuary. Bhetuli, on the other hand, is grid-connected with SHS being provided to just seven BPL families.

Batuliya village: Batuliya is located in Bhasiyachanna block, around 30 km from Almora town. UREDA distributed 33 SHS in the village in 2009, with each household paying Rs 2,000 to the agency. As in Pithoragarh, people welcomed the SHS as it reduces their dependance on kerosene. It has also helped them in keeping wild boars at bay, with many households fixing one light outside their house.

But the villagers do not know that the money deposited with UREDA is for the replacement of their batteries. Batuliya has no village electrification committee. According to Lal Singh, its *pradhan*, most batteries are in working condition but there is no technician in the village if any problem occurs.

Of the two bulbs that Chander Singh got with the 37 Wp SHS, one fused within a fortnight. "I kept waiting for somebody from UREDA to come and check the system," said Singh, as he was not sure what the exact problem was. He is not aware of the one-year warranty for the CFL. Nobody from CEL or UREDA has visited the village since 2009. After waiting for a month, Singh bought a new CFL for Rs 100. "We are left to grapple with the problems on our own," he added. PS Rawat, a technical assistant at the district UREDA office, however insists that there are technicians in each block.

Like Bung Bung in Pithoragarh district, residents of Batuliya want more SHS systems and street lights. "Other than the two bulbs, we need one more bulb to illuminate the outside of the house to save our livestock and children from wild animals," said Lal Singh. The animals often destroy our small farm holdings. "More power is needed to run a television set," he added. Street lights are required as the distance between the village and the town is around 5 km and sometimes people like Mahesh Cheema who runs a small confectionary store in Bhasiyachanna town get late in coming back to the village. "I have to use either a torch or pine wood to light my way," says Cheema.

Bhetuli village: Bhetuli, located in Takula block, around 26 km from Almora, has around 250 households in the village. All -- except seven BPL families who cannot afford to pay for grid-connected power -- have received electricity from the grid. The seven BPL families were given SHS in 2009 by UREDA for free.

Residents of these villages want more SHS systems

ANKUR PALIWAL / CSE

But now, if their battery fails after two years, they will have to shell out the entire amount for replacement from their pockets. These villagers are not sure if they would be in a position to buy a new battery. "We might have to live in darkness again," said Mohini Devi who is happy as the SHS has reduced the dependence of her family on kerosene. "Now I can easily cook dinner even if it is late in the night. Children can also study. I hope we are able to save money to buy a new battery in the future," she added.

These households are even ready to pay a small installment every month which in two-three years would add up to cover the battery cost. But the issue is: who will collect the money? Since there are only seven households in the village, the *pradhan* does not take much interest. "We have spoken of our problems to the *pradhan* many times, but in vain," said Ram who is married to Mohini Devi. Bhetuli too does not have any village electrification committee.

There is no technician and no one from UREDA or CEL has come to check the systems since 2009. The battery in all the systems is in working condition. But if something goes wrong, residents do not know whom to contact. "My lamp fused within two months. I had to buy a new CFL for Rs 100," said Ranjan Ram, a daily wager in the village. He did not know that he had the right of free replacement as per the warranty conditions.

The BPL villagers are reluctant to get the grid-connected power because of high electricity bills. The rest of the village pays around Rs 400 for two months as electricity bills. This village too needs street lights because of the narrow and uneven lanes. But instead of getting grid-connected street lights, villagers want solar-powered street lights. They say that with solar power, they are sure the street lights will work in the night. They cannot say the same for the grid-connected power which is highly intermittent. The village gets around six-seven hours of supply on good days.

One of the seven families recently got connected to the grid by paying Rs 2,500 for a domestic connection. "Two bulbs were not enough, as there are wild animals and I needed to put one more light outside the house. With this grid-connected power I can also watch TV," said Rajendra Kumar. His financial condition has improved as his son has started working in a factory in Gujarat. He pays around Rs 400 for two months. But despite being grid-connected, he trusts solar power more because of the irregular power supply.

Tehri district

Baunth village: Nestled in the high Himalaya, Baunth is located in Devprayag block of Tehri district. From Devprayag, it is a 30-km drive uphill on a recently constructed road and about a 4-km walk further uphill on a pathway of loosely-held stones. UREDA distributed 70 SHS in 2004 in Baunth. It was not connected to the grid then, which reached the village in 2010. According to Pushkar Singh, the village *pradhan*, around 40 per cent of SHS in the village are not in working condition. The villagers are dependent on grid-power which plays truant. Every beneficiary had deposited Rs 2,200 in UREDA to get the SHS.

The SHS is lying unused in the house of 43-year old Umaed Singh. "The battery stopped working three years ago, even before the grid had reached," he says. Singh complained to the *pradhan*, but in vain. "He told me that the grid would soon reach the village after which he would take all the out-of-order SHS/batteries to the UREDA office for replacement," said Singh. It never happened. As a result, when the grid supply is cut, Singh has to go back to kerosene for lighting and other household chores. "Children cannot study in the dim and localised light of the kerosene," he added.

The SHS system in the house of Ranbir Singh, who is an *uppradhan* (deputy head), has also started failing. The illumination is dim even if the modules are charged throughout the day. "It has worn out like most other systems in the village," says Ranbir. "We need new batteries but since the grid has reached here, people have become accustomed to it and are not going in for them because of the expense," he adds.

Pushkar Singh said that he had informed UREDA about the problems many times, though Manoj Kumar, the project officer at the Tehri office of UREDA, denied the fact. Singh said that each time he informed the agency,

he was told that the deposited money was not enough to replace the batteries. Singh says that most villagers do not have any savings to pay the extra amount for a replacement. This raises the necessity of having a mechanism in place whereby somebody in the village can collect money in installments every month for the battery.

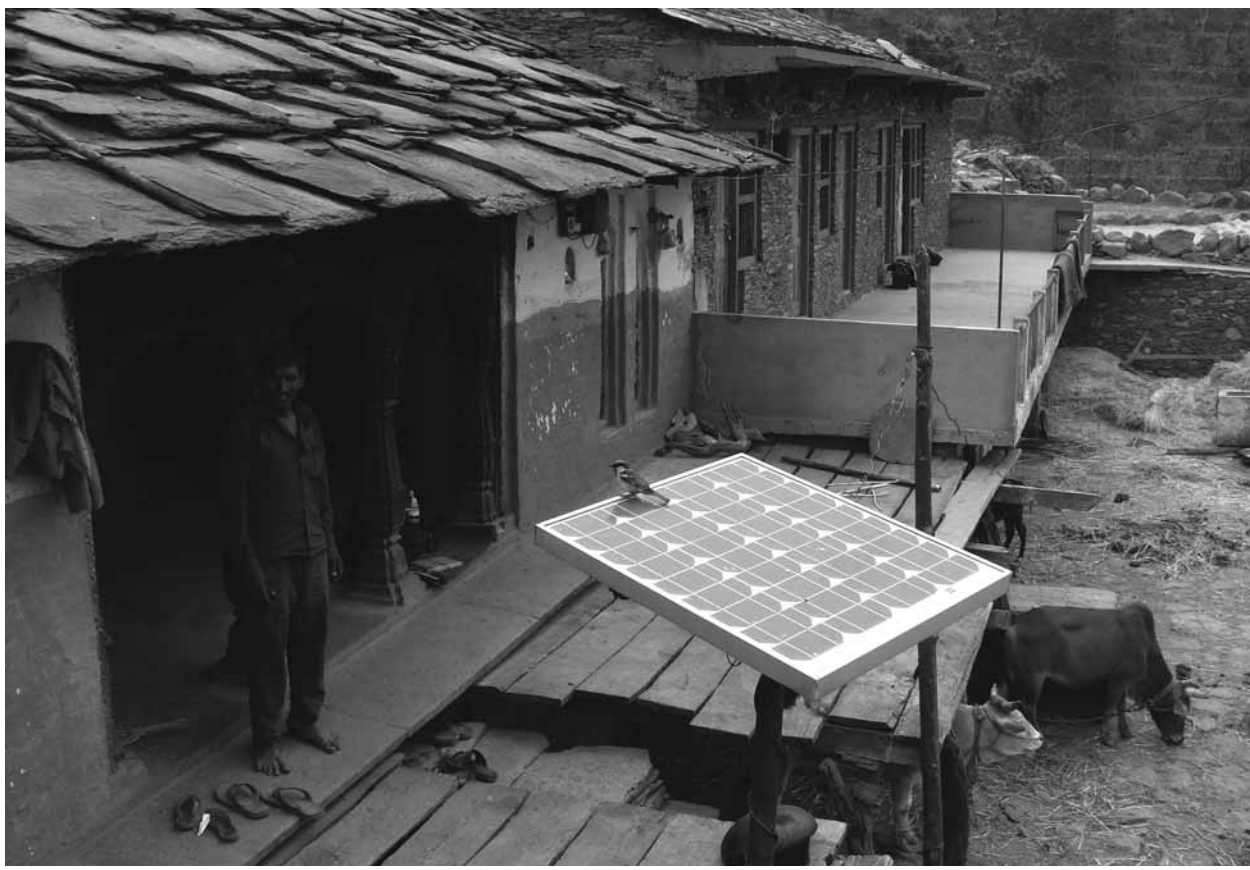
The nearest UREDA office is in Narendra Nagar, around 60 km away. "Even if we take the systems to the UREDA office, there is no surety that we will get the replacements the same day," says Pushkar Singh. We will have to return empty-handed. "One-way fare for a trip to the town is Rs 90," he adds. In the last eight years, only once has a CEL technician visited the village. There is no village electrification committee.

According to Pushkar Singh, the villagers had deposited an amount of Rs 91,000 with UREDA when it distributed the systems. Manoj Kumar confirms: "A fixed deposit of Rs 91,000 was made. Under the fixed deposit policy the amount would be Rs 140,000 at its date of maturation in August 2012. But this would not be enough as the required money to replace batteries is around Rs 255,000." Singh is trying to talk to UREDA for a midway solution.

The villagers need SHS since grid power is supplied daily for six-seven hours only and during the rainy season electricity remains cut for weeks. "In such times we miss the solar systems. It helped us a lot when the grid was not there," said Jaspal Singh, who has a small farm holding. His SHS is still in working condition. "We need movable lights like solar lanterns, especially at night, which we can carry to the fields," he adds.

It is because of the complete maintenance failure on the part of the service provider that some of the villagers in Baunth had to opt for grid power despite the erratic supply. "The government just dropped the system here to meet their target and never looked back. We do not even know whom to call at the time of a technical problem. No workshop was held to tell us even the basics like when to put water in the battery," says Shiv Charan. At least with grid power, a lineman turns up within three to four days of a complaint.

Even in grid-connected villages like Baunth, solar lights are popular, since the supply from the grid is of poor quality



ANKUR PALIWAL / CSE

The villagers of Baunth who have experienced both SHS and grid power want a combination with improvement in servicing. "Grid power helps run big machines in flour mills and TV sets," said Pushkar Singh. "But because of its irregularity, we need solar lights," he added. "If UREDA cannot send a technician it could have trained any one of us to deal with day-to-day problems," says Shiv Charan (see Table 2.5: *Uttarakhand: Problems and recommendations*).

Table 2.5: Uttarakhand: Problems and recommendations

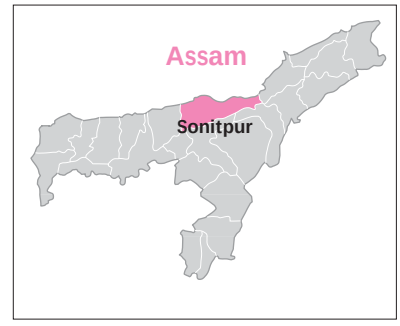
Problems	Recommendation
No after sales service. Technicians do not visit villages, and beneficiaries do not know whom to contact when any problem occurs.	Under the remote village electrification programme (RVEP), the service provider is mandated to provide after sales service for five years. The Uttarakhand Renewable Energy Development Agency (UREDA) should ensure that this is put in place so that technical problems can be taken care of.
In many villages the CFLs fused within six months of distribution of solar home lighting systems (SHS), despite the one-year warranty. Because of this, the beneficiaries had to spend their own money. Most had not even been informed of the warranty.	UREDA should check the quality of the CFLs. Beneficiaries should be made aware by holding meetings about the warranty of the various parts of the systems, and whom and how to contact in UREDA or a service provider. This is important to build trust among beneficiaries, or else they might lose interest in the scheme.
Beneficiaries do not know that the money they have deposited with UREDA is kept as a fixed deposit and can be availed at the time of the replacement of the battery. Even village heads do not know this.	This is either because of the lack of communication or intentional denial of information. Beneficiaries need to be made aware as most of them think that they will have to pay the entire amount when their battery fails.
There is no mechanism on the ground to raise money to pay for the remaining cost of the battery.	As some of the beneficiaries are poor and may not be saving money for the battery, a mechanism can be put on the ground in which they deposit a small amount every month. This money can be utilised at the time of battery replacement.
Lack of capacity building and training to repair the systems.	UREDA should invest in capacity building of village youth by training them as technicians and also pay them. This way beneficiaries will not have to run to town every time. This will also help in maintaining small solar power plants in the village.
Absence of village solar electrification committees (VECs).	VECs are mandatory under RVEP but they are not present on the ground. UREDA should help in building the committees and empower them to discuss and take decisions on collection of money every month for the battery replacement and keeping a track of the problems with the distributed SHS.
Third party audits.	The findings and recommendations of third party evaluation reports need to be considered. These reports show what exactly is happening on the ground and where policy needs to be tweaked in order to achieve the subjected goals.

Source: CSE, 2011

Assam

The RVEP was started in 2005-06 in Assam. Under the programme, the state has been allotted the largest share of financial assistance from the ministry. The state has covered 1,766 remote villages, the maximum number under the RVEP. Still, more than 2,200 remote villages in the state remain to be taken up for electrification. This is also the largest number of remote villages in any state left to be taken up under RVEP.

There is huge potential for off-grid solar lighting in the state. There is a need to steer and monitor the process keenly in the future since the project has been prone to corruption at different stages of its implementation.



Laphaichuk village: The excitement is palpable. A motley crowd gathers around a 44-year old non-profit worker, Indeswar Bhuiyan, as he enters Laphaichuk, a small hamlet of the Mising tribe in Sunitpur district, 327 km from the commercial hub of Guwahati in Assam. Bhuiyan is from the non-governmental organisation (NGO), Chairduar Rural Development Centre (CRDC) based in the same district.

The golden sunset looming, the residents of Laphaichuk doggedly argue their case for solar power with Bhuiyan. The hamlet has been left out of the RVEP; neither has grid power reached it. At least 20 per cent of all villages in Assam, numbering about 5,000, do not have a regular grid connection. Only 16 per cent of rural households have been electrified through the grid. Of these, 2,139 'inaccessible' villages (where conventional grid power cannot reach) were selected in 2006 for the RVEP (see Table 2.6: *Number of villages taken up by the implementing agencies for RVEP*). Three agencies have been involved in the implementation of RVEP in the state -- Assam State Electricity Board (ASEB), Assam Energy Development Agency (AEDA) and the state forest department (see Box: *RVEP in Assam*).

Solar power can bring out the inhabitants of the village from their energy deprivation. They can charge mobile phones, for which they now travel 10 km and pay Rs 5. They can save between Rs 300 to Rs 400 spent every month on kerosene lamps. Children can study after sunset while elders can do

Table 2.6: Number of villages taken up by implementing agencies for RVEP

RVEP (Assam)			RVEP (India) State targets (2007-2011)
Agency	**Target (till 2011-12)**	**Achieved**	Assam – 2,139 villages
Assam State Electricity Board (ASEB)	1,057 villages	1,019 villages 53,405 households (upto December 2011)	Jharkhand – 520 villages Madhya Pradesh – 401 villages
Assam Energy Development Agency (AEDA)	920 villages	730 villages 33,830 households (upto February 2012)	Maharashtra – 257 villages Odisha – 238 villages
Forest Department	162 villages	Not available	Chhattisgarh – 106 villages
Total	2,139 villages 123,918 households		5,028 villages (as of July 15, 2008)

Sources: (a) RTI filed to Assam Renewable Energy Development Agency in March 2012 and response received via email through Mrinal K. Chaudhury on April 11, 2012; (b) RTI filed to Assam Forest Department, Letter No. SFG.30/RTI/2005, dated March 7, 2012, from the Office of the Chief Conservator of Forests, Social Forestry, Guwahati, Assam; (c) RTI filed to Assam State Electricity Board, Letter No. ASEB/CGM (RE)/REW/TECH-30/Pt.1/2008-09/2, dated March 20, 2012, from the Chief General Manager (RE), ASEB, Guwahati, Assam

RVEP IN ASSAM

Generalised model: 37 Wp solar module with 40 amp 12 V battery, 2 CFL lamps of 9 W each, charge controller with cables.

Subsidy: 90 per cent of benchmark cost of Rs 12,500 set by the Union ministry of new and renewable energy. Remaining 10 per cent shared equally between state agency and beneficiary.

Players: Assam state agencies (Assam State Electricity Board – target 1,057 villages, Assam Energy Development Agency – 920 villages, forest department – target 162 villages), village electrification committee (VEC), facilitating non-governmental organisations.[1]

Implementation: An NGO to create awareness and help villagers form the VEC which then makes an agreement with the state agency, deposits its monetary share and receive the home systems. Third party monitors employed by the state agencies to check whether systems have been installed and are working properly.

Problem areas: Poor maintenance and after sales service, no awareness regarding replacement batteries, non-availability of technical repair person at local level, fudging of beneficiary list and selling the systems later, overcharging households compared to their share, systems could not be traced after installation poor households selling the systems, smuggling to neighbouring Bangladesh, third-party monitors coerced to give favourable reports, very little monetary incentive for the NGOs (Rs 1,500 per village) fuelling corruption?

their bamboo work. It can light up a social ceremony and they can watch a black and white television for two hours. And, an existential requirement – they can use their solar lights when their houses are inundated. Situated on the flood plains of the mighty Brahmaputra, the regular grid electricity is not that useful.

Indeswar Bhuiyan listens patiently to their pleas and promises to put their case before the AEDA, an autonomous government body working on renewable energy. The agency, so far, has penetrated 730 remote villages in Assam with 33,830 solar home-lighting systems.[13]

Kutum village: The village is about a kilometre from Laphaichuk. In 2010, each of the 121 households in Kutum received a SHS consisting of two CFL lights, a battery and a charge controller. The market price of the system was Rs 13,476. The MNRE gave a subsidy of Rs 11,250 and the rest was equally shared between the beneficiary household and the state government of Assam at Rs 1,113 each.

Residents of Kutum are proud of their possession but are at a loss when repair and maintenance issues arise. Phaniram Kutum, for instance, had to spend Rs 200 to repair the circuit board inside the charge controller within a few months of purchase. The local technician trained by the company said that he knows only how to connect the components but nothing about internal repairs. Ideally, Phaniram is entitled to free maintenance, guaranteed as per the purchase agreement, but the nearest service centre is 17 km away. The brighter side is that as SHS gain popularity, roving technicians are offering services at the door step. Phaniram's system was repaired

Tupuni Pegu of Kutum is willing to go back to kerosene if her solar light fails

SAYANTAN BERA / CSE

by one such technician.

First time solar users like Tupuni Pegu, a mother of three, do not know that batteries need to be replaced after five years of usage. Seeing CSE's research surveyor in the village, she said, "Can you repair my system? The lights go off after an hour." The SHS are designed for five hours of running time on a bright and sunny day. Sonti, another villager, has no idea where to take the systems for repair. When told the batteries will need to be replaced after five years and will cost Rs 3,500, Sonti retorts, "In that case I will go back to kerosene."

Assam's RVEP challenges: "The Central government's ambitious target of covering 2,139 villages in Assam in four years (2007-11) will entail supplying more than 123,000 systems. The programme is being implemented hurriedly without the required maintenance network in place. There is no awareness regarding replacement of batteries," said Phanindra Sarma, former head of the energy division at the Assam Science Technology and Environment Council (ASTEC), Guwahati and presently a third party monitor for solar projects in the state.

"Which company will go to remote villages that are geographically dispersed to honour maintenance contracts?" asks Sarma. "The only way out is to develop local entrepreneurs through intensive training and draw up a plan for financing battery replacements. At present the target driven project is neither technically nor financially sustainable," he added. As the installed systems reach four to five years of operation, battery replacement will become a serious issue. Moreover, households are not adequately informed of the necessity of replacing the distilled water in batteries every six months, about the correct angle (30 degrees) at which panels should be placed and the processes to clean up the solar panels.

Mrinal Chaudhuri, additional director at the Assam Energy Development Agency (AEDA), agrees to the challenges in the programme. He notes that AEDA, with long experience in promoting solar technology, could only reach 150 villages between the 1990 and 2004. After the plan for 2,139 remote villages was made in 2006, MNRE wanted the state agency come up fast with its share of 920 villages. "Ideally we should train solar technicians at regional industrial training institutes (ITI's) to make the programme technically sustainable," says Chaudhuri.

AEDA, on its part, is encouraging villages to create a corpus fund to finance replacement batteries. One such case is Kalajhar village in Darrang district bordering Bhutan. A total of 89 families from the village collected Rs 70 per month per household: in just two years the corpus fund totalled Rs 1.5 lakh. The fund will finance battery replacements as and when the households need. Such success stories are rare, though.

Out of the 2,139 remote villages, Assam State Electricity Board (ASEB) is the majority stakeholder. Till December 2011, ASEB had completed the programme in 1,019 villages as against the target of 1,057 villages. However, the apparent success in outreach is marred by aspects of technical and financial sustainability, and more importantly, by rampant corruption.

An energy consultant who has worked closely with the state agencies spoke to CSE on condition of anonymity. "ASEB is into conventional grid electricity and has no prior experience in renewable energy. Because the renewable energy wing (AEDA) did not have the manpower or network, a major chunk of the programme went to ASEB. The sorry state is showing on the ground," he said. Till date, ASEB has organised only five training camps with 125 locals (or just one technician for over 400 households).

All state agencies implementing the programme are required by MNRE to employ third party monitors to track the performance. The third party monitors, in turn, employ local youth to carry out field surveys. A local field coordinator, Habibur Rehman (name changed) who has supervised the programme in over 90 villages, explained to CSE researchers how corruption takes root when distributing SHS.

There are three major routes to corruption. Sometimes, the list of beneficiary households is forged. Say, in a village with 100 households, 70 opt for the solar scheme. The remaining 30 are persuaded to apply for the systems with an offer of a bribe. Later, these 30 SHS are sold in the market or find their way across the border to Bangladesh or Bhutan. With a 90 per cent central subsidy on a system which cost between Rs 10,000 to Rs 14,000 this implies a leakage of up to Rs 8,000 per system. For 30 systems, this translates to anywhere between Rs 50,000 to Rs 2 lakh. The booty, says Habibur, is shared between the facilitating NGO,

the village electrification committee (VEC) president and secretary, and engineers from the electricity board.

There are times when the NGO and the VEC president and secretary come together and overcharge the households. Say, for a system where the beneficiary's share is Rs 500, the households are charged Rs 3,000. The balance amount is pocketed.

In a third method, sub-standard SHS are purchased by the state agency. Even though MNRE has an approved list of suppliers and the purchases are made through a tender, the quality standards are often not adhered to. The NGO's or the VEC have little or no financial incentive within the programme. As such, motivated groups have come in to make a quick buck, said a renewable energy expert, requesting anonymity.

Kakla Bari in Barpeta district was connected to grid electricity in 2010 and a year later received 94 SHS and three street lighting systems -- a clear violation of Central ministry rules that subsidised solar equipment are meant for remote villages not connected to the grid. As per the MNRE list of un-electrified remote villages, Kakla Bari has 12 households. Yet it received 94 SHS. Most of these were sold to nearby villages not connected to the grid at prices between Rs 3,500 to Rs 8,000. The stated beneficiary contribution for the village is Rs 517 per household: this implies a leakage of at least Rs 3,000 per system and over Rs 3 lakh in aggregate.

When the CSE team visited Kakla Bari in end-November 2011, it could not locate any system in the village, other than four SHS and a street light in the courtyard of the VEC president, Bisti Ram Giyari's house. He refused to share the list of beneficiary households and instead complained that the systems were useless. Purchased from the Kolkata-based Bose Power, the systems were installed in August 2011. Batteries of as many as 45 systems are malfunctioning, complained Giyari: the charge does not last for more than two hours. About 10 of them were stacked in a room of his house.

A kilometre's walk from Kakla Bari is Hapasera, nestled next to the lush hills of neighbouring Bhutan. Dewaru Gar, a farmer from the village bought the solar lights for Rs 3,120 – a good Rs 2,603 more than what he was supposed to pay. Gar has never attended any meeting of the VEC, as is the norm, and complains that the lights go off in less than two hours, even on a bright sunny day. He has no clue where to take the system for repair and feels cheated. He paid for the lights by borrowing money and later sold off livestock to repay the debt. Four other families had a similar story to tell. Even after repeated requests, the Hapashera VEC president refused to share the list of beneficiaries, thereby avoiding a corroboration of the actual households using the solar lights.

A third party monitoring report, still in its preparatory stages, for a village in Dhubri district (which falls under the Lower Brahmaputra valley with numerous river islands or *chars*) proves government-subsidised equipment is sold off illegally. Of the 660 systems installed, the monitor could only locate 534 – of them 41 had been sold by the beneficiaries, about 19 families moved with their systems and 15 were reportedly gifted to others (see Box: *Summary of third party monitoring reports for Assam*). According to Anal Bhagwati, former project manager at the renewable energy wing of ASEB, "the *char* areas (river islands) of Brahmaputra are poverty stricken. Households sometimes sell their SHS or leave with them when they shift homes due to river erosion. There have been cases where the facilitating NGO's overcharge beneficiaries."

Habibur has more to add. He complains that during the monitoring exercise field investigators are coerced to write favourable reports. This means not recording discrepancies in the list of beneficiaries and the actual number of households using the solar lights. "We are forced to write that systems are installed and are working well," he adds. To make matters worse, the third party monitors are paid by the same state agency (ASEB, AEDA etc) whose work they are monitoring.

Another third party monitor, who chose to remain anonymous, said, "Once MNRE clears a manufacturer, it becomes eligible to apply in the tender process. But there is no guarantee of equipment quality. The solar panels are sometimes 20 Wp instead of the required 37 Wp. Initially we would verify that during monitoring but later we were asked to work fast and just report physical presence and functionality." He also contends that the forest department is the worst offender: "the suppliers and the department siphon the systems between them. Local third party monitors are threatened and not even allowed to enter villages for inspection."

SUMMARY OF THIRD PARTY MONITORING REPORTS FOR ASSAM

A third party monitoring report of 54 villages in Assam was conducted by three organisations – NB Institute for Rural Technology (13 villages), Assam Financial Corporation (4 villages) and Institute of Agriculture Management (37 villages). These villages were electrified under the Remote Village Electrification Programme (RVEP) and implemented by the Assam State Electricity Board (ASEB). According to the report, of the 2,772 allotted home lighting systems, 2,471 were available which means 90 per cent of the given systems were found. The report also claims they are in working condition.

Key findings:

- The three districts of Karbi Anglong, NC Hills and Dhubri were evaluated. What is clear from the data is that among the sold systems, all of them were from Dhubri district. Dhubri lies on the banks of the Brahmaputra. About 15 km downstream, on the same side of the banks, lies Damalgram which is in Bangladesh. A ferry ride downstream is possibly the easiest way to smuggle these systems out of India. This probably confirms our suspicion about the goods being smuggled to Bangladesh. Dhubri is also prone to floods. This is probably the reason why we see many cases in which the beneficiaries have shifted away from the river bank.
- All of the beneficiaries with the home lighting systems claim to have benefitted from them – in terms of reduction in kerosene expenses, educational purposes for students and of productive activities after sunset.
- In all three districts, there has been no after sales service by any of the suppliers Central Electronics Ltd, Suntechnic & Energy System, and Rashmi Enterprises.

Table: Number of systems to be sold and shifted

District	Allotted	Sold/gifted	Shifted
Dhubri	1,747	134	152
NC Hills	228	0	4
Karbi Anglong	797	0	10
Total	2,772	134	166

Source: 'Third party monitoring report for 55 Nos of villages', Assam State Electricity Board

Chinmoyi Sharma, managing director of North East Renewable Energy Pvt Ltd and a distributor of Tata BP, laments, "Being an early player we burnt our fingers." Sharma's firm supplied 3,459 systems during 2007-08 in Dhubri and Dhemaji districts. But during inspection, the systems could not be traced. "They were either sold off by NGO-VEC or poor families themselves. In any case Rs 3 crore of my money got stuck," says Sharma. Now, suppliers get the inspection certificate during the installation and not months later.

Sharma feels that the heavy subsidy is to be blamed for the leakages, be it NGO's overcharging households, or together with the VEC selling solar lights across the border. He contends that poor families are offered a paltry sum of Rs 500 to enlist their names. After installation, the systems are sold off. "We want to move away from the 90 per cent subsidy scheme and instead sell directly to the public. Under the JNNSM a consumer is entitled to a 30 per cent subsidy, 20 per cent of the payment is upfront, the rest is paid through easy bank loans at 5 per cent interest. In Assam, NABARD is offering bank loans through the regional rural [Grameen] banks," says Sharma.

The 30 per cent capital subsidy scheme is more robust, feels Sharma. There is a greater sense of ownership and the consumer does not have to repay bank loans if the home systems are not functioning. The bank, in turn, will chase the company. More importantly, there is little incentive to indulge in fraud. The flip side, however, is that companies might not want to sell in remote and inaccessible areas where it is difficult for them to run a servicing network.

The 30 per cent subsidy scheme is similar to that of the popular Grameen Shakti in Bangladesh -- a micro-financed scheme with 10 per cent down payment and zero interest loans spread over 48 months. The monthly installments are paid from

SAYANTAN BERA / CSE

In Hapasera village, 65 year old Harkeswar Bosumatari paid Rs 3,000 for the solar HLS; this is much more than what this lighting system actually costs after subsidy

money saved by switching to solar from diesel or kerosene. Grameen Shakti has installed over five lakh systems at the rate of 20,000 systems per month. Alongside, it has built an excellent service centre network.[14]

"During the initial years we faced problems of fudged beneficiary lists or households being overcharged," says Mrinal Chaudhuri of AEDA. "All payments by the VEC are now made through bank drafts. We also issue receipts to each beneficiary household so they cannot be cheated. The *gram panchayat* together with the VEC president/secretary and the block development officer or circle officer authenticates the list of households. Additionally, we have stringent quality standards: companies like Bose Power cannot apply when we float tenders," he adds. Notably, Bose Power supplies systems for less than Rs 10,000 while for Bharat Electronics Ltd or Tata BP, the equipment costs upward of Rs 14,000.

Under the RVEP, NGOs are charged to create awareness and motivate villagers to take up the programme. They also play an important role of facilitating the agreement between the VEC and the state implementing agency. But the monetary incentive is a paltry Rs 1,500 per village which does not cover costs, says Indeswar Bhuiyan of CRDC.

Bhuiyan, who also runs a service centre for the 1,892 systems installed by BEL in Sunitpur laments the lack of future planning. "The company promised Re 1 per system per month for the battery maintenance but the money has not reached yet," he complains. He has only received some circuit boards for internal repairs. The centre is more than 15 km from the villages making it difficult for either households to come for repair or for him to provide services at the doorstep.

Not to be dampened by the problems, the residents of Laphaichuk want their slice of the sun, as soon as possible. They are ready to travel the 327 km to Guwahati, get a certificate from the state electricity board that the village is not going to be connected to the grid and then plead their case for the solar home lights.

Chhattisgarh

The RVEP was introduced in Chhattisgarh in 2003. When the programme was initially started, similar to other states, the Chhattisgarh Renewable Energy Development Agency (CREDA) distributed SHS at the subsidised rate to households in the identified remote villages. However, the agency had to undergo a huge loss in the process because most of the subsidised panels ended up being stolen or sold at higher rates. "Half of the panels got stolen within a year. Some even sold them off or mortgaged them," said S K Shukla, director of CREDA**.** A survey conducted by CREDA in 2004 showed that of the 617 solar modules installed in tribal hostels, *ashrams* and primary health centres, 500 were stolen. This is when CREDA opted to provide remote villages with community power plants.[15]

Since then, the state has been rapidly upscaling the use of SPV technology to fulfill the electricity needs of remote villages. The first micro-grid was installed by CREDA in 2004. As of May 2012, 1,439 remote villages have been electrified through micro-grids in this state. The micro-grid capacity adds up to 3,500 kW of power serving around 58,000 families. Street lights are also connected to these micro-grids in the villages (see Table 2.7: *Electrified remote villages in Chhattisgarh, June 2012*).[16] So far, 9,500 street lights supported by solar power plants have been installed in Chhattisgarh's remote villages. Such installations have also been done in tribal hostels, rural health centres and remote police camps. Rest of the villages and hamlets, where houses are scattered, were provided with solar home lighting systems. "In scattered villages it is not feasible to invest in wiring for long distances," says Shukla.

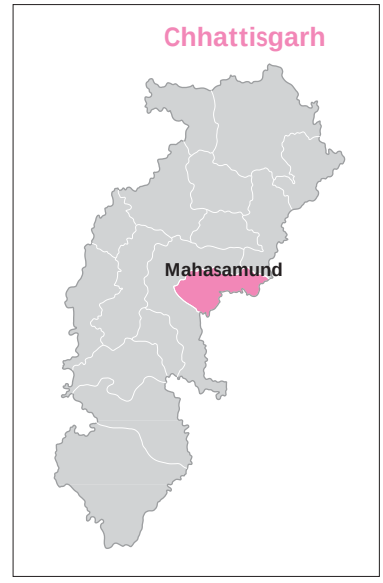
Table 2.7: Electrified remote villages, June 2012

District	No. of villages electrified	Benefited beneficiaries	Un-electrified villages	District	No. of villages electrified	Benefited beneficiaries	Un-electrified villages
Raipur	0	0	0	Sarguja	15	721	0
Gariaband	128	4,265	0	Balrampur	2	306	0
Baloda Bazar	22	1,535	0	Surajpur	42	2,066	0
Mahasamund	5	165	0	Jashpur	183	7,262	0
Rajnandgaon	51	1,401	0	Koria	123	6,354	0
Durg	0	0	0	Dhamtari	41	1,911	0
Balod	0	0	0	Kanker	114	3,179	0
Bemetara	0	0	0	Kondgaon	5	324	0
Kabirdam	67	2,795	0	Jagdalpur	44	2,037	5
Bilaspur	50	1,216	0	Sukma	4	430	125
Mungeli	45	2,413	0	Dantewada	215	8,562	36
Raigarh	12	552	0	Narayanpur	9	170	131
Korba	238	9,142	0	Beejapur	23	1,100	109
Jangjir Champa	1	62	0	**Total**	**1,439**	**57,968**	**406**

Source: 'Chhattisgarh, a booming solar power hub', presentation by Sanjeev Jain Chief Engineer, Chhattisgarh Renewable Development Agency (CREDA) in a round table conference "Off-grid solar', organised by CSE, June 2012

Implementation model of micro-grid

CSE visited Deba in Mahasamund district in order to study the implementation model of the micro-grid. The village lies in the Barnawapara Wildlife Sanctuary and the power grid cannot be extended here. A 4 kW solar power plant generates 28 units (1 unit = 1 kWh) of electricity a day. It is sufficient to light all houses and lanes of Deba with CFLs (compact fluorescent lamps) for seven hours without fail: from 4 am to 6 am and from 6 pm to 11 pm. According to one of the villagers, the solar power plant, installed by CREDA has been a boon to the village residents who had always relied on kerosene lamps and lanterns. The power plant has also been able to provide uninterrupted scheduled power supply. It has not only minimised cases of stealing or selling solar panels, but fuelled the commercial demand for solar systems in the region. The only time the village has faced a blackout was when a powerful lightning bolt hit the transmission cables and damaged the inverter according to a resident of the village.



Kaya Bara, the village neighbouring Deba (in the sanctuary), has a 3 kW solar power plant that generates 24 units of electricity a day. Until 2008, it was sufficient to light 45 households in the village for eight hours a day. During CSE's visit in 2010, there were three TV sets in the village which had increased the load on the grid and residents got light barely for two hours a day. The operator, Monu, blamed those who own TV sets for the load-shedding. A TV set can gobble up the entire 24 units of electricity in just a couple of hours. But there is no let up in their use. Rather, more residents in Kaya Bara are planning to buy TV sets and other electrical equipments like fan and water pumps. "There is not much we can provide other than lighting to each remote house. But people have starting accepting the technology and are buying solar modules and solar water pumps in large numbers," says Rajiv Gyaani, executive director of CREDA.

Limitations of the programme

Discontent with limited electrification is palpable across the solar-powered villages in Dhamtari district. Kalaar Baahra, for instance, a tribal hamlet in Dhamtari has a SHS in each of the 15 houses. Residents still demand a link to the grid, which is just half-a-kilometre away. They also wrote to the district administration apprising it of their demand. "Illumination is not sufficient," says Itwarin Bai, who is in her 50s. She is proud of the solar panel on her rooftop but is jealous of the villagers half-a-kilometre away who have access to the grid. "Grid electricity means more income," she says. This reflects the fact that lighting is not enough for the villagers -- it suffices for very basic needs. However, villagers require applications like water pumping units for their irrigation facilities. This is not possible through SHS which is subsidised by the government.

A solar shop owner, Hari Narayan Gupta, of Sarguja district in Chhattisgarh, says that the commodity most in demand from his shop is a solar module. "People do not want just home lighting systems because they serve their lighting needs only. However, some customers buy these panels for even recharging their tractor batteries. The government, unfortunately does not have subsidy mechanisms for this needful application," says Gupta. This is why mini-grids in Chhattisgarh have proved to play a bigger role than just providing lighting needs. "Solar-powered water pumps are very expensive. We cannot afford them. If we have access to the grid we can buy the regular water pumps and grow vegetables even in summers like people in the neighbouring village. We can also draw water when the level dips," Itwarin Bai explains. The systems subsidised under the RVEP does not ensure adequate supply to meet the demand of remote villages, explains Kapil Mohan, who was in charge of the rural electrification programme in the MoP.

Regular maintenance

CREDA employs a three-tier system to provide for maintenance of the systems. An operator is chosen from each solar-powered village to clean solar modules every day and repair them in case of a glitch. For this, he charges Rs 5 from each house per month. For regular maintenance of batteries

SAYANTAN BERA / CSE

Kaya Bara: A TV set can gobble up 24 units of electricty in just two hours. But the villagers want more out of their SHS

and inverters, and for fixing technical problems, CREDA enrolls an operations and maintenance contractor, who appoints a cluster technician for every 10-15 villages. The technician directly receives a payment of Rs 25 per household per month from the state government. This is equivalent to the subsidy that the Chhattisgarh government provides to families below the poverty line in grid-connected areas for availing one unit of electricity a day. CREDA pays Rs 2,000 per month to the technician and Rs 400 to the operator.[17]

"The technician files a monthly monitoring report for every solar installation. The solar equipments that are not working and the problems associated are also recorded," says Shashi Dwivedi, an operation and maintenance contractor.

The third tier is managed by CREDA, which monitors all installations through the monthly reports and replaces equipments in case of major breakdowns. The success of solar power in Chhattisgarh is clearly due to the efforts that went into the maintenance model designed by CREDA (see Box: *Third party review on Chhattisgarh*). CREDA is also the only agency in India that is financially supported by the state government for providing salaries and remuneration to technicians, besides training villagers for maintenance of solar lighting systems.

THIRD PARTY REVIEW ON CHHATTISGARH

Chhattisgarh is one of the most successful examples of implementation of the Remote Village Electrification Programme (RVEP). This can be attributed to the comprehensive maintenance solutions that are being provided by the Chhattisgarh State Renewable Development Agency (CREDA) for solar-powered remote villages. Out of the 50 systems that were evaluated by the National Council of Applied Economic Research (NCAER), only one was found to be out of order at the time of evaluation.

The NCAER had also evaluated Madhya Pradesh and Odisha during the same survey. It was found that Chhattisgarh had the least battery problems and most number of working systems. At least 88 per cent of the respondents replied that there was a local mechanic in their village as against 31 per cent in Odisha and 3 per cent in Madhya Pradesh. It seems that Chhattisgarh had organised more awareness campaigns than the other two states after completion of a project. Respondents from Chhattisgarh were also most satisfied among the three states to receive solar systems in lieu of grid extension.

Chhattisgarh had most of its problems during the rainy season. Otherwise, the systems have been performing better than the other two states. The beneficiaries in Chhattisgarh showed most satisfaction for the services rendered by the technicians among the three surveyed states. The survey showed that the technicians visited the sites on a scheduled basis as per the maintenance contract. This was also reflected by the fact that there weren't many repairs in Chhattisgarh as compared to the other two states. Therefore, according to the survey, the beneficiaries have been spending much lesser on repairs as compared to Madhya Pradesh and Odisha.[1]

Bihar

Bihar is the only state besides the Punjab which has received neither funds nor been sanctioned any projects under RVEP. One reason for this could be that there are about 80 remote villages in Bihar according to the MNRE.[18] The rest are un-electrified villages that need to be taken up for grid extension by the power ministry. However, most of the rural areas are dependent on kerosene for their lighting needs. The state has about 20 per cent of the nation's kerosene users who use it for their lighting needs. This makes it the second largest user of kerosene -- about 15.6 million households[19] -- as a source of lighting in the country.

However, data from the Census also tells us that Bihar is the third largest user of solar applications (about 113,644 households).[20] The state seems to have managed this position without the need for financial support from the Centre unlike any other state. "Individuals and organisations within the state have donated funds to provide for solar home systems. However, the state has not put in an effort to aid the uptake of these applications," says Rajmohan Jha, Deputy Director of Bihar Renewable Energy Development Agency (BREDA). It was only recently, in 2011 that BREDA formulated a renewable energy policy for Bihar, which has approved 175 MW of large-scale solar projects connected to the grid.[21] But the policy has no clarity on off-grid solar.[22] Even after a year of the formulation of the policy, the government has not received any projects for off-grid solar energy. "This is why few entrepreneurs are showing interest," says Harish K Ahuja, president, strategy and corporate affairs, Moser Baer, a solar panel manufacturer. Off-grid solar energy in Bihar is completely market dependent.

Exhibition Road, Patna

In Bihar's capital city, Patna there is a hub for SPV applications, touted as the biggest off-grid solar market in the world. On Exhibition Road, a one-kilometre stretch with narrow by-lanes, there are rows of shops where one can find solar lanterns, street lights and panels of various capacities. Though there is no study which has evaluated its worth, it makes a profit of around Rs 500 crore annually, say solar energy industry sources.

This vibrant solar market sprung up in the state for an obvious reason. State government figures say that while Bihar needs 3,500 MW, it generates only 1,595 MW.[23] Also, a fifth of the kerosene users in India are in Bihar.[24]

This solar market caters to the energy needs of everybody, depending upon their purchasing capacity. Solar panels of various sizes and wattages – ranging from 3-200 Wp – can be bought in this market. Popular companies such as Tata BP, Reliance and BEL jostle for shelf-space with lesser known brands such as Surana Ventures and Plaza Power and Infrastructure. The market is also flooded with brands specific to the state, quirkily named TBP – which sounds similar to Tata BP – and Fusion Power.

A 75-Wp panel can be bought anywhere between Rs 2,400 to Rs 10,000 in this market. Such a panel from Tata BP costs Rs 6,500, while the same wattage panel selling under the similar sounding brand 'TBP' which has no warranty can be had for just Rs 2,400 (see Table 2.8: *Cost of 75-Wp panels sold under different brand names*). Together with the battery, it can be purchased between Rs 5,500 and Rs 15,000, depending on the make. A well-branded solar street lighting system costs around Rs 20,000 but the same can also be put together at the cost of just Rs 8,000. The cheaper systems are usually sold without warranty and are of much lower wattage than what is specified on the label.[25]

Trying to compete with the thriving Exhibition Road market, companies are now taking solar equipment closer to villages. "Every block in all the 38 districts of Bihar has its own small 'Exhibition Road'," says Ramadheer Singh, retailer at Jandaha block in Vaishali district. Every shop, be it for clothes or stationery, also stocks solar equipment. "Panels from 'TBP' are the cheapest and sell the most, despite its sub-standard quality," says Bachchu Singh, retailer at Jandaha.

Table 2.8: Cost of 75-Wp panels sold under different brand names

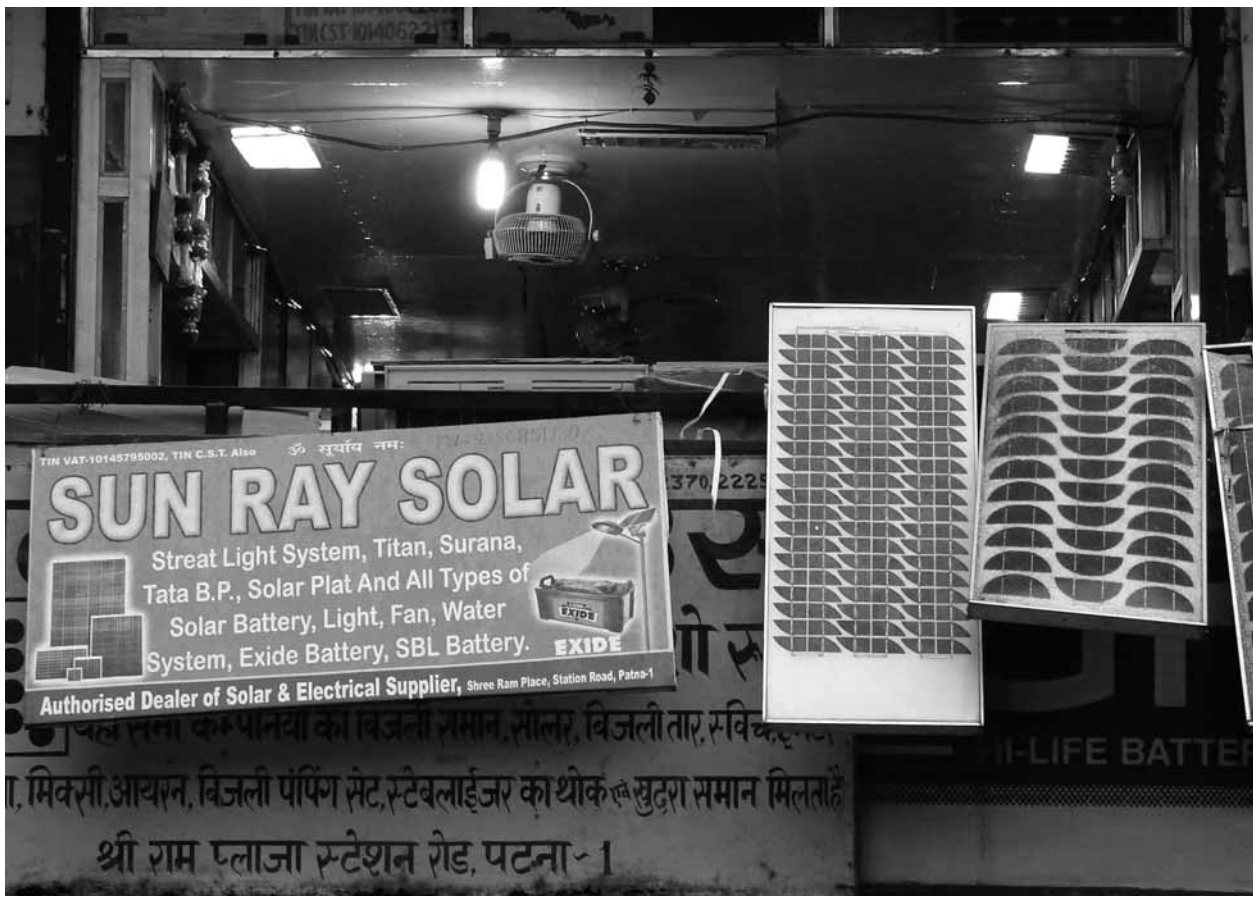
Brand name	Cost (Rs)	Warranty
Sharp	9,000	20 years
Central Electronic Limited	8,500	10 years
Waaree	6,700	10 years
Tata BP	6,500	20 years
Luminous	6,500	10 years
Reliance	6,000	10 years
Plaza	4,800	10 years
Surana	3,200	5 years
Fusion	3,000	2 years
TBP	2,400	No warranty

Source: Personal communication with retailers of solar products on Exhibition Road, Patna, July 2012

Accredited equipment, sub-standard quality

The solar market in Bihar is flooded with sub-standard panels made in Hyderabad and Mumbai. "We tell companies what we need – cost, wattage and warranty period. We can choose the brand name," says a dealer requesting anonymity. "Hyderabad-based Surana Ventures has a big share in the market here," he said. The company has been cleared by the MNRE to access capital subsidy for supplying panels under projects sanctioned by the JNNSM. "The standards apply only to projects sanctioned under government programmes. The regulations don't apply in this market as the modules sold do not fall under such programmes," says an official of BREDA, seeking anonymity. "We have no control over the market here," he adds.

Fifty per cent of the state's solar market is captured by those who make inferior equipment. The business of these cheap under-wattage panels has flourished so much that big players are feeling the pinch. Tata BP's monopoly over the solar



ANKUR PALIWAL / CSE

Exhibition Road, Patna, thriving market for solar applications

market has dropped by almost 70 per cent in the past five years, says Piyush Agrawal, of Krishna Solar House, located on Exhibition Road. The company, which offers a 20-year warranty, is losing business to the cheaper TBP. Krishna Solar House is an authorised dealer of solar products of BEL and Reliance. **"**We are badly hit and have almost lost individual customers," he added. Agrawal's company now hunts for government schemes to sell their products.

On the contrary, a retailer of sub-standard panels in Patna said that even on a bad day he sells at least 50 solar panels. "The consumer is duped by selling a panel which has been labelled 75 Wp but actually has a capacity between 30 and 40 Wp," said Agrawal. He says that if the customer knew that the panel is actually 40 Wp, he can buy a panel from a branded company at almost the same cost and with warranty. "But the real problem is that the retailers in the villages push for sub-standard panels since they get a higher profit margin," said Amrendra Kumar, senior sales executive, Tapan Solar Energy Pvt Ltd, a Delhi-based solar applications manufacturer who also sells in Bihar.

But many solar panels supplied for street lights under the Backward Region Grand Fund scheme of the Bihar government are also under-watted. "To cut costs many village heads buy cheap solar panels and batteries. A system can be put together for as low as Rs 8,000," says a village *pradhan* who does not want to be named. He admits that 30 per cent of the solar street lights in his village have under-watted panels and cheap batteries.

Consumers look for affordable systems

People have had mixed experiences with the cheaper systems and purchases them despite their inferior quality for no other reason than they are cheaper than the well-established brands. This is a proof of strong demand, yet low purchasing power in the energy-starved state.

Saroj Kumar, a daily-wager from Jagdeeshpur village in Vaishali district bought a panel, with the knowledge that it was of bad quality. He also bought an Exide battery, a well-established brand, for Rs 3,000. He paid a total of Rs 6,500. A good quality system with the same specification would have cost around Rs 12,000. "That's beyond my reach," he says. It has also come out cheaper than paying for power through a diesel generator. Before the solar market flourished, most basic lighting requirements were fulfilled by these generators. Earlier, he used to spend Rs 100 per month for a diesel generator to illuminate a 10 Wp CFL for four hours and to charge his cell phone. This works out to Rs 83 per unit of electricity, perhaps the highest price being paid in the country. Saroj is satisfied. His panel is working.

Residents of nearby Arania village have similar stories to tell. The two 75 Wp TBP solar panels in the house of Dharmendra Kumar are both a source of energy and happiness. He runs two 10 Wp CFLs and two small 18 and 22 Wp table fans with these panels. Kumar bought one of the panels in 2010 for Rs 5,000 with a year's warranty and the other in early 2012 for Rs 3,000 with no warranty since he did not have enough money. "Our requirement of energy has increased," said Kumar, a daily wager. "I know that the panel has no warranty and can stop charging anytime. But it has been working well so far," he added.

There is a general perception in the villages that even a sub-standard panel would easily work for at least two years. It is the battery where they need to make a good investment.

But later in the year, keeping in mind the monsoon, Kumar also started buying electricity from a diesel generator operator at Rs 100 per month which lit an 8 Wp CFL for four hours daily. "I keep this as an option for cloudy days," he said.

However, Rakesh Rai has had problems with the cheap solar panel that he chose. When he bought the 75 Wp TBP solar panel in Jagdeeshpur for Rs 3,500 it could support a 10 Wp CFL and at times an 18 Wp table fan. Six months later, the CFL gives dim light for not more than an hour. "The panel is not charging the batteries properly," he said. He is back using kerosene that costs around Rs 200 per month. "I can't complain because I bought it knowing it has no warranty," he says.

Not all buy TBP. Those who can afford them have bought good quality panels with warranty. Rajkumar Shah who runs a small confectionary shop from his home in Salha bought an 80 Wp solar panel from Luminous, a solar brand, for Rs 6,000. It has a warranty of 10 years. He uses the panel for running one 15 Wp CFL which lights his shop and two 10 Wp CFLs for his home. He also runs a 22 Wp fan. When asked why he did not buy a cheaper TBP panel, he says "It is good to buy panels with warranty. I can get it replaced, if the need arises. It

gives full wattage unlike TBP," said Shah.

Some residents have also innovated energy solutions and are earning money out of it. One such case is that of Jagdeep Kumar who realised that he can make good money selling electricity. He saved for two years and borrowed some money from friends and relatives to buy six Tata BP panels of 80 Wp, each costing around Rs 10,000. He bought six 75 Wp batteries of Rs 5,000 each. The entire installation in his home cost him around a lakh of rupees. Now he supplies electricity to 50 households for four hours every day in the evening and collects Rs 75 monthly for an 8 Wp CFL bulb from each family. This is equivalent to about Rs 78.125 per unit of electricity. This shows that many people in Bihar are paying the highest cost for energy since they neither have grid connected power nor enough money to buy upfront.

A potential for clean energy

The large potential for clean energy is evident in Bihar, This is being exploited by low-grade companies in a market that is clearly not regulated by the government. However, it has successfully catered to the basic electricity requirements of the poor through an environmentally sustainable option. Unlike most other states where the government has intervened, in Bihar the market has sustained the needs of rural consumers for solar applications without any subsidies.

People are also paying a huge amount for a unit of electricity whether the generation is based on diesel or solar. Their methods of payment show that they cannot afford quality solar equipment upfront but wish to pay on a monthly basis. To put it simply, innovative financial instruments like soft loans could enable users to purchase well-branded and quality solar lighting systems from this market.

CHAPTER 3

The National Solar Mission

The Jawaharlal Nehru National Solar Mission (JNNSM) includes a 2,000-MW target for off-grid solar energy systems – roughly 9 per cent of the solar target of the country. But the quantum of target is one aspect of the issue, up-scaling off-grid solar systems and making them work is the main issue at hand. This scheme under JNNSM provides capital subsidy of the benchmarked cost and subsidized loan at 5 per cent per annum. But already the programme is finding it difficult to reach the real target – the poor households in remote and off-grid villages. The bulk of the projects sanctioned and commissioned are located in educational, government and even corporate sector institutions. An analysis of the situation on the ground speaks of urgent changes that are needed in the system of accreditation – large rating companies currently qualify to assess performance. But as these agencies have little experience or interest in reaching the unreached and remote, the scheme falters. Worse, the complicated procedures for disbursement of capital subsidy make the programme unwieldy and inefficient. The question remains: how can off-grid programmes be greatly up-scaled to meet the very real needs of energy in the country.

India launched the Jawaharlal Nehru National Solar Mission (JNNSM) in 2009 as a part of the National Action Plan for Climate Change (NAPCC) which was finalised in 2008. The JNNSM aims to create a policy framework to encourage the use of solar applications – both off-grid and grid-interactive. A target of 2,000 megawatt (MW) has been set for off-grid solar applications bu 2022, while for the grid and grid-connected roof-top applications, the target is 20,000 MW.[1]

Guidelines for phase I

To facilitate the execution of the targets and objectives of JNNSM's phase I under the Union ministry of new and renewable energy (MNRE), the 'guidelines for off-grid and decentralised solar applications' were released on June 16, 2010. These are focussed on providing an "enabling framework and support for entrepreneurs to develop markets".[2] The core objectives:

a) to incentivise the market to promote sustainable business models,
b) create awareness on the use of solar systems, and
c) encourage the replacement of kerosene and diesel wherever possible.

A wide range of applications have been included under the scheme: solar home-lighting systems (SHS), solar street lights, power plants, water pumps, lanterns and solar thermal systems such as water heaters, air heaters/steam generators and solar cookers. These were all part of earlier programmes of the MNRE, which were superseded by the JNNSM by an administrative order of the ministry on July 8, 2010.[3]

The guidelines also permit solar photo-voltaic (SPV) mini-grids up to a maximum capacity of

100 kilowatt-peak (kWp) per site to meet lighting, power, heating and cooling requirements. Mini-grids for rural electrification can be scaled up to 250 kWp per site for support under this scheme. Hybrid systems with other renewable energy technologies such as wind and biomass are also eligible for consideration under the scheme.

Financing

Under JNNSM, the MNRE gives a capital subsidy of 30 per cent of the benchmarked cost and subsidised loan (for 50 per cent of the benchmarked cost) at 5 per cent interest per annum. The remaining money can be made as a down payment by the consumer or the bank can decide at which rate it wishes to finance the scheme with a payback period of up to five years. The subsidy for off-grid SPV applications is granted up to 250 kWp per site. Industrial/ commercial entities can only avail capital or interest subsidy for a project. The benchmark costs for SPV applications as established by the MNRE for 2010-11 were:

- SPV with battery back-up: Rs 300/Wp
- SPV without battery back-up: Rs 210/Wp.

The ministry has also decided on reducing the benchmark costs by 10 per cent, year by year, as subsidisation is considered a temporary method to incentivise products. The benchmark prices for 2011-12 are therefore:

- SPV with battery back-up: Rs 270/Wp
- SPV without battery back-up: Rs 190/Wp.

Capital subsidy of 90 per cent of the benchmark costs is available for special category states which include Sikkim, Jammu & Kashmir, Himachal Pradesh and Uttarakhand. It has also been extended to remote areas like Lakshadweep, the Andaman & Nicobar Islands and districts with international borders. However, funding for 'solar thermal' systems is limited to 60 per cent capital subsidy for all these areas.

The MNRE has recently raised the amount of capital subsidy available through regional rural banks (RRBs) – from 30 to 40 per cent of the benchmarked costs for solar home lighting systems – by an administrative order dated February 29, 2012. The funds for this operation, Rs 46.80 crore, have been sought for a year (2012-13) from the National Clean Energy Fund, which is a clean energy cess levied on coal. However, this subsidy is only limited to solar lighting systems with module capacity ranging from 10 watt-peak (Wp) to 210 Wp. The scheme aims at deploying 120,000 solar home lighting systems within a year from March 15, 2012, the date on which it took effect.[4]

All funds are released only after completion and verification of the proposed projects. However, for programme administrators (state nodal agencies), the release of funds are front-ended with installments of 70 per cent on sanctioning of project and 30 per cent on completion.[5]

Modes of implementation

Three modes of implementation can be drawn out from the guidelines prescribed by MNRE:

Implementation through a state nodal agency: This is a direct process. Every state has its own nodal agency through which MNRE implements projects. The agency identifies areas where off-grid solar applications could be useful and applies to MNRE for financial support. The suppliers are identified through a tender process by the agency. Once MNRE approves the project, 70 per cent of the Central financial assistance (CFA) is released to the agency. After completion of the project, the remaining financial assistance is released. The agency receives funds directly from MNRE. States can also financially intervene when the beneficiary is unable to foot the entire costs. Under this model, the beneficiary is not entitled to soft loan credit facilities.

RESCO model: A renewable energy service providing company (RESCO) installs, owns and operates a power plant and provides energy services to its consumers. These companies may link with a financial integrator to access capital subsidy. Financial integrators would have the capacity to pool in funds from different sources such as carbon financing and Central government funding. The aim is to be open to any form of financing in order to design affordable financial products. RESCOs are best suited for setting up community-based power plants in rural areas.

MFI model: Micro-finance institutions (MFI), RRBs and primary lending institutions which already have an established client base can use this model.

The customers, on establishing their relationship with the financial institution, can avail both capital and credit subsidy.

The beneficiary is eligible for a capital subsidy of 30 per cent of the MNRE-benchmarked cost (now 40 per cent). The beneficiary can also avail of a soft loan facility (for 50 per cent of the benchmarked cost) at 5 per cent interest per annum, with the loan to be paid back in five years. The financial institution has to join hands with a manufacturer (system integrator) for the sake of this policy. This model can be used for SPV applications like lanterns, SHS and water pumps.

Access to funding for financial institutions

Unless the state nodal agencies directly implement the projects, the funds for the financial institutions cannot come directly from MNRE. The Indian Renewable Energy Development Agency (IREDA), which is under the administrative control of the MNRE, channels the subsidy funds to the institutions through the National Bank for Agriculture and Rural Development (NABARD). This subsidy is released upfront to the financial institution by NABARD on receiving a request for sanction of the loan. The system integrator also submits a letter declaring that they will abide by MNRE's guidelines. The project records and work site can be scrutinised as and when MNRE or NABARD wishes to do so.

The loan subsidy is availed through a refinance scheme from NABARD. The financial institution is charged 2 per cent on the loan amount as interest. It can charge the beneficiary only up to 5 per cent under the scheme.

The MFI model of JNNSM can bring the greatest benefit to individuals or communities living in rural areas. In case there is a need for energy services in their households, they can visit the local branch of an RRB (in case the bank has a tie-up with a system integrator accredited under the JNNSM) or the system integrator itself, whichever is convenient. The beneficiary is supposed to submit the down payment along with requisite documents to the bank: land documents (for security), an invoice copy, vendor's letter of declaration stating that no other subsidy is being availed for the system, quotation of the project (from vendor), two photographs of the beneficiary, income certificate of the beneficiary and a surety for the loan (or a third party recommendation). The system integrator is supposed to install the system after the submission of these documents.

The local branch scrutinises these documents that come from different beneficiaries. Once the branch has reached its targeted collection, it forwards them to the headquarters of the RRB. The headquarters, in turn, collects the documents from all its branches and forwards them to NABARD, which scrutinises them before releasing the subsidy.

Once the RRB receives the capital subsidy, they combine it with the down payment from the beneficiary, and the rest can be availed of as a loan from that particular financial institution. This combined amount is finally paid to the system integrator. The whole process is cumbersome and time consuming. "We are still awaiting subsidies from NABARD for many applications under the scheme. Many companies have not received their payments for the systems and have been unable to close their balance sheets for the financial year 2011-12," says a branch manager of an RRB.[6]

Accreditation of channel partners

Under the Solar Mission, system integrators and RESCOs have to be 'credible' to undertake projects. They are not eligible to participate in the subsidy programme without accreditation from MNRE. The companies requesting for accreditation are rated. Four agencies have been assigned by MNRE for the rating process – CRISIL Ltd, ICRA Ltd, CARE Ltd and Fitch India.

The rating assesses the performance capability and financial strength of the accredited channel partners.[7] The performance overview looks into the capacity installed by the channel partner. The technical expertise and the adequacy of humanpower are also evaluated. The other parameters include the quality of suppliers that the company is linked with and the operation and maintenance (O&M) capabilities of the channel partner. The financial parameters include sales figures, net worth of the channel partner, return on capital employed, feedback of bankers on account of integrity and current ratio, that measures a company's ability to grade short-term obligations.

The rating agencies also charge a fee for performing this task. To exemplify, CRISIL charges a fee of Rs 2 lakh for a channel partner whose previous year's turnover has been up to Rs 5 crore. It charges Rs 5 lakh for a channel partner with an annual turnover between Rs 5-20 crore. For

channel partners with an annual turnover of more than Rs 20 crore, the fees would be Rs 10 lakh. A service tax of 12.36 per cent is also levied over and above the fees.[8]

As inferred from the rating process of the MNRE, a channel partner would get a high rating if it has an established client-base in the off-grid sector and a large market share. The channel partner would also have to be high on profit, capital and manpower in order to gain a high rating. The performance capabilities are rated between 1 and 5, the highest possible rating being '1'. Similarly, financial strengths are rated between A and E, the highest rating one can receive being 'A'. Accordingly, '1A' is the best rating that a channel partner can get and '5E' is the poorest. To participate in the JNNSM, a channel partner must have a rating of at least '3B'. The latest list of accredited partners under JNNSM shows that 17 companies have a rating of '1A'. They include Lanco Solar Energy Pvt Ltd, Wipro Eco Energy Ltd, Tata BP Solar, and Larsen & Toubro.[9]

Targets and progress

Under JNNSM, off-grid solar applications constitute a meagre share. Only 9 per cent of the overall Mission target – or 2,000 MW – has been allocated for these applications which are aimed at catering to remote areas. For the first phase, of the 200 MW installed capacity aimed at, 40.648 MW was achieved during the first year of implementation (2010-11).[10] However, certain projects were found to be incomplete as per the deadlines (see Box: *Incomplete Solar Mission projects*).

According to the JNNSM guidelines, there is an immediate need to "promote off-grid systems to serve populations without access to commercial energy and modest capacity addition in grid-based systems."[11] Only 27.5 per cent (11 MW) of the sanctioned projects meet this particular objective. This comprises of street lights, SHS and mini-grids only, for rural communities without access to the grid.

The JNNSM has also extended its scope to educational institutions, government institutions, forest management and health centres in remote areas, institutions that would be of use to rural communities. These entities constitute 40.6 per cent (16 MW) of the sanctioned projects (see Graph 3.1: *Analysis of JNNSM projects*).

The least relevant entities, which include banks, theatres/telecom towers, industrial units and other commercial entities together constitute 31.8 per cent of the sanctioned projects. This

INCOMPLETE SOLAR MISSION PROJECTS

The Union ministry of new and renewable energy had released a list of sanctioned projects (for 2010-11)[1] under the Jawaharlal Nehru National Solar Mission (JNNSM) for off-grid solar photo-voltaic applications. This was accessed online by Centre for Science and Environment (CSE) in August 2011.

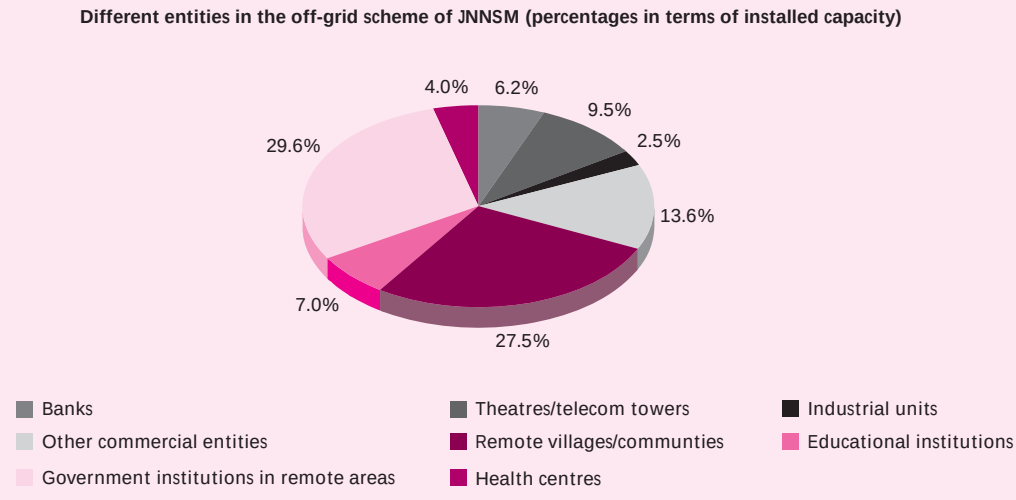
All sanctioned projects had deadlines. In Uttarakhand, seven out of eight projects were supposed to be completed by August 2011. However, at the time of CSE's visit to Uttarakhand in September 2011, only one of the indicated projects had been completed. The others had not even been initiated. The documents available to the public do not indicate this nor mention about the delay in these projects.

This points to an under-achievement on targets and misinformation to the public. Since then, the document has been removed from the official website of JNNSM and there is no further information on the status of the projects.[2]

SURYA SEN / CSE

The priorities under JNNSM are skewed: till 2022, a target of 2,000 MW has been set for off-grid solar power against 20,000 for the grid

Graph 3.1: Analysis of JNNSM projects



Source: Centre for Science and Environment (CSE), 2011

indicates that the scheme is open to entities without any restriction as to where off-grid solar applications are to be prioritised.

The income of telecom tower operators, theatres and banks are much higher compared to people living in areas with poor electricity supply or without access to the grid. Yet, all of them are eligible for central financial support under the same policy.

The guidelines should, at the least, steer away from sanctioning commercial projects in urban centres where the grid is strong (see Box: *Undue government subsidy to industry*). These commercial entities are capable of funding their own solar power plants. Those without any access or with partial access to energy should have the first right to valuable subsidy under JNNSM.

UNDUE GOVERNMENT SUBSIDY TO INDUSTRY: HERO MOTORCYCLE'S SOLAR

Hero Motocorp's industrial unit in Gurgaon, Haryana depends on its own power plants, primarily based on diesel and gas for their energy needs. Though this unit is a captive power producer, the company was given a government subsidy to set up a solar power plant.

When first set up, the factory was totally dependent on diesel generator sets. Over the years, the electricity production capacity has been increased. Currently, the factory has five diesel generators of 1.9 MW each, four diesel generators of 1 MW each, three gas generators of 2 MW each, and a 100 kW solar power plant.

The solar power plant was commissioned in October 2011. To set up the plant, the company received Rs 54 lakh from the Central government under the off-grid solar scheme of the Jawaharlal Nehru National Solar Mission, which is about 30 per cent of the entire project cost of Rs 1.8 crores. So far, the Union ministry of new and renewable energy has released about 25 per cent of the funds – or Rs 11.91 lakh. In all, 432 photo-voltaic panels with individual panel capacities of 235 Wp were set up.

On an average, the plant generates 350-400 kWh every day. On asking it was learnt that there has been marginal electricity generation from the solar power plant as compared to the other conventional generators. "For a manufacturing unit of this size, the utility of the electricity generated from the solar power plant is very low. The plant is part of a green initiative policy of the company. We wanted to experience solar's potential and it was mostly a research and development project," explained an employee, who did not wish to be named.

SOLAR STREET LIGHTING SYSTEM: SIRSA, HARYANA

Most villages in the district of Sirsa, Haryana have no street lights. Although the entire state is connected to the grid, there are frequent and sustained power cuts, especially in rural areas. Even if street lights were proposed through conventional power, prolonged power cuts would have nullified the utility of the lights.

In 2010, after detailed surveys, the district administration, through the Haryana Renewable Development Agency (HAREDA), sanctioned 6,660 solar street lighting systems in 333 villages. The systems comprise of a 74 W solar panel, 11 W compact fluorescent lamp (CFL) and 12 V battery. Each system costs Rs 18,900 and comes with a two-year warranty. For an additional Rs 100 the manufacturers have included a three-year maintenance contract. This sum of Rs 100 has to be paid only after the overall five-year period. The overall project cost is Rs 12.65 crore. Every village is entitled to 20 street lights, regardless of their requirements or purchasing power. The project has been equally divided among three suppliers, each serving 111 villages – Central Electronics Limited (CEL), RGVP Energy Sources and Su-Solar Tech Systems Private Ltd.

Financing

The MNRE has subsidised 30 per cent (Rs 3.80 crore) of the project cost. The remaining 70 per cent (Rs 8.85 crore) has been shared between the beneficiaries (villages) and the state. According to the initial project report, it was found that certain villages in the district could not raise funds on their own. Hence, in villages where self-financing was not possible, financial interventions were made by the state.

Self-financing: Ten villages have borne 70 per cent of the cost (Rs 2.66 lakh per village) out of the available *gram panchayat* funds. The *panchayats* own common land in these villages; they lease out the land to farmers. The funds available with each of these villages have accumulated to more than Rs 10 lakh per annum which allows them to finance the projects on their own.

JOEL KUMAR / CSE

Some street lights have been placed within the premises of houses

Partly funded by the state: Ninety-eight villages have *panchayat* funds anywhere between Rs 5-10 lakh per annum. Such villages could pool Rs 2.2 lakh each – a total of Rs 215.6 lakh out of the required Rs 260.6 lakh. The remaining Rs 45.08 lakh was met out of the 'Hariyali Development Plan, a community watershed project.

Fully funded by the state and Centre: The remaining 225 villages were completely incapable of funding themselves. Hence, the entire sum of Rs 598.50 lakh has been taken from the Backward Regional Grant Fund (BRGF), a developmental scheme under the Union ministry of panchayati raj. The fund finances local infrastructural projects and professional support on infrastructure in select rural districts.

Monitoring and maintenance

Under JNNSM guidelines, a village energy committee (VEC) has to be constituted in every village. Headed by the village *sarpanch* (head), it must include a technician who has cleared the government-run Industrial Training Institute course and has been trained by the supplier before the end of the five-year maintenance period. The HAREDA also monitors projects through a committee set up by them.

In the first year of installation, every village has to deposit a sum of Rs 2,500 per system from *panchayat* funds in the VEC accounts . Between the second and fifth years, a sum of Rs 1,000 per system has to be deposited in the VEC account annually. This amounts to Rs 130,000 per village in the VEC funds. This corpus will be used to maintain the systems after the five-year contract with the suppliers. In reality, the VECs are yet to be constituted in these villages.

Assessing implementation

After studying the funding model in Sirsa district, the Centre for Science and Environment (CSE) visited seven villages in the district to assess implementation on the ground – Fawain Khurd, Fawain Kala, Bharokhan Dhani, Sikanderpur, Kanganpur, Shahpur Begu and Odhan. Some of the villages were also visited after sunset for a first-hand impression on the luminosity of the street lights.

In these villages, street lights are not found on the streets. Instead, they are placed within the premises of households. The batteries, in most cases, are not fixed on the pole itself, which is usually the case in a solar street lighting system. The wiring has been extended and the batteries are placed inside the house. The house owner keeps the keys to the battery box. The panels are fixed high up on the poles. The lights are extended on to the adjoining street, thereby serving its purpose of lighting the street.

"One of the first problems in setting up solar street lights in public places is theft. These panels and batteries are expensive. A few years earlier we did a pilot solar street lighting project for Sirsa town. About eight street lights were fixed in public places. In just about three months, almost all the batteries were stolen. We realised that the systems had to be protected from vandals and thieves," said Indraj, assistant project officer for the project's implementation. The households in which the lights were placed, are responsible for the safety of the systems. "In many villages, BPL households have been given this responsibility in order to maintain equitable distribution," added Indraj.

Unfortunately, the equipment is badly maintained. The panels are supposed to be dusted by the householders. Only some of the houses were aware of this. And very few actually keep the panels clean.

Four systems in Sikanderpur went defunct just after they were installed. The households spoke about this to the *sarpanch*. He was expected to forward the complaint to the Sirsa district authorities who would in turn inform the technicians provided by the suppliers. In this case the *sarpanch* had not forwarded the complaint.

Two systems were not working in Shahpur Begu. Here, the *sarpanch* had forwarded the complaint to the district authorities but the authorities had not responded. No VECs had been set up in any of the villages, nor were there trained technicians.

The villagers in Farwain Khurd understand the advantages of solar. "These systems are reliable. Even when there is a power cut, people can step out of their homes and there is no darkness outside at least," said Ramjas, the *sarpanch* of the village.

Key findings:

- Theft of panels and batteries has come down because of their placement within household premises.
- The number of street lights are not enough. Just 20 street lights per village – regardless of its size – leaves a large part of a village unlit. For instance, Odhan has a population of about 7,326, with roughly around 1,800 households. Largely, people living around the lights benefit from it. "Lack of funds both at the *gram panchayat* level and from the government has been a hindrance in deploying more of these expensive lights," according to Indraj.
- The VECs need to be constituted as soon as possible. There is no trained person in these villages to repair and maintain the equipment although such measures have been proposed in paper. The solar panels have to be cleaned regularly, but very few houses are aware of this. In almost every village, many panels do not face the sun. This could lead to inefficient charging of the batteries. The villagers need to be educated on these issues.
- The process to repair or replace a system is long drawn out. At first, the village *sarpanch* has to be informed during a *gram panchayat* meeting. Thereafter, a letter including all the details of the failed system has to be prepared and sent to the project officer. The officer informs the relevant supplier and a servicing technician is expected to arrive at short notice. A lot of time can be saved if the villagers directly inform the supplier.
- The project officer noted that the state level green energy funds had not been utilised for this project at all by HAREDA which could have gone a long way in putting in place more systems.

Implementation strategies: a critique

JNNSM is struggling to meet its targets. What is worse, it is moving away from the mandate given to it by the NAPCC. The private sector and social businesses are reluctant to take up projects, and most projects are being implemented by government departments. There is a need for a major policy reform, which will push the Mission to fulfill its mandate.

Accreditation of channel partners: "The accreditation processes are being done hastily without actually checking the performance of a company on the ground," according to Hari Natarajan, Chief Executive Officer of Inclusive Infrastructure Development Consulting, an energy consultancy.[13] According to an employee of CRISIL, it takes 10 days to rate a company and if necessary, it can be done faster. According to newspaper reports, ICRA has been able to rate eight companies within 10 days.[13]

Surana Ventures, an SPV supplier based in Hyderabad, was rated 2B by ICRA in the latest accredited list released by the MNRE.[14] Reportedly, the company is also a large supplier of under-wattage panels in the unregulated solar applications market on Exhibition Street, Patna.

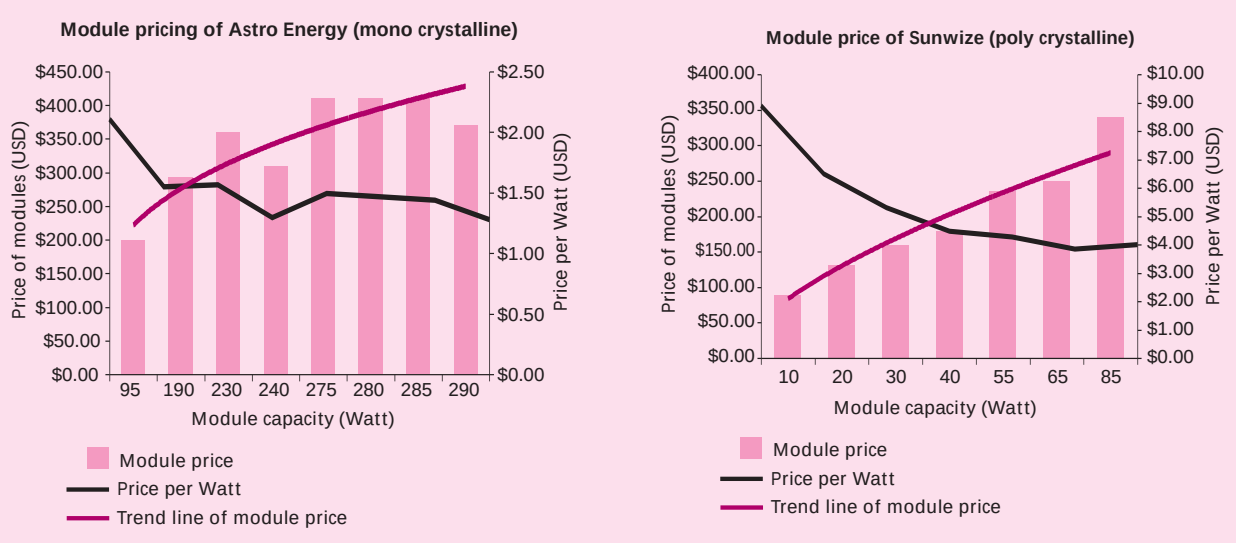
During the accreditation process, some key parameters have been overlooked. The current framework looks at the number of systems sold rather than to whom they have been sold. It is important to give weightage to the quality of the client base rather than the number of clients since the subsidies are going to be allocated to the rural population, who have poor electricity supply or no supply at all.

The current accredition process keeps the smaller companies away from participating since their net worth and technical expertise would not be adequate for a good rating. "Even worse, their annual turnover would not even let the companies pay the fee that is required to get it rated and therefore accredited by the MNRE. It is actually these small-scale models that are genuinely working in remote and rural areas to serve those in need of the technology at affordable cost," says Harish Hande of Selco, a system integrator.

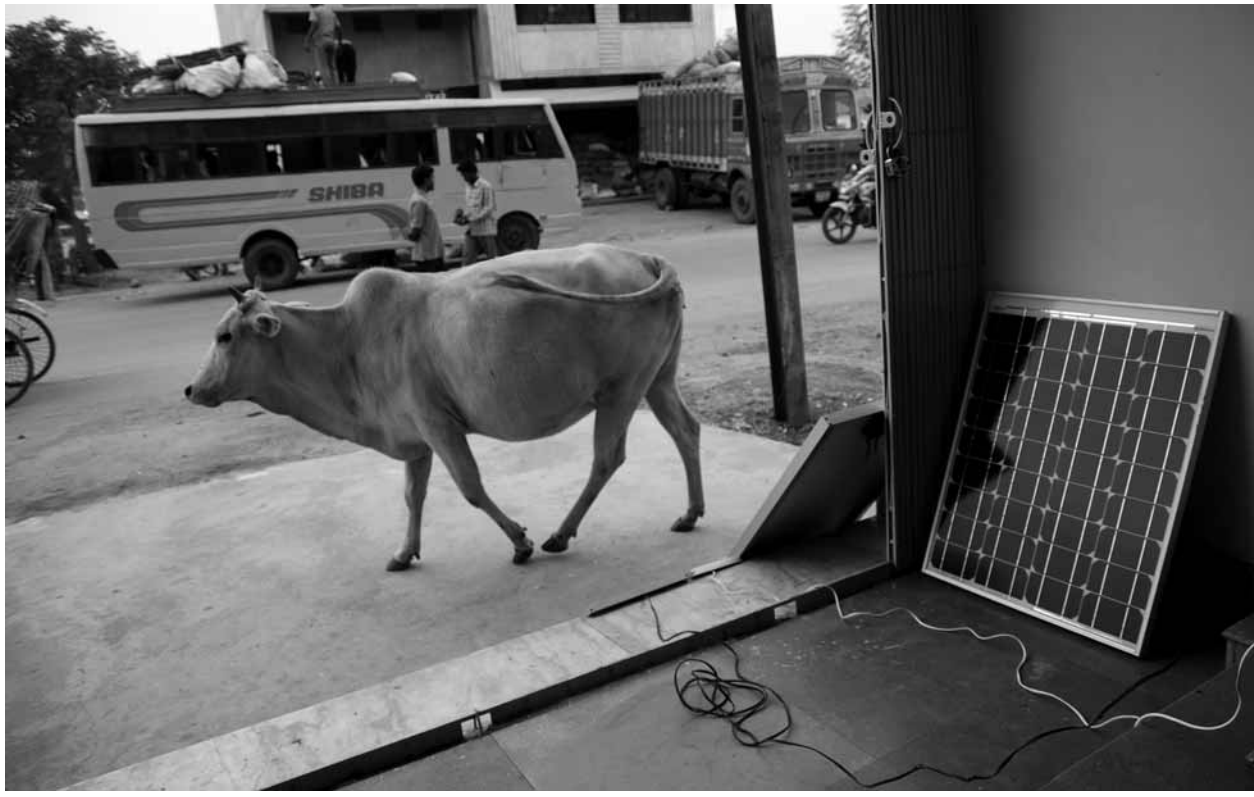
Benchmark costs: The benchmark costs suggested in the guidelines are not feasible in terms of the actual SPV module costs, according to the industry. The reason for this dissonance: the price per Watt peak of a SPV module has been benchmarked. This price is regressive with relation to the capacity of the system. For example, the cost per Watt of a module would be higher in a 37 Wp module than a 74 Wp module (see Graph 3.2: *Regressive nature of SPV prices per Watt*).[15]

Setting the same benchmark cost for a wide range of module capacities – from an 18 Wp home lighting system to a 250 kWp mini-grid system –

Graph 3.2: Regressive nature of SPV prices per Watt



Source: http://www.wholesalesolar.com



SURYA SEN / CSE

Current MNRE benchmarks are lopsided: they subsidise high capacity plants at the cost of small home lighting systems used by rural poor

does not work out as desired in terms of capital subsidy. The decreasing costs show that the current benchmarks set by MNRE would subsidise a 250 kWp mini-grid plant more heavily as compared to a 37 Wp home lighting system. These large power plants are mostly used by industrial units and telecom operators as seen in the list of sanctioned projects so far under the scheme.

The current system of benchmarking discourages the small-scale systems because although the capital subsidy is 30 per cent, the actual subsidy the beneficiary receives would be only between 12-16 per cent of the actual price of the system. Due to this inefficient benchmarking system, the beneficiary has to take a loan (in case he is unable to finance it upfront) from the bank at the normal interest rate of 12 per cent for the rest of the amount.[16]

Financing the projects

Interest subsidy: The existing financial model under JNNSM is designed in such a way that private bankers can also lend to off-grid projects. Under NABARDs refinancing mechanism, loans at 2 per cent interest rates are disbursed to the bankers, who can lend at a ceiling interest rate of 5 per cent to the beneficiary. Conversations with some of the private sector banks provide us with the following cost insights. The cost of operation for the largest banks amounts to about 2 per cent of the loan, with 0.5 per cent for risk provisioning. This implies that 4.5 per cent of the loan has to go on administration, management information systems (MIS), loan processing and collection. Therefore the current scheme expects private bankers to lend at a profit of 0.5 per cent of the total loan amount. Given the large amount of projects involved (because of small-scale) and huge risk of recovery (because of lending to people who are traditionally not seen as credit worthy) a profit of 0.5 per cent on the disbursement might not encourage private sector financing.[17]

MFIs are also expected to be financial aggregators in this process. However the lending costs for MFI are noted to be at least 5 per cent. This would mean that MFIs would actually have to lend at a loss if they are to participate in the scheme, ruling them out from the financial aggregators.

Access to capital subsidy: The ministry has decided to channel the capital subsidies through NABARD under this scheme. This has brought in further complications to the model.

Earlier, many manufacturers of off-grid SPV systems and system integrators tied up with banking institutions, especially RRBs and nationalised banks, to offer financial support to the rural poor for purchasing solar lights. The banks would sell their financial products at normal rates to the rural poor complemented with a solar application given by the system integrator. The manufacturers and system integrators had to work with the tail end of bank branches to provide for the rural poor.

However, after introduction of the current policy, the process has become more strenuous for channel partners. The user comes up with a down payment to the RRB and the system integrator is expected to set up the solar application with the beneficiary. Then, after collecting all the documents from the beneficiary, the bank applies to NABARD for the release of the 30 per cent of the subsidy. NABARD waits for such applications from all other banks and scrutinises the documents. If there are any that are not in order as per the format, then NABARD sends back the application. Then the process is back to square one for the banking institution. This way, there have been delays over the last financial year in terms of receiving capital subsidies from NABARD.[18]

The time taken for applying for funds through these banks is simply discouraging. The companies would only be paid after project completion.

Technical specifications: The MNRE does not accommodate LED bulbs in its guidelines for home lighting purposes. These bulbs are extremely efficient. One can bring down the panel size to such an extent that it has a significant effect on the cost of these systems. There is no space for product innovation and customisation due to the rigidity of the technical specifications in the guidelines.

Eligibility: Farmers in remote areas, educational institutions, entertainment centers in cities, telecom companies, and private sector enterprises like banks have large varying purchasing power, willingness to pay, and interest in an off-grid solar application. To take an example, Hero MotoCorp, for its industrial unit in Gurgaon, had captured the subsidy for a 100 kW power plant. However, research shows that the electricity generated by the solar power plant is minuscule as compared to the already installed power generators. The opportunity cost of the amount spent on the power plant is extremely high. The same could be used for villages frequented by power cuts or villages without any source of electricity at all. The utility of the electricity generated in the villages would be much higher, since the dependency of the villagers on the power plant for their basic lighting needs would be high.

There needs to be varying scalable subsidy levels for different entities which lie at varied levels of the income strata. An eligibility criterion is required in terms of income levels so as to keep commercial entities away from the subsidies meant for the rural power deprived poor.

CHAPTER 4

Solar: social entrepreneurs

It is not as if solar energy systems are not being disseminated and used in remote and poor villages and cities. There are many entrepreneurs who have worked hard to innovate to reach the unreached markets, delivering services and technologies to the very poor. Interestingly, these models do not subsidize the technology package; instead, the poorest pay for the system – in installments. Micro-finance is one way of producing support: small loans to pay back the cost of the solar household system. What is clear is that the poor want energy and are willing to pay the cost to power their lights and fans and to work in their homes. They pay for this energy, as against for government-supplied power, because they get reliable products and timely service for repair and maintenance. This after-sales service is the difference between programmes that work and those that do not. The other key is the design of the product line so that it is flexible to the needs and the purse of the buyer. So, there are models as well as opportunities for the future. The problem is that these micro-models – the largest in the region comes from Grameen Shakti in Bangladesh – remain prototypes. They do not get scaled up to meet the massive challenge that exists. Business, which is so savvy in providing all that paying and easy to reach consumers need, has not worked out a model which is replicable at scale and which, like the mobile phone technology, can revolutionize energy technology to reach all.

The implementation of off-grid solar photo-voltaic (SPV) applications in India is not just government business. The market has also created opportunities for the private sector and civil society groups. The power deficit in the country has induced even urban areas to consider off-grid SPV applications, at least as a back-up. However, it is rural India that is turning to solar to find light in their homes.

Although the purchasing power is much higher in urban areas, they are not willing to pay a very high price for electricity, no matter what the source is. On the other hand, in rural areas, even though the purchasing power is low, consumers are willing to pay higher prices for electricity. As long as the service is good, villagers will make an effort to pay for it. Government policies overlook this and continue to focus on the fact that with their low purchasing power, rural areas require heavy capital subsidies.

On the other hand, a whole group of social entrepreneurs – which include non-governmental organisations (NGOs) and regional rural banks (RRBs) – have come up with solutions that focus on the consumer. They have designed innovative financial instruments and also modified the technical specifications of systems in line with the purchasing power of users. They have also set up strong service networks to sustain the life of their products. This has built a market for solar.

Avani: Disseminating solar in the Himalaya

Avani, a non-governmental organisation (NGO) headquartered in Tripuradevi, Pithoragarh district of Uttarakhand has done extensive work in disseminating solar technology and awareness since 1998 in the Kumaon region of the state. The NGO trains village youth to install, repair and maintain solar home lighting systems (SHS) and solar lanterns in remote villages.

Avani's programme for distribution of SHS which ran from 1998 to 2002 provided solar lighting to around 2,500 families in more than 254 villages in Kumaon and was completely funded by grants from the European Union (EU). The SHS were at first provided by the Barefoot College of Tilonia in Rajasthan. After the EU programme ended in 2002, Avani started selling solar appliances – manufactured in its campus in Tripuradevi, Pithorgarah – in villages and the commercial market.[1]

Designed with people in mind

The NGO has created financial models whereby the villagers can earn their livelihood and also pay for solar power. "Providing solar lighting alone in a village does not suffice. Rural households need to generate income to pay for their solar electricity," says Rajnish Jain, director of Avani.

Under the 'installment model', the SHS are handed over to the beneficiary against a small advance payment and the rest of the money is collected in installments. Normally, a 37-watt peak (Wp) SHS costing Rs 7,500 is sold.[2] Each beneficiary has to make an advance payment of Rs 2,000 which is paid into the corpus of the Village Electrification Committee (VEC) to be used for replacing batteries. The VEC is responsible for setting up and maintenance of SPV applications.

As installment, Rs 90 is collected every month, till the complete amount is paid off. Of this Rs 30 goes to the technician and Rs 60 is the monthly addition to the battery replacement corpus. The technician's salary is about Rs 2,500 per month.[3] According to Avani's annual report for 2006-07, 90 per cent of the salary for solar technicians was sought by collecting fees from users in villages and the shortfalls were covered through the sale of solar lanterns and lightings.[4]

The technicians were always chosen from among the village youth and included women. They were trained by Avani at its Tripuradevi campus. During the three to six months training, they were taught to install, repair and maintain solar systems. They also assemble Avani's solar products in the same campus. Many of these technicians have repaired non-project systems provided by the Uttarakhand Renewable Energy Development Agency (UREDA) in the nearby villages.

Sustaining the programme

Since 2003, after the EU funding ceased, Avani has found it difficult to sustain the programme, especially the crucial maintenance and servicing component. "We have found it difficult to pay for the training and monthly salary," said Jagdish, a project coordinator with Avani. "We still train village youth if somebody funds their training and stay," he adds. It is also important to employ them, or else, the training goes waste. "A few years ago, UREDA asked Avani to train around 50 village youth and provided the requisite funds but after training no one was employed," said Rajnish Jain.

With the funds crunch, the NGO has found it difficult to maintain the VEC corpus fund. "Now that the funding has ended, we have been having a tough time in keeping up with the villagers. Many of them now do not see value in paying the monthly installments. Now, we have to tell the villagers to bring the system to our service centres, get them repaired and pay the service fee," said Rajnish Jain. In fact, a good servicing network and a mechanism to pay for battery replacement is crucial to run the programme successfully, adds Jain.

In Mahrodi village, Bageshwar district, Uttarakhand, Avani had provided 102 home lighting systems in 2003. The village is connected to the grid, but the service is irregular. CSE researchers spoke to seven households in the village to assess the situation.

To light up her two-room house, Parvati Joshi is dependent on grid-connected power which is irregular. On the other hand, two CFLs that 40-year old Joshi received with the 37-Wp SHS from Avani in 2003 have stopped illuminating. "I do not know whom to contact," said Joshi who lives alone in her house in Mahrodhi. A female technician trained by Avani left the village when she married. "Now there

JOEL KUMAR / CSE

As Avani looks to the future it is reducing costs of the SHS and experimenting with micro-finance

is nobody to make routine repairs," said Joshi's neighbour, 56-year old Madhvanad Kumar.

On checking the battery at Joshi's house, the wires were found to be loose and the battery had not been filled with distilled water. Joshi is scared of filling it and waits for her sons to do so when they come home. It has been over a year since they visited. In fact, no distilled water has been put in the battery for the last two years. "When there is a power cut, I use a kerosene lamp," said Joshi.

Despite the maintenance problems, the villagers trust solar lighting more than grid power. Some families have purchased new batteries from the village corpus fund. "This way the villagers did not have to pay money upfront," said Jagdish. This facility is not avaliable with the government subsidised UREDA programme.

Besides, the grid is looked upon with disdain. "We get grid electricity only for 5-6 hours a day and there are times when we don't get power for weeks. Yet, we get enormous bills," said Kumar. "With SHS we do not have to worry about power cuts. The installment amount is also fixed and a small amount," he added.

Reduction of costs

Avani is now trying to re-orient its approach because of the financial crunch. "We are experimenting with micro-finance and are in talks with banks," said Jagdish, project coordinator.

The NGO is also planning to start a pilot project offering solar lanterns to the beneficiary. The estimated market cost of a solar lantern manufactured by Avani is Rs 2,128. With the manufacturing cost at Rs 1,600, Avani makes a profit of Rs 528. The beneficiary can have the lanterns after an advance payment of Rs 500. The rest of the amount is collected as installments of Rs 100 with Rs 8 as interest. The beneficiary has to pay this installment till the amount matures to Rs 2,128.

Avani is also working on reducing the cost of the SHS. "Using LED's in the SHS makes the system much cheaper compared to CFLs. Also, LEDs are more luminous than a CFL when compared in terms of their power consumption. Therefore an LED set would require lesser power than an 11 W CFL to disperse the same amount of lumen. In this way, the module size can be reduced to a great extent with a consequent reduction in the price of the system," said Jain. This way the cost can be brought down without reduction in efficiency. Jain adds that the huge subsidies earlier made sense since the SHS were expensive. But, now, he feels that the government needs to find a mechanism where systems can be made affordable for people.

Aryavart Gramin Bank: Uttar Pradesh's experiment

Aryavart Gramin Bank, the first bank in India to have received carbon credits under the Clean Development Mechanism (CDM) agreed under the Kyoto Protocol in 1997, provides SHS to its customers on credit. It is spread across six districts in Uttar Pradesh -- Lucknow, Barabanki, Farrukhabad, Hardoi, Kannauj and Unnao. It has 333 branches, six regional offices and a head office in Lucknow. The bank has been recognised internationally for its pioneering work in financing SHSs. In 2008, the London-based Ashden Trust awarded it the International Global Green Energy award, one of the world's leading green energy prizes.[5]

Operational since 2006 in rural Uttar Pradesh, the bank tapped into an existing client base, specifically rural consumers who had been paying for their Kisan Credit Cards (KCC) and teachers drawing their salaries from the bank. Under the Kisan Credit Card scheme, short-term credit is provided to farmers, which mainly helps them to purchase inputs during the cropping season. Currently, there are around 3.7 lakh KCC customers and 27,000 teachers.[6]

Basing itself on these captive customers, the bank roped in Tata BP, a company accredited by the Union ministry of new and renewable energy (MNRE) to supply SHS. The company would provide the SHS sets to the customers, the financing coming from the bank. As a result, Aryavart became a hub for both energy and financial products.

The financial process

The bank provides a loan for up to 95 per cent of the system cost and the rest is collected from the user as down payment. The loan is offered at an interest rate of 12.5 per cent per annum. The loan can be repaid in monthly or half-yearly installments, within five to seven years, depending on the product.[7]

The bank negotiates a reduction in the price of the systems with Tata BP by assuring them their large client base. For example, the Venus 1 model (two 9 W CFLs, a 37 Wp panel, 12 V - 40 Ah battery), originally costing Rs 14,500, was negotiated for a price of Rs 13,650 (see Table 4.1: *Cost of photo-voltaic models, Aryavart Gramin Bank*). This includes Rs 650 as value-added tax. Out of this, the Union ministry of new and renewable energy (MNRE) gives out a subsidy of Rs 3,996 per system.

The customer deposits the down payment of Rs 750 to the bank and the rest of the amount is credited to Tata BP by the bank. The rest of the amount is repaid with a monthly installment of Rs 200 with 12.5 per cent interest in five years.

The project has proved to be a successful venture for Tata BP since they do not have to worry about credit repayment. Till March 2012, around 55,555 customers have been given SHS.[8] Now, anybody with an identity proof can apply.

On its part, Tata BP provides an extended warranty period of 10 years for solar panels and five-year warranty for batteries. This reassures the rural clients who often lack a well-coordinated maintenance apparatus. According to the company, its local dealers have qualified mechanics on hand, who install the systems. "For proper installation and maintenance, we have partnered with a local dealer which takes care of installations and maintenance," said S M Jafar, regional manager, Tata BP. Solar Power Systems (SPS) is a Lucknow-based dealer of Tata BP and has trained *suvidha data* or 'business facilitators' in the areas where the systems have been delivered. "We pay them a monthly salary of Rs 3,000 and the beneficiary pays them service charges when the system is out of warranty," said Manoj Gupta, manager, SPS.

Table 4.1: Cost of photo-voltaic models, Aryavart Gramin Bank

Model	Panel	Luminaire	Battery Capacity	Price
Venus 1	37 Wp	2 x 9 W CFL	Tubular 12 V 40 Ah	Rs 14,500
Venus 2	74 Wp	4 x 9 W CFL	Tubular 12 V 75 Ah	Rs 27,000

Source: Tata BP

Arayavart has now has embarked upon its next phase of development in the SHS sector using its earnings from carbon credits. In 2010-11 the bank earned US $ 77,536 (nearly Rs 35 lakh) as carbon credits. It has a six-year deal with Micro Energy Credit, a US-based company, which applies for credit with the United Nations Framework Convention on Climate Change its behalf. Micro Energy Credit takes 20 per cent of the profit. To begin with, it is organising camps in rural areas to popularise the SHS. Aryavart is also planning to engage more channel partners (such as Tata BP) and business facilitators.

The bank is also using the funds to devise ways to develop the service delivery mechanism, the key grouse of most consumers. Many villagers have complaints about the SHS they purchased and the problems with efficient after-sale services, as CSE discovered when they visited Barabanki and Hardoi districts.

Madeenpur

The family of Shrinand Lal bought an SHS in 2008. In two years the solar panel had shrunk in size. "We do not know how it happened. The panel was kept on the roof of the house. First it started developing cracks and then shrunk," said Kamlesh Rani, wife of Shrinand. Since then, the family of seven, who live in Madeenpur village in Barabanki district of Uttar Pradesh, has been spending around Rs 280 every month on buying kerosene. The village, despite being just 30 km away from the state capital Lucknow, is off the electricity grid. Around 50 SHS had been distributed in this village.

The family does not know whom to contact. "Earlier technicians used to visit to check the systems but nobody has come in the last two years," said Rani. The regional manager of Tata BP has a ready answer. "There is no warranty on breakage of systems. The warranty is on performance," said S M Jafar.

Rani was happy after getting the SHS. "The solar light was very helpful. It lit up the evening cooking period. My children could study. But now we are back to our previous situation of using kerosene lamps," she added.

The family has not complained to the bank since they owe it money. "We have not paid the installments and the interest is piling up. We don't have this much money," said Rani.

Defective panels and poor service discourage payment of installments

ANKUR PALIWAL / CSE

The key technical complaint emanating from the villages has to do with the battery – it 'deep discharges'. Every battery has a reserve point, which should be used only in case of emergency. When this reserve charge finishes, the battery enters into 'deep discharge' mode.

Beer Singh has an SHS, the battery of which has deep discharging problems. "Only one CFL works and that too only for two hours," says Sarita, his wife. Singh purchased a new lamp but that too failed after some time. He too has not paid his dues for a long time and does not have the contact number of the technician.

Tata BP blames the battery problems on the overloading of the system. "A 37 Wp SHS has been designed for lighting around five hours a day. Despite telling the villagers repeatedly not to run a television and fans for long hours together, the practice continues. There is a charge controller that cuts off power when the battery is about to go into reserve mode. The beneficiary does not understand this and removes the charge controller, and directly connects the wires of the panel with the battery. This puts pressure on the battery. The charge finishes completely and the battery goes into deep discharge mode. The only solution in such cases is to leave the system untouched for two to three days to get it fully charged," said Jafar.

In some of the houses that CSE visited the panels were directly connected to the batteries. However, the affected villagers say that when nobody attended to their systems, they had to apply their own minds. "What is the use of a warranty if the battery does not charge properly? When nobody is listening to us, what do we do?" asks Ramkumar Singh. His family has been using kerosene oil for lighting for at least a year despite having a SHS. Ramkumar stopped paying monthly installments and has pending dues of about Rs 4,000.

Besides, not all houses that CSE visited have televisions. Many beneficiaries said that they had been using the system only for lighting and still their battery is creating this problem. "Earlier when the system was delivered, it not only powered CFLs for at least five hours, but also a fan for two hours," said Gajraj Singh, Shrinand's neighbour. "However, we enjoyed this relief only for a year and a half, as after that the power of the battery started diminishing," he added. The family of Gajraj is buying kerosene oil for lighting. "When the systems were installed, the whole bank was here to take pictures, but nobody has come to see us since then," said Gajraj. He too has not complained to the bank because of his pending dues.

Non-payment of dues is a major problem across Aryavart's operational area. The bank's branch at Kursi (25 km from Lucknow) has 14 villages, including Madeenpur, in its service area. The branch has provided around 1,000 SHS in its service area. Of these only 300 beneficiaries have paid their complete installments while some others have time to complete the five-year loan period. "Non-payment of installments is our biggest challenge. On an average, there are 20 per cent defaulters," complains Anwer Husain, Chief Manager, Finance, Aryavart Gramin Bank, Lucknow. "We are planning a mechanism where we will train and pay local persons in the village to motivate people to regularise their installments," added Husain.

Aryavart's manager in Kursi puts the onus of the problems on the villagers. "There is a complete lack of ownership among the beneficiaries. They think that since the bank has given them the system, it is its responsibility to knock on their doors to check for problems and repair," said Ravindra Kumar Trivedi, branch manager of Aryavart at Kursi village. "Until the beneficiary comes and reports problems, how would we know that there is a problem? We do address problems which come to us. Around five solar panels were stolen from Madeenpur village in 2011. New panels were arranged free of cost once we were informed," he adds.

Ramkumar Singh has a different viewpoint. He does not have the telephone number of the local technician and said that he had put in a complaint with Trivedi. The manager promised to have a technician sent, but he never arrived. Madeenpur is just three kilometres from Kursi. According to the bank's system every branch is supposed to keep a separate complaint register for SHS to note the complaints but none of the two branches at Kursi and Gondwa (in Hardoi district) that CSE visited had the register.

The technicians too have their side of the story – their own service conditions. In one instance, a local technician, who had been trained by Tata BP, told CSE on conditions of anonymity that he had not been paid his salary for a year. "I get around three to four calls every day but I have a large area of around 50 villages to cover. I cannot spend my own money to pay for the conveyance. Around 20 per cent of the batteries are not in order

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The demand for SHS remains high in spite of technical problems

right now. I have complained to the bank and the local dealer SPS many times but no action has been taken. People are angry here and consider that they have wasted their money on SHS," he said. On being asked about payment to his technicians Manoj Gupta, manager SPS said, "We regularly pay our technicians".

Tikaitganj

Tikaitganj is three kilometres away from Madeenpur. Around 40 systems were distributed here. The people were happy when they received the systems in 2008, as it reduced their dependence on kerosene and helped improve their businesses. But now some of them are complaining.

Mohammad Rizwan is upset. The battery of the SHS he got from Arayavart four years ago has not been charging properly for at least a year. "The CFL lights only for an hour," said Rizwan who lives with his extended family of ten people in the village. Rizwan does not know that there is a warranty of five years for the battery and he can get it replaced. The family thinks that it would have been better if they got an inverter instead. "Even with three hours of grid electricity every day the inverter would have charged for some time to give us relief for four to five hours," he added.

He has complained to the bank many times, but in vain. "I have paid all my installments and still I am not being given any services," said Rizwan. "What is the use of this system, if I still have to purchase kerosene oil for lighting? All the promises that the bank made about services was hollow," he lashes out. He has not heard of any technician trained by Tata BP in the area.

His neighbour Mohammad Ayub echoes his sentiments. Ayub also complains of the problem of deep discharging of the battery. Few houses away live Mohammad Mohsin who took the SHS from the bank around the same time. He has similar complaints. "This system is of no use to us now. If it is not charging properly what will I do with it? There is nobody to repair it. The bank can take it back," said Mohsin. Seeing these problems, Mohammad Nizamuddin, has put his plans for an SHS on hold.

But not all are unhappy. The SHS in the house of Ramdulare Singh, the *pradhan* (head) of the village is working fine. He also purchased the system around 2008. "I have paid all my dues," he said. He uses two CFLs for 3-4 hours a day and sometimes watches TV for an hour. "I try not to overload the system," he said.

Atahra

Some ten kilometres further north from Tikaitganj, along fields of peppermint, lie Atahra. The problems are more or less similar. In this village around 100 families had bought the SHS from the Kursi branch of Aryavart, around 15 km away.

The solar panel in the house of Ganesh Sahu was stolen within eight months of its installation. He put in a complaint with the bank but was told that no help could be provided. "Around Rs 3,000 has gone waste as I have paid some installments," Sahu said.

Rakesh Sahu who got the SHS in 2008 complains that the battery does not charge properly. The family uses only one CFL of the two as one fused within a year. It illuminates for two hours, at the maximum. Sahu has not bothered to buy a new CFL. "No technician has come to check on the system. I do not know why the battery is not charging properly," he said. Sahu also finds the 12.5 per cent interest rate high. He has not paid the installments for two years. "It is difficult for us to pay every month. And, then the interest piles up," said Sahu.

Six months ago Raju Kumar paid Rs 50 to a technician to check his SHS battery which was deep discharging. The problem continues. No technician has come to check on him since then. As he did not take the contact number of the technician, he does not know whom to call. He also does not know that he can register his complaint with the bank. He hesitates visiting the bank since he has not paid the installments.

Despite these problems the demand for SHS is increasing. The Kursi branch alone, which sold around 1,000 systems in 2011, had sold 180 systems till March 2012.

Bambrauli

Around 70 km from Hardoi district headquarters lie Bambrauli block. Almost all 175 families in the village had bought an SHS between 2008 and 2009. The systems were supplied by the Gondwa branch of Aryavart Gramin Bank. Bambrauli is three kilometre away from Gondwa village in the same district. Presently there are 76 villages in the service area of the Gondwa branch. The SHS has been given to around 1,000 beneficiaries. Bambrauli is not connected to the grid.

The SHS in the house of Nand Ram is functional since it was installed in 2009. The former *pradhan* of the village has got two SHS sets and runs a colour television using an SHS for an hour every day. "The system has to be used carefully which beneficiaries do not understand," he said.

On the other hand, 65-year old Harivansh Verma has been waiting to have his solar panel replaced for a year. He spends Rs 220 every month on kerosene. The solar panel of the SHS which he bought three years ago developed cracks and the battery has also stopped charging.

Harivansh had the battery deposited at the Gondwa branch with a request for replacement. "I have paid Rs 3,000 including installments but still my panel has not been replaced," says Harivansh. Solar panels have a warranty of ten years. "But there is no warranty for theft or broken panels," said Jafar. When Harivansh was told about this, he questions the quality of the panel. "We have communicated this problem to Lucknow office and Tata BP but have not got any reply," said Dilip Kumar Das, branch manager with Gondwa branch of Aryavart.

Few houses away, Munnilal Singh, who also got the system on credit from the bank in 2009, has complaints. "For a year, now, the battery has not been charging properly," he said. Munnilal complained many times to Pradeep Awasthi, a local technician trained by Tata BP, but no help was forthcoming. When CSE spoke to Awasthi regarding the problems that the beneficiaries were facing, he said, "I have been given a very large service area. It is difficult for me to attend to everyone's problems." Munnilal has not approached the bank because he has not paid his dues.

"There are 60 per cent defaulters in our service area. We have given many of them notice but they do not bother. The last option for us would be to seal their accounts which are with us," said Das. He has not received even a single request of battery replacement from his service area since 2008 when it first distributed systems.

Gondwa

Gondwa too is off the electricity grid. Virendra Nath Shukla lives just a few metres away from the village branch of the Aryavart Gramin Bank. He is unhappy with the SHS he acquired. "Even in this heat of June, the red light on the charge controller comes on within an hour, which indicates that the battery has discharged," said Nath. This has been the case since last year. He got the system from the bank in 2008. "I have complained about this to the bank but no help came our way. I have to light up a kerosene lamp as soon as the CFL dims," he added.

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Ashish Singh of Gondwa village with his portable DVD player powered by a solar home lighting system

In another house 43-year old Satya Prakash has a similar problem. "Why am I not being given good service, when I have paid all my installments?" he asks. Like other villagers Prakash is unaware of the complaint book in the bank where beneficiaries can register their complaints. He too got the system in 2008.

Ashish Singh's SHS is working fine. He has got two systems, and among other uses, he charges his laptop and watches a small TV for an hour. The four CFLs are working well. "SHS has proved to be very helpful. It is only because of this that I can give enough time to my studies," said 23-year old Singh, who is writing his BA final year exam.

Key findings

There is clearly a huge demand for SHS as was seen during the visit. The system is failing only because of the lack of a proper after sales service mechanism and non-payment of dues. Aryavart considers the problem of non-payment of dues as its biggest challenge.

The bank claims to be working on a plan to facilitate battery replacement. They are considering either giving loans to the customer for buying a new battery or working out a system where they can provide the battery at half of the market price. Nothing though has been finalised till now. The survey of the villages brings out some key facts:

1. After sales service is a problem. The problems of beneficiaries are not being attended properly as a result they try to attend to their systems on their own which only creates more problems. For example, many of them remove the charge controller and join the wires of panels directly with the battery. There is a lack of awareness.
2. There is a lack of ownership in beneficiaries. They enjoy the benefit of the system till it is working fine and when it starts developing problems, many abandon it.
3. Many of them have not paid their installments in time and therefore fear complaining about the problems to the bank. The beneficiaries want their dues to be waived off.
4. The bank and its technical partner Tata BP have not thought of any mechanism yet for replacement of batteries after the warranty period end. As per the situation on ground now, the user will have to purchase the battery without any financial assistance. Many users may not be able afford such a huge amount which has alo been the case in many such situations.

SELCO: Karnataka's bright light

The Solar Electric Lighting Company (SELCO Private Ltd) was founded in 1995 as a commercial enterprise to sell solar lighting applications to the rural poor in Karnataka. The company brings technology and financial products together and provides low-cost sustainable energy services to the power deprived poor. Bengaluru-based SELCO has managed to provide basic lighting to 135,000 households across Karnataka since 1995.[9] This was accomplished mostly in south Karnataka.

They operate in Karnataka with 26 branches. The enterprise is trying to upscale their work and spread to neighbouring states. Lately, they have ventured into Maharashtra and Gujarat with a branch office in each state. However, business in other states is still in its nascent stages.

SELCO started out with aid from international agencies such as United States Agency for International Development (USAID) as they required large initial capital to start out their venture. In 1993, before forming SELCO, its CEO Harish Hande implemented a programme to install solar lights in 100 households in Karnataka's Western Ghats region using a grant of US $ 40,000 from the US-based Rockefeller Foundation.[10]

The major shareholders of SELCO are the New York-based non-profit organisations Good Energies and E + Co, as also the Lemelson Foundation based in Portland, Oregon in the US. Hence all the profits are largely used for the operations and also the expansion of the business. "Since the shareholders do not expect returns from this investment, SELCO has been able to marginalise the profits and work out cheaper end products as compared to most commercial solar enterprises," said Surabhi Rajagopal, an analyst with the SELCO Foundation.[11]

To understand the state of implementation on the ground, Centre for Science and Environment visited three villages selected on the basis of penetration by SELCO – Kayarthaduka, Nada and Shishila in Belthangady *taluk* of Dakhshin Kannada district. Shishila was visited at sunset and therefore provided us with an understanding of the luminosity of the lights provided. The village was grid-electrified more than 15 years ago, but a lot of houses there are still completely dependent on kerosene or solar lights from SELCO. Nada and Kayarthaduka are getting grid-connected under the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) scheme of the Union ministry of power.

System integration

SELCO is a system integrator and sources solar panels from various manufacturers and technical suppliers such as EMMVEE Solar Systems, Tata BP, Anand Electronics (for electronic equipment) and Shakti Electronics (for their batteries). The systems are then assembled by the company in its branches. SELCO does not standardise products. A number of combinations – in terms of the battery and panel sizes – with regard to the load required can be assembled. Depending on the number of rooms and the purchasing power of the household, SELCO customises products to meet the needs of the end user.

Most of the households has at least one LED bulb. This has helped them in procuring more light in smaller-sized modules because LEDs use lesser power. SELCO has products beginning with Rs 7,500, which is a basic model with a 10 Wp module, 10 Ah battery and a 5 W CFL. However, most of the households visited had the 4-light model and very few houses had a 2-light system. The panel sizes varied between two households even for a 4-light system because of the varying combinations of LEDs and CFLs. This also influenced the prices.

The usage pattern in Raja Acharya's shop is a good example. Acharya owns a shop by the side of the road leading into Kayarthaduka village and lives in the same building as his shop. His SHS has 3 LEDs (2.4 W x 2 + 3.6 W x 1), 1 CFL (7W) and a 30 Ah battery. He needed a CFL for running his shop. For his house he uses the LEDs, one in the kitchen and the other in the living room. He uses the other LED (3.6 W) to illuminate his front porch. Now all this could be managed using a 25 Wp Tata BP panel. The entire system cost him Rs 16,500, out of which he had paid Rs 1,500 as down payment, with the rest being paid through monthly installments (Rs 330 per month) for five years.

"I purchased the system in 2004. I had to replace the CFL bulb during the first year itself. Since it was under warranty, the company replaced it for free. The bulb has been working fine since then. I am still using the same battery and I am yet to replace it. The battery capacity has deteriorated over the years. I run the lights only for three hours in the evenings

these days and I do not use more than two lights at the same time unless the need arises," said Raja. He also did not renew the maintenance contract after the first year but called up the technicians whenever he felt the need to do so.

Vasant Hegde of Nada village, on the other hand, purchased a 4-light system consisting only of CFLs. The whole system cost him Rs 24,000. The system comprised of a 40 Wp panel, 60 Ah battery, three CFLs of 7 W each and a 11 W CFL. His 'areca' business also helped him clear the dues in two months itself. He had no grid power. They were in use at the time of CSE's visit.

This pattern of differences in technical specification was noticed in all the households visited. Between Raja and Vasant, although the systems are both four-light models, the similarities stop there. The batteries are twice as different in terms of capacity and Vasant's module was almost twice the size of Raja's. The purchasing power also varies among different beneficiaries.

Financing

Since the beginning, SELCO has been working with micro-finance institutions and regional rural banks (RRBs). Some of its current partners include financial institutions such as the Syndicate Bank, Pragathi Grameen Bank, Sri Mahila Self-Employed Women's Association Sahakari Bank (SEWA Bank) and Sanghamitra Rural Financial Services. In association with these banks, SELCO aims at making the products affordable to the poor.

Usually, the user pays a down payment of 10-15 per cent of the total costs. The rest is collected as monthly installments for a maximum period of five years at a 12 per cent interest. "There are also instances when SELCO has subsidised the prices for the user," says Hande. In special cases, where the user was unable to make the down payment, SELCO waived it off with aid from the Renewable Energy and Energy Efficiency Partnership (REEEP).[12] This is an Austrian non-profit legal entity that works mostly in developing countries and acts as a market catalyst for the deployment of renewable energy technology. Besides REEEP, SELCO also partnered with the United Nations Environment Programme (UNEP), and provided villagers an interest subsidy for the solar systems (see Box: *Solar loan programme*).

Financial inclusion

Umesh Gravida, a tailor by profession, lives with his wife, three children and parents in Nada village. The seven of them depended on kerosene for lighting, consuming about four to five litres a month, till they picked up an SHS in 2006.

At the same time, he opened a savings account at Vijaya Bank in Ujire, a village in Belthangady *taluk* in Dakshina Kannada district, which is about 40 km from Nada. "These lights have been a boon for us as I can now stitch at night while my children are busy studying. I also use the bank account for savings occasionally," said Umesh.

Similarly, among all the households visited in

SOLAR LOAN PROGRAMME

The United Nations Environment Programme (UNEP) initiated the solar loan programme in India in 2003 with the Syndicate Bank and Canara Bank as partners. The programme mainly focused on Karnataka. The banks participated in this programme and reached rural areas through rural regional banks (RRBs) – such as Malaprabha Grameen Bank and Tungabhadra Grameen Bank - under their sponsorship.

Four vendors were chosen for this programme which included Kotak Urja Private Limited, Selco Solar Private Limited, Shell Solar India Private Limited and Tata BP Solar India Limited. These vendors were monitored on their performance by UNEP throughout the programme.

This programme complemented SELCO's model where there is no capital subsidy involved. The interest rates were brought down by UNEP with a grant of US $1 million for this programme. By the time this programme was completed in 2007, 18,000 households in Karnataka had been provided basic lighting over a period of four years.[1]

The market had also grown in the project regions where more than 50 per cent of the sales took place through financing from banks. In a UNEP press release, Eric Usher, programme manager of the Finance Unit, Energy Branch, UNEP stated that the market had grown not because the costs of solar technology had come down but because access to financing had been rendered.[2]

JOEL KUMAR / CSE

Clients in villages in rural Karnataka are identified by SELCO's robust network of locally recruited buisness associates

the three villages, at least 60 per cent had opened their first bank accounts for getting the solar loan, and some continue to use the account to deposit their savings even after repayment of the loan.

Business penetration

Interventions such as that by UNEP have helped SELCO grow and expand their area of sales. However, reaching out to the rural poor is still not an easy task for a commercial enterprise. That problem was solved by setting up branches in these areas. "We have been recruiting only the local people to manage our branches because they understand the people and region, in terms of geography, much better," says Rajagopal. Each branch consists of a branch manager, sales executive and at least two technicians and an office administrator.

Although the branches are managed by local recruits, there are a lot of chances where potential customers can be missed out. "In order to penetrate remote regions where we don't even know whether there are people living there, we started the concept of bringing in business associates to enable our sales," according to Guruprakash Shetty, an area manager of SELCO.

The branches identify business associates within their area of operation who identify potential customers. They get a 5 per cent commission on the price of the number of systems sold. "Sometimes, the business associate manages to identify and convince the customers into purchasing the systems. He also has to make sure that the users repay their loans in time. In such cases we pay the business associate a commission of 10-12 per cent on the price of the number of systems," says Guruprakash. There are many houses in between the two villages because they live next to their fields and sometimes just off the road. Such customers are best found through the aid of business associates.

The branches keep equipment for different models and replenish stocks as sales deplete their shelves. "Stock arrives from Hubli which is where our equipment from suppliers are stored. From there, according to the demand of the branches the systems are disbursed," says Guruprakash.

An important part of SELCO's model is their pre-sales activity. They visit their clients and find out exactly how many lights are needed for the households. According to the purchasing power of the people, the number of lights required could vary from one to four and the combination of CFLs and LEDs also vary. During the first visit, a technician assesses the requirement of the client and matches it to their purchasing power. The

amount of wiring required is also calculated during this visit. Wiring is done economically, thereby bringing down the cost a little more. In case they do not have a bank account they are asked to open one so that the loan is sanctioned in their favour.

Since SELCO has tie-ups with banks, they do not have to go back to the users for payment of dues, which is the responsibility of the bank. This is a definite business advantage. In case of a default on payment, the bank waits for up to three months for the user. If the user is unable to pay still, the system would be taken back and resold at the depreciated value.

Expansion and awareness

The potential for business penetration in Nada was brought to SELCO's notice by Harish, a member of the *gram panchayat* of the village. "I met the sales executive of SELCO and explained the need for lighting in the village. I was one of the people responsible for spreading awareness in our region and was paid a commission by SELCO," explains Harish. Since he was a member of the *panchayat* he could easily hold meetings for this regard with the rest of the *panchayat* members.

Harish is in his late thirties. He ferries passengers in his auto rickshaw for a living. He also finds new customers for SELCO as he visits nearby villages and meets people while giving them a ride. He can also access houses that lie between two villages. "I have brought in around 45 clients for SELCO," he said.

Among the households visited, CSE also discovered that many of them could not pay their 'margin money' or down payment. While treading through Nada, CSE discovered a house which neither had grid power nor solar lights. "We could not afford it. The down payment was too high for us. We have always been using kerosene," said the lady of the house. Her husband is a wood cutter.

Maintenance

SELCO focuses on after sales service. It is this service-oriented approach that seems to have sparked things in the right direction for SELCO. They have succeeded in establishing a positive relationship with the community. There were no complaints among users in terms of the functionality of the systems. "During the rainy season, the charge barely lasts for two hours. But in summers, they are back to normal again," says Nonaya, a farmer in Nada village.

All components of the system are under warranty. The batteries are usually under a 3-year warranty while that of the panels are up to eight years. The lights are usually under a one-year warranty.

For the first year, the maintenance is free of cost. During this year, the technicians are supposed to make two visits at the end of six months. After the one-year period the user has the choice of extending his contract annually at Rs 250 per annum. Most of the households visited had not renewed their maintenance contract with SELCO. "We don't see why we have to renew it. In case there is a problem, my husband informs the technician who is paid only after he repairs the system. Besides that, I dust the panels about once in two or three months and my husband gets back distilled water from Ujire, whenever required," explains Kamala from Kayarthaduka. She received her system about four years ago and has not had many problems except during the rainy season.

None of the villagers had television sets. The very few who had a television, were connected to the grid. They did not use the SHS to power their television sets. The only other appliance they had connected to the charging units was a mobile charger.

Key findings

The SELCO model proves that solar lighting can be made available through marginal subsidisation alone – soft loans in its case. This financing instrument has made solar power affordable while replacing kerosene. There also have been instances when the user was unable to pay the down payment which had to be covered by one of the donors. However, in most cases, the users are capable of purchasing different models of the SHS according to their purchasing power. The solar loan programme conducted by the UNEP has also laid emphasis on the usage of soft loans.

The second important point is that the system integrators have been able to modify the system specifications according to the needs of the consumer rather than having one standard product that suits all. By customising the product one can also tweak the costs of the system and reduce the financial burden of the consumer.

SELCO has been able to deliver solutions in rural Karnataka. The challenge that remains for the company is to skillfully upscale or multiply similar models throughout the country.

Grameen Shakti, Bangladesh

Bangladesh, India's eastern neighbour, has a massive power shortage. About 51 per cent of the country is electrified or grid-connected and the rest have no access to electricity. The power generation capacity of the country, as of June 11, 2012 was 7,551 MW.[13] The per capita electricity consumption in Bangladesh was just about 146.5 kWh in 2011.[14] However, the country has huge potential of generating power from renewable energy with a promising future for solar energy.

The Dhaka-based Grameen Shakti, established in 1996, is a social business catering to rural Bangladesh and aims to serve the rural poor with reasonably priced clean and sustainable energy. Consequently, the organisation also focuses on improving incomes and the quality of life in the rural sector. Grameen Shakti was registered as a 'social business' on December 6, 2010.

The major activities of this organisation cover almost the whole of Bangladesh which includes providing energy services through solar home lighting systems (SHS), biogas plants, improved cooking stoves (ICS) and even organic fertiliser production. As of May 2012, Grameen Shakti had installed 22,368 biogas plants, 479,745 ICS and 864,000 SHS. Grameen Shakti has also installed over 2,050 micro-utility systems.[15] The total installed capacity of power and micro-utility systems and biogas plants is 42.50 MW with a daily power generation capacity of 170 MWh, covering 64 districts of Bangladesh.[16]

The rate of installation of SHS is about 21,000 per month. India, on the other hand, has had a much slower growth rate with regard to its entire un-electrified population. As of 2011, India had about 1.08 million households using solar energy as a source of lighting.[17] The quick yet sustainable uptake and grasp of the technology in rural Bangladesh is what makes their financial model unique, and an excellent model for developing countries.

The financial model

Grameen Shakti's financing solutions are designed to suit the purchasing power of the rural poor. It does not provide direct capital subsidy and supplies SHS mostly on a micro-credit basis. However, if the user can pay the full amount upfront, then they get a 4 per cent discount on the total price, the only time the price is marginally subsidised. Besides this initiative, their schemes are primarily based on micro-financing.

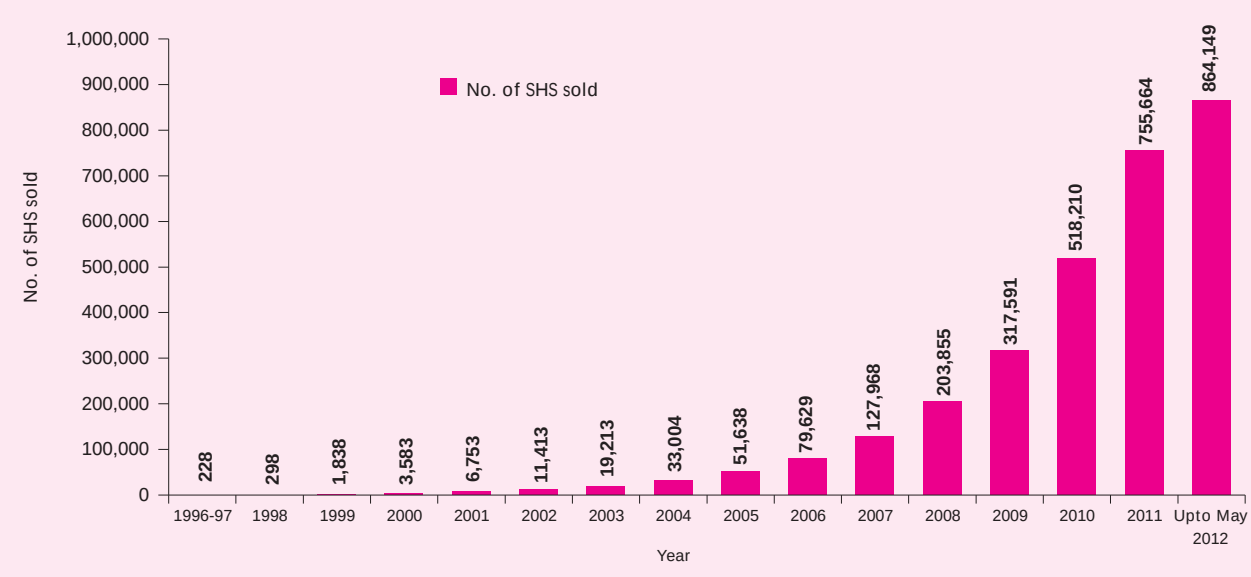
There are various micro-finance schemes for Grameen Shakti products. There are three schemes which are a combination of varying measures of down payment and payback periods. According to the financing abilities of the client, one can approach the company with a down payment of 15 per cent, 25 percent or 35 per cent. The payback periods would ease out according to the downpayment – 3 years, 2 years or a year respectively.

Another model, the 'micro-utility' scheme, encourages entrepreneurs to install SHS modules in their own premises and share the load with their neighbours. For example, entrepreneurs would buy a 50 Wp system which can support more CFLs bulbs than they themselves require. They would rent out the rest of the bulbs to neighbours on a daily basis. At least 50 per cent of the costs incurred can be covered through rent

ADITYA BATRA / CSE

To cut costs bamboo poles are sourced locally to place the panels

Graph 4.1: Grameen Shakti – SHS sales



Source: Md. Majbabul Huq 2012, 'Grameen Shakti – The largest renewable energy company in Bangladesh', presented at round-table conference, 'Off-grid SPV policy for India', organised by Centre for Science and Environment, N Delhi, June 29.

Table 4.2: Lighting options from Grameen Shakti

System capacity	Load used	Price (BDT*)
20/21 Watt peak (Wp)	5 Watt (W) CFL 2 pieces or 5 Watt CFL and tube light	13,100
40/42 Wp	7 W tube light 3 pieces and 14" B/W TV	23,600
50 Wp	7 W tube light 4 pieces and 17" B/W TV	29,500
63/65 Wp	7 W tube light 5 pieces and 17" B/W TV	36,000
80/83 Wp	7 W tube light 7 pieces and 17" B/W TV	44,500
85 Wp	7 W tube light 8 pieces and 17" B/W TV	44,800
120 Wp	7 W tube light 10 pieces and 17-20" B/W TV	69,200
130 Wp	7 W tube light 11 pieces and 17-20" B/W TV	72,000

Note: *1 Bangladesh Taka (BDT) is around Rs 0.65.
Source: Md. Majbabul Huq 2012, 'Grameen Shakti – The largest renewable energy company in Bangladesh', presented at round-table conference, 'Off-grid SPV policy for India', organised by Centre for Science and Environment, N Delhi, June 29.

alone, thereby benefitting the neighbours. This scheme allows small shop keepers and vegetable vendors to purchase a 50 Wp system with just a 10 per cent down payment. There is no interest on the loan for which the payback period is spread over 48 months. At least 10,000 systems had been sold through this scheme alone, as on November 2010. As of May 2012, 864,000 systems have been sold by Grameen Shakti through all their schemes (see Graph 4.1: *Grameen Shakti–SHS sales*).[18]

Technical modifications

To reduce the high upfront costs Grameen Shakti gives out a 10 Wp system which can power two LED lights and one 5 W CFL bulb. This requires a 15 per cent down payment. The rest is collected through an equated monthly installment of Tk 220 spread over a 36-month period. There are other technical models too. The users have the convenience to choose between a range of products to suit their purchasing power and household structure (see Table 4.2: *Lighting options from Grameen Shakti*).

Maintenance

The sustainability of Grameen Shakti's operations can be attributed to their dedicated maintenance network. Several technicians have been trained to operate on the field. Around 5 per cent of their Tk 1,000 crore annual turnover focuses on travel allowances for maintenance because of the large number of households they cater to. This is a significant component for the consistency of the model.

Within the warranty period, it is the responsibility of Grammen Shakti for any maintenance or repair works, which is free of charge. A sum of Tk 300 can be paid annually to avail annual maintenance contract facility post-warranty. The annual maintenance service after the warranty period comes at a service charge of 8, 6 and 5 per cent, depending on the financing options chosen by the user.

To meet the annual demand for SHS modules, Grameen Shakti has set up Grameen Technology Centres (GTCs) to train women technicians (see Box: *Grameen technology centres*). They assemble components which brings down the costs of equipment. They are paid per piece of equipment assembled. The company offers different warranty periods for different components (see Table 4.3: *Warranty of components*).

GRAMEEN TECHNOLOGY CENTRES

Grameen Technology Centres (GTC), a division of Grameen Shakti (Grameen Shakti) organisation, provides training for local technicians, Grameen Shakti staff and consumers. The GTCs help in various activities that complement the ultimate objective of the Grameen Shakti solar programme. GTCs train solar technicians and end users on the maintenance of the technology. It employs women to help in assembling the components of the product. Entrepreneurship development is also part of their curriculum. There are 46 GTCs that are operated by 150 female engineers. The model has readily generated employment for women. More than 3,000 women have been trained to take care of the operations and maintenance of the installed SHS.[1]

ADITYA BATRA / CSE

Trained women technicians of Grameen Shakti's service network

Table 4.3: Warranty of components

Component	Warranty period
Photo-voltaic solar panel	20 years
Deep cycle solar battery	5 years
Charge controllers	3 years
CFL bulbs	1 year
LED bulbs	5 years

Source: Md. Majbabul Huq 2012, 'Grameen Shakti – The largest renewable energy company in Bangladesh', presented at round-table conference, 'Off-grid SPV policy for India', organised by Centre for Science and Environment, N Delhi, June 29.

Growth of Grameen Shakti

Grameen Shakti's ability to sustain operations, expand their client base and thereby upscale their operations is reflected in their sales activity over their years of operation. Part of Grameen Shakti's growth in sales can be attributed to Infrastructure Development Company Limited (IDCOL), one of their key financial partners. This is a government owned non-banking financial institution that funds infrastructure projects. Investments of about 40 per cent of their accounts focus on renewable energy technologies. IDCOL selects partners to help them implement their programme and Grameen Shakti is one such partner.[19]

The role of IDCOL is simple. It helps in channeling grants and soft loans to the partner organisations like Grameen Shakti. Soft loans are provided at 8 per cent so that the partner organisations are able to cover their costs while providing services. Grants are usually channeled to manufacturers who use them to reduce the final cost of the products. The government helps by waiving taxes and duties for imports of certain components. IDCOL, besides providing financial support, keenly monitors the activities of their partner organisations on the ground. They also set up technical specifications for the manufacturers and system integrators who are supposed to adhere to the guidelines.

What has worked in social businesses

CSE has looked into four business models extensively and undertaken field visits to understand the perception of the user. None of these models utilise capital subsidies as their primary financing method. Although some models exhibit a few weaknesses, the strengths can be gathered and included in government policy to help in better structuring of policy, allocation of financial resources and skillful implementation in a sustainable manner.

SURYA SEN / CSE

Social businesses complement the government's goal to provide solar lighting to the rural power

Financing

In all the business models that we have looked at, the user pays on a monthly basis. As long as the systems are working, the users are definitely willing to pay except in few cases where the households could not afford the marginal amount. Social businesses look at heavy capital subsidies as a dangerous instrument. The loan mechanism has worked in Bangladesh too, and in a very large scale manner. From the case studies presented, it is clear that credit facilities can be a much greater alternative to the capital subsidy mechanism.

However, the government programmes are heavily dependent on capital subsidies. This has

led to undermining the value of the systems by the beneficiaries. The technology providers on the other hand, move on after installing the system. They do not provide technical assistance and servicing as and when required as the technical providers have received their payments upfront. The service oriented approach is lacking in government programmes.

Technology

In order to cut down on costs, most businesses have worked out various product specifications thereby offering a wide range of products at varying price levels. The social businesses have worked out low-cost models by reducing the panel size and switching to LED bulbs. The power consumed by LEDs compared to the CFLs is far lesser when the luminosity of both are the same. By accomodating LED bulbs in a CFL based home lighting system, the utility is increased for that particular system. By replacing the CFLs with LED bulbs one can reduce panel size to great extent and therefore provide the product at a much cheaper rate. Flexibility in the end-use of systems allows households to enjoy the benefits of solar lighting better.

This flexibility in providing customised products to the end user is currently not possible under the government programmes. The guidelines of the government programmes, therefore, discourages innovation by the technology providers. This is a serious setback that needs urgent attention by the government.

Maintenance

Social businesses have been taking service issues seriously. They are either keen on training villagers to enable them to repair systems and maintain them in sustainable or use their own technicians to perform this task. After-sales servicing has been considered vital by them to sustain the perception of the people that solar is a technically feasible option to satisfy electricity needs. However, in the government programmes, although they are supposed to set up service centres, there have been few instances of such an initiative on the ground.

The way ahead

Social businesses should be encouraged to exhibit their potential in this field. They clearly complement the government's intention to provide lighting to the rural poor. For social businesses to thrive and participate in these programmes, they require a revamp in the processes that have been mentioned above.

CHAPTER 5

The way ahead

Reform and reinvent the revolution for clean energy for all

The challenge is clear: large numbers of unconnected villages and homes, poor because of lack of energy and in need of this enabling tool and opportunity. That energy poverty is disabling is known and accepted. It needs to be removed. Access to energy is the driver for change in vast parts of the world. But there also lies an opportunity here: those who are currently unconnected to the polluting fossil fuel grid, can be leapfrogged to a clean and futuristic energy source. It could be the way the world solves its twin problems of energy poverty and climate change, in one stroke.

It is also clear that reaching the grid to the unconnected has not happened till date and will take much more time. It is precisely for this reason that the 'mobile phone solution' seems so appealing. Much like mobile phone technology that cuts through the expensive and difficult-to-reach landline connections across the poor and remote areas of the world, here is an option. The world can cut through the rigmarole of the transmission grid and go straight to where darkness exists.

That much is known and accepted. But what is still not clear is how this path will be paved in the future. As yet, all experiments to provide clean energy to the energy-deprived through a non-grid based model remain exactly that: largely experimental. The model to up-scale these efforts is not available. Where the state has stepped in to upscale the reach, it cannot emulate the way of civil society groups who excel because they can carefully deliberate and individually craft their services to the poor. Even the best designed programmes fall apart through apathy and lack of a well established and working delivery systems.

The issue is made more difficult as energy is still expensive and people who need it still poor. Therefore, the models demand some form of credit – loans or subsidies. All this works when an operation is relatively smaller and can be managed. It does not work through large-scale governmental delivery systems.

There is another problem: currently, even the successful 'experiments' are built on limited opportunity models – such as the lantern or the solar panel with a few light-bulbs, which works when people are poor. It does not suffice needs or aspirations as people become richer or have energy needs. In this way, existing solar energy systems have been

designed only for the very poor and only when they are very poor. This will not work. The most debilitating but telling statement comes from the interview of a local government functionary, who says that people should not demand energy for their television. The solar panels supplied are only for meeting basic needs – light, fan and may be for mobile recharge. Nothing more. Thus, solar energy becomes only the transitory system, till the fossil fuel grid reaches. But more importantly, it becomes blacklisted and condemned in people's views as the system that is appropriate only when they are poor. They will then aspire to move ahead – not to a clean future but to a dirty one.

This is the opportunity and the dilemma. How does the world 'upscale the current distributed energy systems' to make them the real option in the real world?

In the course of our research we have come across many examples of what is working and what is not. We present here two options for reform – one, introduce changes in existing government programmes to make them more effective and two, completely rethink the programmes so that new opportunities can arise.

Recommendation 1: Rework the remote village electrification programme

Create opportunity for technical partners: Small-scale system integrators and manufacturers of off-grid solar components should flourish on a region-wise basis. This will enable them to provide good quality after-sales service. For the final point of distribution, small-scale system integrators, social entrepreneurs, NGOs and self-help groups seem to better understand the needs of the end user. They are capable of assembling components for the rural areas in line with their purchasing power and the actual lighting needs based on the structure of the beneficiary's household. They can be the technical partners for the execution of the projects. Large-scale companies can also compete in the process, provided that they are based close to the project location.

State nodal agencies should supervise and not execute: The state nodal agencies need not execute projects for the sake of achieving targets at the pan-India level. They have an instrumental role to oversee the operations of the channel partners involved in the process. They need to ensure that targets are being met at the district/regional level. They need to verify that the system integrators and entrepreneurs in the field are complying with the maintenance contracts. Overall, they need to keep a tab on the sustainability of the technologies involved in the programme.

More financing from subsidy to micro-finance: The capital subsidies provided by the government have been working against the fulfillment of the desired objectives of the programme. Under the RVEP, people have been receiving solar systems at a heavily subsidised price. Since it comes by easily, they lack a sense of ownership. Rather, micro-financing instruments, such as soft loans have brought about better results, since the beneficiary has to make a monthly payment and thus has a greater stake. In fact, they would not pay the installment if the service was bad.

Banking institutions also become an integral part of the implementation process when soft loan instruments are to be delivered. The subsidies should be delivered directly to the banking institutions for channeling it to the beneficiary. The technical partner should have a tie-up with the local banking institution.

There could be two options by which the installments of the loans can be collected. The monthly payment can be collected by the banking institution directly, or the technical partner can collect it from the consumer and deposit with the bank. The process should be flexible and allow the technical partners to identify clients in their area of operation. The process should also be simple and flexible enough for a consumer (from an un-electrified household) to seek a loan directly from the bank.

Rework rigid technical guidelines: The RVEP

allows only two models of home lighting systems to be given out under subsidy. Under such circumstances, the technical partners are restricted from innovating. They cannot design technology that actually suits the individual needs of the poor under the programme. However, the case studies by CSE show that the private sector is capable of customising products to meet the purchasing capability of the poor. There is an urgent need to let individual households identify their requirements according to the size of their houses and their purchasing capabilities. A soft loan, unlike a capital subsidy (which mandates a particular type of system), gives the beneficiary the financial independence to customise the solution. This way, the technical partners also have greater flexibility to design the system according to the identified requirements.

Concentrate on ensuring maintenance contracts work: The ministry should clearly detail out the maintenance operations to be performed by companies. They need to mandate and specify the frequency of visits to be made by suppliers and the response period in case of repairs. It should be made mandatory for companies to set up service centres for clusters of villages and train a person from every village energy committee. A mere mention of a five-year maintenance contract has allowed companies to lose focus on their service responsibilities.

Ensure village energy committees are created and integrated into panchayati raj systems: The village energy committees are to be formed not just in paper. They need to be proactive and should be in direct contact with the suppliers. They must also assist and encourage in pooling corpus funds for battery replacement from individual households. The corpus funds should be deposited in the bank through which the beneficiaries have received their loans. Awareness programmes need to be conducted by the state nodal agency and technical partners in order to educate the beneficiaries about basic maintenance.

Strengthen monitoring and evaluation: The state nodal agency should monitor the after sales services of the suppliers. They should penalise the suppliers in case they do not comply with the terms of the maintenance contract or any such obligations. Third party reports on the overall process of execution of projects should be analysed and responded to in a timely manner and whenever changes in policy are necessary.

Transparency is critical: The ministry must be transparent in the entire process of implementation. All third party reports must be readily available to the public. The ministry also needs update the villages being covered under the programme at least on a half-yearly basis. The state nodal agencies should complement this objective of the ministry.

Recommendation 2: Rework off-grid solar photovoltaic applications under JNNSM

Provide clear policy direction on the kind of projects to be supported: There needs to be a clear direction as to the kind of projects that the mission should take up. The mission should focus on rural areas only where power cuts are severe, at least for the first two phases of the Jawaharlal Nehru National Solar Mission (JNNSM). There is an immediate need to target the rural areas that have had dwindling and poor quality power for a long period of time. The mission should respond to the needs of the rural poor first.

Remove benchmarking of costs: Current benchmarked costs do not match up to actual price of the household solar system. System integrators and technical partners should be able to sell at the market prices. The low purchasing power of the rural population will ensure that the system integrators set reasonable prices.

Revamp the system of accreditation of companies: The accreditation processes under JNNSM needs to be revamped to accommodate small-scale enterprises. The current processes require a large fee for accreditation. Only large-scale companies can take financial risks. This has led to large-scale companies being rated higher than social entrepreneurs, who are more capable of reaching out to the needs of the rural poor. The current rating agencies do not understand the operational and technical requirements of a company whose client base is the rural poor. There needs to be a separate committee appointed by the government which will accredit these companies. The committee should consist of reputed experts, professionals, representatives of

civil societies and government officials who have substantial experience in the off-grid electrification sector.

Change the financing model from capital subsidy to micro-finance: The current system of capital subsidisation is not necessary. It has only delayed processes and channeled projects for large-scale uses. Soft loans have benefited both the rural population and the technical supplier. Complete removal of the capital subsidy and inclusion of subsidies, purely based on the loan interests, suffice. This would remove several complications in documentation for application of funds from the National Bank for Agriculture and Rural Development (NABARD).

Evolve an effective financing mechanism: Banking institutions are crucial in channeling the finances for the beneficiary. They should tie up with accredited technical partners in order to release the funds to the end consumer. The process should be flexible enough to allow the beneficiary to come to the bank directly or through identification by the technical partner in order to avail the loan amount.

Make technical specifications more flexible: The off-grid SPV technology currently available is developed enough to run televisions sets, DVD players, mobile phone chargers, LED and CFL light bulbs and many such appliances. The ministry, by providing technical specifications, is only limiting the innovative capabilities of the technical partners. For the technology to reach the poor, it must be appealing and actually serve their increasing needs, rather than lighting alone. Even if it is purely to light their households, the ministry should not specify any one particular type of light. The households and the technical partner can decide the technical requirements of the systems as per their requirements.

Recommendation 3: Think big and reinvent the programme

There is also the opportunity to reinvent the programme so that it is designed to be big and bigger. This is where the decades of experience and a number of studies on technological feasibility and scaling up can be useful for a new programme design. The 'learning' would enable growth of solar energy, not so that it remains the domain of the rich already connected to the grid super highway or the very poor, who use solar household devices as a transition solution to get the first taste of lights. But so that it can be the energy option for all and the future.

One case study included in the research studied mini-grids as a solution for remote village electrification in Chhattisgarh. This programme has been rated as one of the most successful projects in this area by third party audits. Therefore, the economics of a decentralised distributed generation model with a solar power plant needs to be accommodated into the policy framework. Such mini-grid systems should be designed in a manner that they are grid-interactive and not just stand-alone.

They will solve several problems at one go. Firstly, the villages will have electricity – not just a light – which they can use for any purpose. Secondly, maintenance will be easier with one big system instead of hundreds of small ones. Thirdly, even if the grid reached the village, being grid interactive, the systems can both supply to the grid and borrow from the grid if required. These systems are also ideally suited for villages, which may be on the grid but have, at best, intermittent power supply.

It does not mean that stand-alone SHS are redundant. They will play an important role in lighting up thousands of villages where the grid cannot reach for a long time or mini-grids cannot be installed because of geographical and terrain constraints.

Reworking the draft guidelines on RVEP 2012

In mid-2012, the MNRE put out draft scheme on village lighting programme under the RVEP for public comments. Under the proposed scheme, village lighting will no longer be restricted to un-electrified remote Census villages where grid-connectivity is neither feasible nor cost-effective or those that are not covered under the RGGVY under the Union Ministry of Power (MoP). It will instead extend across the country. Most importantly, the guidelines, incentivize the setting up of mini-grids so that rural households can be supplied power to meet needs (See box: Elements of draft guidelines for off-grid solar programme)

The 2012 revised guidelines issued by the

ELEMENTS OF DRAFT GUIDELINES FOR OFF-GRID SOLAR PROGRAMME

- The programme would now pertain to villages that are electrified but receive less than six hours of electricity a day averaged over the year. A certificate from the power department of the states is required to prove this. This means that RGGVY villages would also be included.
- It would be mandatory to provide streetlights to the villages. For every 100 households seven streetlights will be allotted.
- Mini-grids between 10-250 kW would receive a 90 per cent subsidy on the capital costs from the central government. This subsidy will also be applicable to micro-grids up to 10 kW if the mini-grids are not feasible. If these power plants are not feasible, then SHS will be delivered for lighting. However, the village cannot be considered as electrified.
- The project developer would operate the mini/micro grids for five years. They shall build, operate, maintain and transfer (BOMT) it to the state government assigned agency.
- Central financial assistance (CFA) would be provided for up to 58 Watt (W) per household. Tariff will be fixed by the state nodal agency. Tariff will be sought through metering (pre-paid/net/flat rate).
- If grid power reaches the village with micro/mini grid, the project can be handed over to the distribution company. The power can be exported/imported to the main grid.
- SPV modules would have a warranty for 10 years.
- Project developers are required to open service centre for a cluster of villages or hamlets for operations and maintenance (O&M). Provision for the constitution of village energy committee, awareness campaign, provision for maintenance and independent evaluation have been included as part of the scheme.
- Pattern of funds release from the Centre (MNRE): The ministry needs to release the 30 per cent CFA and 100 per cent service charge to state nodal agencies. It would be conducted in three stages. With the initial sanction order, 30 per cent of the CFA and 50 per cent of the service charge is paid. After commissioning of project, another 30 per cent of the CFA and 50 per cent of the service charge is released. Then, between the second and fifth year, the remaining 40 per cent is released on receipt of yearly monitoring reports.
- Solar Household Systems (SHS) subsidy from the Centre would be reduced to 30 per cent of the cost (including AMC). At least half the balance needs to come from the state government funds.
- SPV suppliers should have valid test certificates from MNRE authorised centres.

Table 5.1: Intended CFA for the beneficiaries

Technology	CFA (Rs)
Solar photo-voltaic (SPV) home lighting systems Model-I with 18 W module, 1 light	1,458/-
SPV home lighting system Model-II with 37 W module, 2 lights	2,997/-
SPV street lighting system with 74 W module and 11 W CFL lamp	5,994/-
SPV power plant which includes modules, batteries, electronic systems, internal cabling, structures, all civil works, fencing, distribution lines, service connections, fittings and fixtures inside the houses, etc.	243/Wp

Source: Draft No.13/14/2011-12/RVE, Remote Village Electrification Programme, released by the MNRE, March 21, 2012

MNRE are a major departure from the way RVEP was conceptualised. In many ways, if this programme is re-conceptualised and implemented well, it will lead to a renewable energy revolution in the country. But for that to happen, the proposed scheme will have to be tweaked.

Let us look at the proposed scheme from the perspective of the unfinished rural electrification

agenda of the country. As per the 2011 Census, of the 167.8 million rural households:

- 44.2 per cent use sources other than electricity for lighting.
- 72.4 million households still use kerosene for lighting.
- 0.9 million households have no lighting.

As per MNRE data:

- Of the 18,000 remote villages identified for electrification under RVEP, about 8,000 have been covered under RVEP so far.

As per surveys done by various institutions, including CSE:

- Even when a village is declared electrified, it does not get more than a few hours of electricity supply. In fact it can be rightly assumed that a majority of villages in India don't get electricity for even six hours and most don't have streetlights either.

Considering the backlog of households to be electrified – villages to be provided streetlights and electrified households to be given at least six hours of electricity – if the proposed village lighting programme is to be applied universally, following numbers emerge (see box: Calculated assumptions):

CALCULATED ASSUMPTIONS

Calculating energy demand to light and power households:

1. Census 2011 data on lighting used for estimation.
2. Of the households that use electricity for lighting, 75 per cent get less than six hours of electricity supply.
3. Of the households that use electricity for lighting, 75 per cent don't have access to street lighting.
4. Each un-electrified household and households receiving less than six hours of electricity supply get 58 Wp entitlement under the programme.
5. Streetlights of 11 Wp is provided at the rate of seven per cent of un-electrified households and households that don't get six hours electricity supply.

- About 50.4 million units of electricity is required each day to fulfill the 58 W load requirement running 6 hours per day for each rural household that is not electrified or those that get less than six hours electricity supply from the grid.
- About 1.33 million units of electricity are required to provide street lighting to all villages without streetlights.
- Altogether, about 20,900 MW worth of solar PV capacity will provide basic lighting for six hours to all rural households (145 million rural households) and provide streetlights to all villages. This is almost equivalent to the target set under the Jawaharlal Nehru National Solar Mission (JNNSM) for solar energy in the country.
- At the rate specified in the proposed scheme (Rs. 243/Wp), it will cost about Rs. 5 lakh crore to achieve the above objective.

Revolutionising off-grid: A CSE proposal

The proposal is simple: government should greatly incentivize the mini/micro interactive grid, by creating conditions so that there is adequate feed-in tariff for scaling up and for markets to operate. The key advantage of mini/micro-grid is that it can be made grid-interactive as and when the grid reaches a village. It can export power to the grid as well as import from it for growing needs or deficits. In this way, rural India will take the lead in developing and operationalising the 'smart grid' concept.

Under the draft guidelines issued by MNRE, 90 per cent of the capital subsidy for the mini/micro-grid would be provided by the central government. The rest would come from the state government and project developers. State governments also have to guarantee replacement of batteries. The project developers can charge for supplying electricity to meet operations and maintenance (O&M) costs and profit.

In reality, therefore, the entire scheme remains subsidy-driven. This then remains its Achilles heel as governments will not be able to afford the money for scaling up – some Rs 5 lakh crore is needed as per our assessment to role out this programme. More importantly, we do not have capacity in state agencies to absorb this quantum of funding. The programme will remain crippled in size.

We need a new approach to break this size-

logjam. Currently we know that large industries have invested in grid-connected solar because of assured feed-in tariff. Government has not given any capital subsidy. Through bundling of power and renewable purchase obligations (RPOs), the burden of high feed-in tariff has been shifted to the consumers.

The business model for grid-interactive mini/micro-grid has to be similar to that of grid-connected solar power. The difference is, instead of big businesses, we will be promoting small businesses and social entrepreneurs who will set up small power plants to serve the rural population.

The business model should be based on assured feed-in tariff for a certain period. The entrepreneur should organise the capital and technology and install the system. Interest rate subsidy can be offered after detailed examination.

The feed-in tariff should be divided into two parts; one paid by the consumers and another to be funded by some other mechanism – green cess on consumers (like Chhattisgarh and Gujarat) or from the National Clean Energy Fund or from an international funding mechanism.

If we consider Rs 15 per unit as feed-in tariff for supplying electricity for six hours for 9,000 MW systems, the annual feed-in tariff would amount to about Rs 3,000 crore.

If each beneficiary household (about 145 million households) is charged a flat rate of Rs 100 per month for a 58 Wp system and streetlights, the annual collection will be about Rs 17,000 crore.

The remaining Rs 13,000 crore can come by imposing a cess of 20 paise/kWh on all electricity consumed in the country. This money can also come from international funds such as the Green Fund under the United Nations Framework Convention on Climate Change.

If the above concept is operationalised, it will revolutionise the way power is produced and consumed in India. Instead of few big power producers, thousands of smaller producers can feed the grid using renewable energy sources. They will create local jobs and help build the local economy. This model can also be used in urban areas for rooftop power producers. This will be the beginning of a true renewable energy revolution in the country.

This we believe is the way ahead. All this, then can be combined effectively, with markets for efficient appliances, including individual solar systems. The market will grow as access to energy grows. The use of energy will lead to economic opportunity, which in turn, will lead to a more sustainable energy market.

The key is to make mini/micro grids sustainable – affordable to the very poor but yet profitable for industry to scale up. This is the opportunity of the future.

ANNEXURES

ANNEXURE 1: Details of Projects sanctioned during 2010-11 under off-grid applications of JNNSM

Sl. No.	State	Sanctioned systems	Location	Date of sanction	Date of completion	Released CFA (Rs in Lakhs)	Capacity in kWp
1	Andhra Pradesh	Power Plants	Educational Institutions	16.07.2010	16.03.2011	161.00	404
2		Power Plants	Govt. offices/Industry	13.08.2010	13.02.2011	12.50	36
3		Power Plants	Telecom Towers	24.09.2010	30.09.2011	225.00	1012
4		Power Plants	Theatre NGO Home Art Gallery	04.10.2010	30.03.2011	40.00	119
5		Power Plants/ Street Lights	Colleges/ Tribal Village	30.11.2010	31.03.2011	–	110
6		Power Plants/ Street Lights	Temple/ Police/ Charitable institutions	23.02.2011	30.06.2011	–	122
7		Power Plants	Educational institutions/ Industry	30.03.2011	30.09.2011	–	129
8	Arunachal Pradesh	Power Plants	SSB/Battalions/Border outposts	19.08.2010	19.06.2011	216.00	320
9	Assam	Power Plants	University	20.09.2010	30.05.2011	200.00	150
10		Power Plants	SSB/Engineering college	15.11.2010	31.07.2011	450.00	350
11	Bihar	Power Plants	Telecom Towers	17.09.2010	30.09.2011	225.00	1000
12		Power Plants	Branches of bank	15.11.2010	31.03.2011	–	22
13	Chhattisgarh	Power Plants	Bank branches/ hospitals/ temples/ Govt. Institutions	24.08.2010	24.09.2011	549.90	1222
14		Power Plants	Branches of State Bank of India	24.08.2010	24.08.2011	105.75	235
15		Power Plants	25 locations in the state	11.10.2010	31.10.2011	246.00	547
16		Power Plants	Industry/Charitable institutions	15.11.2010	30.06.2011	125.00	278
17		PV Pumps	Tribal farmers	31.03.2011	30.09.2011	17.00	54
18	Delhi	Power Plants	School	22.03.2011	31.05.2011	–	2
19	Gujarat	Power Plants	Saurashtra University	01.10.2010	31.03.2011	8.75	25
20		Power Plants	Bhavnagar/Baroda	28.02.2011	31.07.2011	5.00	28
21	Haryana	Street Lights	330 villages in Sirsa district	15.07.2010	15.04.2011	189.75	493
22		Power Plants	TERI Retreat, Gwal Pahari	15.07.2010	15.01.2011	22.00	50
23		Power Plants	BPDO offices in Sirsa district and hospital at Rewari	15.07.2010	19.03.2011	42.88	100
24		Power Plants	Branches of the bank	25.08.2010	31.03.2011	14.00	32
25		Street Lights	13 districts in the state	13.09.2010	13.05.2011	60.00	157
26		Home Lights	Four districts	19.01.2011	31.08.2011	30.45	264
27		Power Plants	Govt. Institutions/Industry	25.01.2011	31.07.2011	40.00	258
28		Power Plants	Industrial Units,Faridabad	17.08.2011	31.07.2011	8.00	21
29	Himachal Pradesh	Power Plants	SSB Training centers	13.08.2010	13.05.2011	270.00	400
30		Street Lights, Home Lights, Lanterns	34 selected villages in five districts	28.09.2010	30.06.2011	174.00	129

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Conti... ANNEXURE 1

Sl. No.	State	Sanctioned systems	Location	Date of sanction	Date of completion	Released CFA (Rs in Lakhs)	Capacity in kWp
31	Jammu & Kashmir	Lanterns	Leh district	17.08.2010	17.09.2010	19.60	74
32		Power Plants, Home Lights	Kargil district	28.09.2010	28.09.2013	1369.73	1625
33		Power Plants	69 Health centers	23.12.2010	31.12.2011	200.00	1090
34		Power Plants	Vaishno Devi Shrine	31.12.2010	31.07.2011	–	40
35		Power Plants	Leh district	23.02.2011	28.02.2013	400.00	2522
36		Home Lights	Twelve districts	28.02.2011	31.12.2011	100.00	740
37	Jharkhand	Power Plants	Temples in Deogarh	07.09.2010	07.04.2011	100.00	250
38		Power Plants	BIT Deogarh Palamu Tiger Project	29.09.2010	30.03.2011	26.60	66
39		Power Plants	Jari village	21.12.2010	30.06.2011	50.00	100
40	Karnataka	Power Plants	Bus stations	31.08.2010	31.03.2011	18.00	40
41		Power Plants	Kagnele/Haveri	27.09.2010	28.02.2011	–	16
42		Power Plants	Branches of Bank	06.10.2010	31.03.2011	24.00	90
43		Power Plants	Ten locations	28.12.2010	31.08.2011	–	49
44	Kerala	Power Plant	Balklava Sweets, Thodupuzha	21.12.2010	30.04.2011	4.5	10
45	Lakshadweep	Power Plant	Various islands	09.08.2010	09.02.2012	1387.00	1100
46	Madhya Pradesh	Power Plants	Tribal Hostels/Police stations	16.07.2010	16.03.2011	197.38	521
47		Power Plants/packs	Forest check posts	28.07.2010	28.03.2011	400.00	900
48		Power Plants	CHCs	06.08.2010	06.01.2011	100.00	280
49		Street Lights	438 villages in 23 districts	01.10.2010	30.09.2011	89.78	226
50		Power Plants	Various institutions	17.01.2011	30.06.2011	15.00	36
51		Street Lights	Villages in Singrauli district	17.03.2011	30.09.2011	10.00	38
52		Power Plants	Various districts	22.03.2011	30.11.2011	100.00	1008
53		Street Lights	152 villages in Jabalpur district	30.03.2011	30.11.2011	20.00	59
54	Maharashtra	Power Plant	Thane Municipal Corporation	15.07.2010	15.01.2011	20.00	100
55		Power Plants	SEEPZ SEZ	15.07.2010	16.01.2011	–	50
56		Power Plants	Hospitals, Jail and Training academy	19.08.2010	19.08.2011	135.00	100
57	Manipur	Power Plants	University	24.02.2011	31.08.2011	5.00	10
58		Street Lights	Manipur Rifles/ Indian Reserve Battalion	30.03.2011	30.09.2011	20.00	34
59	Meghalaya	Home Lights	Aganwadi centers in the state	09.09.2010	30.06.2011	174.00	129
60		Power Plants	Schools	29.12.2010	31.12.2011	100.00	510
61	Mizoram	Power Plants	Charitable Institutions, hospitals	26.08.2010	26.06.2011	163.00	121
62	Nagaland	Power Plants	Govt. Institutions	14.01.2011	31.12.2011	10.41	72
63	Orissa	Power Plants	Secretariat	30.12.2010	30.06.2011	–	50

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Sl. No.	State	Sanctioned systems	Location	Date of sanction	Date of completion	Released CFA (Rs in Lakhs)	Capacity in kWp
64	Punjab	Power Plants	Educational Institutions	16.07.2010	16.01.2011	39.75	105
65		Power Plants	Educational Institutions	07.09.2010	07.05.2011	71.00	220
66		Power Plants	Villages in Gurudaspur	12.10.2010	30.06.2011	240.00	180
67		Power Plants	Villages in Tarntaran	31.01.2011	31.08.2011	40.00	60
68		Home Lights	Villages in four border districts	22.03.2011	30.11.2011	50.00	201
69	Rajasthan	Power Plants	Gram Panchayats in the state	04.06.2010	04.06.2012	2100.00	10268
70		Pumps	Horticulture Dept.	28.09.2010	30.06.2011	35.00	114
71		Home Lights	In identified villages in 20 districts	08.11.2010	31.05.2011	236.00	525
72	Sikkim	Power Plants	Border outposts of SSB	11.10.2010	30.06.2011	155.00	115
73		Street Lights Home Lights Lanterns	32 villages	31.03.2011	30.11.2011	31.18	33
74	Tamilnadu	Power Plants	Schools/Commercial originations	20.08.2010	20.04.2010	35.00	97
75		Power Plants	Vaishnavi College, Chennai	02.12.2010	31.03.2011	–	10
76	Tripura	Power Plants	Various Govt. Institutions	18.01.2011	31.08.2011	90.00	68
77	Uttarakhand	Street Lights	316 villages in eight districts	12.08.2010	12.05.2011	82.00	122
78		Power Plants	Battalion/border outposts of SSB	14.09.2010	30.06.2011	700.00	570
79		Lanterns	Nine international border blocks	06.10.2010	31.10.2011	535.00	794
80		Street Lights	381 villages in 7 districts	01.11.2010	31.10.2011	400.00	598
81		Power Plants	BEL Kotdwara	14.12.2010	31.03.2011	25.00	25
82		Street Lights	289 villages	24.01.2011	31.12.2011	50.00	363
83		Charging Stations	Khatima Block	10.03.2011	31.10.2011	16.00	60
84		Lanterns	Pokhari block Chamoli district	22.03.2011	30.09.2011	20.00	15
85	Uttar Pradesh	Street Lights	230 number of villages in nine districts	13.07.2010	13.03.2011	93.17	207
86		Power Plants Street Lights	57 number of ashram schools	15.07.2010	15.03.2011	134.50	299
87		Street Lights	2086 villages in 46 districts	28.07.2010	28.07.2011	200.00	772
88		Street Lights	648 villages in 37 districts	13.08.2010	13.08.2011	198.00	441
89		Power Plants	294 branches of the bank	30.08.2010	30.08.2011	269.00	599
90		Power Plants	70 branches of Baroda UP Gramin Bank	13.09.2010	13.09.2012	88.00	250
91		Power Plants	Telecom Towers 100 numbers	17.09.2010	30.09.2011	225.00	1000
92		Power Plants	Bank branches	03.01.2011	31.05.2011	20.00	98
93		Power Plants	Milk collection centers/Block offices/Electricity office buildings	11.01.2011	31.07.2011	35.00	159
94		Power Plants	IOCL petrol pump, Dariba Rae Barelly	24.02.2011	31.05.2011	–	9
95		Power Plants	RDSO, Lucknow	24.02.2011	31.08.2011	–	35

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Sl. No.	State	Sanctioned systems	Location	Date of sanction	Date of completion	Released CFA (Rs in Lakhs)	Capacity in kWp
96		Power Plants	School/Industry	09.03.2011	31.08.2011	10.00	140
97		Street Lights	Minority/SC/BC villages	17.03.2011	31.10.2011	25.00	115
98		Power Plants	CISF battalion, Ghaziabad	22.02.2011	30.09.2011	–	200
99		Power Plants	Institutions	31.03.2011	31.08.2011	6.41	13
100	West Bengal	Power Plant	Engineering college	12.01.2011	30.06.2011	25.00	100
101		Power Plants	Charitable institutions, Engineering college and IOCL R&D center	19.08.2010	19.03.2011	100.00	280
102		Power Plants	NIT, Agartala IIM Shillong	03.09.2010	03.06.2011	200.00	150
103		Power Plants	SEZ/Industry	08.09.2010	08.04.2011	55.00	130
104	Others	Home Lights	Selected villages in J&K, Bihar and Rajasthan	22.11.2010	30.11.2011	34.96	37
105		Power Plants	TIDC Agartala,31.12.2010 College of Home Science, Tura	31.07.2011	113.06	158	
106		Home Lights	Rajasthan, Bihar	12.01.2011	31.10.2011	–	37
107		Power Plants	Telecom Tower in eleven states	20.01.2011	31.12.2011	150.00	750
							40.647 MW

ANNEXURE 2 A

State Code	India/State/ Union Territory	Distribution of households by source of lighting (Absolute Numbers)						
		Total No. of Households (Excluding institutional households)	Electricity	Kerosene	Solar energy	Other oil	Any other	No lighting
1	2	3	4	5	6	7	8	9
01	Jammu & Kashmir	20,15,088	19,50,605.2	56,422.5	2,015.1	4,030.2	40,301.8	40,301.8
02	Himachal Pradesh	14,76,581	14,29,330.4	41,344.3	1,476.6	1,476.6	1,476.6	1,476.6
03	Punjab	54,09,699	52,25,769.2	1,19,013.4	5,409.7	10,819.4	16,229.1	37,867.9
04	Chandigarh #	2,35,061	2,31,300.0	2,820.7	235.1	235.1	235.1	470.1
05	Uttarakhand	19,97,068	17,37,449.2	2,21,674.5	23,964.8	3,994.1	3,994.1	5,991.2
06	Haryana	47,17,954	42,69,748.4	3,82,154.3	9,435.9	14,153.9	23,589.8	23,589.8
07	NCT of Delhi #	33,40,538	33,10,473.2	23,383.8	3,340.5	0.0	3,340.5	3,340.5
08	Rajasthan	1,25,81,303	84,29,473.0	38,87,622.6	75,487.8	37,743.9	37,743.9	1,00,650.4
09	Uttar Pradesh	3,29,24,266	1,21,16,129.9	2,03,80,120.7	1,64,621.3	98,772.8	98,772.8	65,848.5
10	Bihar	1,89,40,629	31,06,263.2	1,56,07,078.3	1,13,643.8	56,821.9	56,821.9	18,940.6
11	Sikkim	1,28,131	1,18,521.2	8,456.6	256.3	128.1	128.1	640.7

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Conti... ANNEXURE 2 A

State Code	India/State/ Union Territory	Distribution of households by source of lighting (Absolute Numbers)						
		Total No. of Households (Excluding institutional households)	Electricity	Kerosene	Solar energy	Other oil	Any other	No lighting
1	2	3	4	5	6	7	8	9
12	Arunachal Pradesh	2,61,614	1,71,880.4	48,398.6	7,586.8	784.8	5,493.9	27,469.5
13	Nagaland	3,99,965	3,26,371.4	62,394.5	1,199.9	799.9	4,399.6	4,399.6
14	Manipur	5,07,152	3,46,892.0	1,27,295.2	9,635.9	2,028.6	18,257.5	3,042.9
15	Mizoram	2,21,077	1,86,146.8	29,845.4	2,874.0	663.2	663.2	663.2
16	Tripura	8,42,781	5,76,462.2	2,45,249.3	16,012.8	1,685.6	0.0	2,528.3
17	Meghalaya	5,38,299	3,27,824.1	1,99,170.6	4,306.4	1,614.9	1,076.6	4,306.4
18	Assam	63,67,295	23,62,266.4	39,34,988.3	50,938.4	6,367.3	6,367.3	12,734.6
19	West Bengal	2,00,67,299	1,09,36,678.0	87,29,275.1	2,40,807.6	40,134.6	20,067.3	1,00,336.5
20	Jharkhand	61,81,607	28,31,176.0	32,82,433.3	43,271.2	12,363.2	6,181.6	6,181.6
21	Odisha	96,61,085	41,54,266.6	53,42,580.0	38,644.3	9,661.1	9,661.1	1,06,271.9
22	Chhattisgarh	56,22,850	42,34,006.1	13,04,501.2	50,605.7	11,245.7	5,622.9	16,868.6
23	Madhya Pradesh	1,49,67,597	1,00,43,257.6	48,04,598.6	44,902.8	29,935.2	14,967.6	29,935.2
24	Gujarat	1,21,81,718	1,10,12,273.1	9,86,719.2	12,181.7	24,363.4	24,363.4	1,21,817.2
25	Daman & Diu #	60,381	59,837.6	483.0	0.0	0.0	60.4	60.4
26	Dadra & Nagar Haveli #	73,063	69,556.0	3,214.8	0.0	0.0	0.0	219.2
27	Maharashtra	2,38,30,580	1,99,93,856.6	34,55,434.1	47,661.2	47,661.2	71,491.7	2,14,475.2
28	Andhra Pradesh	2,10,24,534	1,93,84,620.3	14,50,692.8	63,073.6	42,049.1	21,024.5	84,098.1
29	Karnataka	1,31,79,911	1,19,40,999.4	11,33,472.3	26,359.8	13,179.9	13,179.9	52,719.6
30	Goa	3,22,813	3,12,805.8	7,747.5	645.6	322.8	322.8	1,291.3
31	Lakshadweep #	10,703	10,670.9	21.4	0.0	0.0	10.7	0.0
32	Kerala	77,16,370	72,84,253.3	4,01,251.2	15,432.7	7,716.4	7,716.4	0.0
33	Tamil Nadu	1,84,93,003	1,72,72,464.8	10,91,087.2	18,493.0	36,986.0	18,493.0	73,972.0
34	Puducherry #	3,01,276	2,94,346.7	6,326.8	0.0	301.3	0.0	602.6
35	A & N Islands #	93,376	80,396.7	12,045.5	186.8	280.1	93.4	466.9

Source: *Census of India, 2011*
Note: *The Census of India released the state-wise data on housholds using different lighting in single decimal percentages. The above data was computed by CSE using the overall statewise number of households. Since the percentages were in single decimal point, the error margin was found to be anywhere between (+/-) 5 to 12 %. Therefore, when we add up the state-wise numbers, it might not match up to the pan-India numbers shown in the previous table.*

ANNEXURE 2B: Distribution of lighting in households across Indian states, 2001

Distribution of households by source of lighting (Absolute Numbers)							
State/Union Territory	**Households**	**Electricity**	**Kerosene**	**Solar energy**	**Other oil**	**Any other**	**No lighting**
Jammu & Kashmir	15,51,768	12,50,738	2,29,493	10,309	2,086	52,005	7,137
Himachal Pradesh	12,40,633	11,76,338	56,671	1,423	1,405	2,076	2,720
Punjab	42,65,156	39,20,301	2,87,174	5,643	4,667	9,410	37,961
Chandigarh	2,01,878	1,95,362	5,678	204	61	146	427
Uttaranchal	15,86,321	9,56,995	5,91,090	29,726	1,049	2,709	4,752
Haryana	35,29,642	29,26,038	5,71,700	6,874	5,921	5,618	13,491
Delhi 25,54,149	23,71,811	1,58,476	2,365	1,369	13,785	6,343	
Rajasthan	93,42,294	51,09,018	41,22,172	31,584	19,443	12,720	47,357
Uttar Pradesh	2,57,60,601	82,16,439	1,73,70,591	93,047	23,745	22,996	33,783
Bihar 1,39,82,590	14,33,477	1,24,88,085	40,700	7,648	6,973	5,707	
Sikkim	1,04,738	81,444	22,610	149	55	111	369
Arunachal Pradesh	2,12,615	1,16,275	66,779	481	1,582	9,853	17,645
Nagaland	3,32,050	2,11,194	1,05,066	648	511	5,485	9,146
Manipur	3,97,656	2,38,733	1,51,219	918	184	3,009	3,593
Mizoram	1,60,966	1,12,079	46,141	849	154	1,020	723
Tripura	6,62,023	2,77,015	3,80,747	1,268	248	1,366	1,379
Meghalaya	4,20,246	1,79,597	2,34,716	1,114	991	914	2,914
Assam49,35,358	12,29,126	36,85,787	10,082	2,104	3,461	4,798	
West Bengal	1,57,15,915	58,85,724	97,27,836	49,112	8,830	20,735	23,678
Jharkand	48,62,590	11,81,628	36,60,073	10,333	4,961	2,695	2,900
Orissa 78,70,127	21,18,195	56,74,090	27,208	4,680	9,976	35,978	
Chattisgarh	41,48,518	22,02,987	19,08,190	6,804	3,705	11,004	15,828
Madhya Pradesh	1,09,19,653	76,41,993	32,24,055	15,130	8,715	9,638	20,122
Gujarat	96,43,989	77,54,307	17,45,351	23,115	14,511	24,052	82,653
Daman & Diu	34,342	33,573	610	6	8	31	114
Dadra & Nagar	43,973	37,813	5,686	63	5	59	347
Maharastra	1,90,63,149	1,47,72,090	41,03,826	24,654	31,619	40,180	90,780
Andhra Pradesh	1,68,49,857	1,13,17,766	54,14,683	37,704	19,512	10,858	49,334
Karnataka	1,02,32,133	80,37,052	21,26,345	21,989	5,187	7,047	34,513
Goa 2,79,216	2,61,273	15,968	476	97	260	1,142	
Lakshadweep	9,240	9,213	18	2	0	6	1
Kerala	65,95,206	46,32,722	19,18,660	33,291	3,965	4,358	2,210
Tamil Nadu	1,41,73,626	1,10,81,424	29,87,630	34,614	5,161	10,523	54,274
Puducherry	2,08,655	1,83,217	24,663	338	44	99	294
A & N Islands	73,062	56,097	15,860	338	201	130	436

Source: *Census of India, 2001*

ANNEXURE 2 C: Absolute changes in the distribution of households using the following sources of light from 2001 to 2011

Sl.No.	State / UT	Electricity	Kerosene	Solar energy	Other oil	Any other	No lighting
1	**India**	**58,815,111**	**-5,666,242**	**464,210**	**308,961**	**188,077**	**618,614**
2	Jammu & Kashmir	699,867	-173,071	-8,294	1,944	-11,703	33,165
3	Himachal Pradesh	252,992	-15,327	54	72	-599	-1,243
4	Punjab	1,305,468	-168,161	-233	6,152	6,819	-93
5	Chandigarh	35,938	-2,857	31	174	89	43
6	Uttaranchal	780,454	-369,415	-5,761	2,945	1,285	1,239
7	Haryana	1,343,710	-189,546	2,562	8,233	17,972	10,099
8	Delhi	938,662	-135,092	976	-1,369	-10,444	-3,002
9	Rajasthan	3,320,455	-234,549	43,904	18,301	25,024	53,293
10	Uttar Pradesh	3,899,691	3,009,530	71,574	75,028	75,777	32,066
11	Bihar	1,672,786	3,118,993	72,944	49,174	49,849	13,234
12	Sikkim	37,077	-14,153	107	73	17	272
13	Arunachal Pradesh	55,605	-18,380	7,106	-797	-4,359	9,824
14	Nagaland	115,177	-42,671	552	289	-1,085	-4,746
15	Manipur	108,159	-23,924	8,718	1,845	15,248	-550
16	Mizoram	74,068	-16,296	2,025	509	-357	-60
17	Tripura	299,447	-135,498	14,745	1,438	-1,366	1,149
18	Meghalaya	148,227	-35,545	3,192	624	163	1,392
19	Assam	1,133,140	249,201	40,856	4,263	2,906	7,937
20	West Bengal	5,050,954	-998,561	191,696	31,305	-668	76,658
21	Jharkand	1,649,548	-377,640	32,938	7,402	3,487	3,282
22	Orissa	2,036,072	-331,510	11,436	4,981	-315	70,294
23	Chattisgarh	2,031,019	-603,689	43,802	7,541	-5,381	1,041
24	Madhya Pradesh	2,401,265	1,580,544	29,773	21,220	5,330	9,813
25	Gujarat	3,257,966	-758,632	-10,933	9,852	311	39,164
26	Daman & Diu	26,265	-127	-6	-8	29	-54
27	Dadra & Nagar	31,743	-2,471	-63	-5	-59	-128
28	Maharastra	5,221,767	-648,392	23,007	16,042	31,312	123,695
29	Andhra Pradesh	8,066,854	-3,963,990	25,370	22,537	10,167	34,764
30	Karnataka	3,903,947	-992,873	4,371	7,993	6,133	18,207
31	Goa	51,533	-8,220	170	226	63	149
32	Lakshadweep	1,458	3	-2	0	5	-1
33	Kerala	2,651,531	-1,517,409	-17,858	3,751	3,358	-2,210
34	Tamil Nadu	6,191,041	-1,896,543	-16,121	31,825	7,970	19,698
35	Puducherry	111,130	-18,336	-338	257	-99	309
36	A & N Islands	24,300	-3,814	-151	79	-37	31

Source: *Census of India statistics from 2001 & 2011*

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