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Energy-microfinance intervention for below poverty line households in India

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ABSTRACT

More than 72% of India's population resides in rural India[1] and it also has a high concentration of people living under abject poverty. Of the total rural population 27.1–28.3% lives below the poverty line[2] (BPL). A lack of energy-finance options is hampering the "quality of life" of the BPL community. The members of this disadvantaged household which forms 27.1% and 23.6% of the India's rural and urban population[3] has no ready access to mainstream finance or know—how of sustainable energy products nor do they have access to energy service providing agency. This lack of energy-finance options has provided the marginalized population little means to break the conventional energy paradigm and the corresponding poverty cycle.

Considering the afore-mentioned problem we propose an energy-microfinance intervention or a model that encompasses two independent entities. One has an energy expertise and the other possesses finance management skills. Alternately, we also propose a special purpose entity that comprises of these two entities. This entity fosters different institutional, technical and financial engineering approaches to the provision of energy, finance and infrastructure services necessary for poverty alleviation.

1. Background

Energy and poverty have figured in several recent policy documents and statements made by agencies such as the World Bank, United Nations Development Program, World Energy Council and UK's Department for International Development. A number of these reports were prepared in the build up to the Johannesburg 2002 World Summit on Sustainable Development, and all of them affirm that energy must be made a crucial part of all development and poverty alleviation projects and programs (Pachauri and Spreng, 2004).

In modern times no country has managed to substantially reduce poverty without greatly increasing the use of energy or utilizing efficient form of energy and/or energy services. Without ensuring minimum access to energy services for a broad segment of the population, countries have not been able to move beyond a subsistence economy. But merely introducing cheap, easily available modern energy is not enough to ensure socioeconomic progress. Other factors are also crucial. Clearly energy for the sake of energy is not useful. Its utility lies in facilitating human development. The energy sector has strong links with poverty reduction through income, health, education, gender, and the environment (Saghir, 2005).

Within energy-poverty context it will be too naïve to ignore the role 'access to finance' can play in improving the lives/livelihood of the impoverished masses. Without an inkling of doubt, a lack of access to credit (for energy products) at rates/terms that meet the seasonal cash flows/expenditures of the marginalized population has been one of the primary reasons for a lack of 'mass-appeal' and acceptance of reliable and energy efficient products. That said the energy scenario(s) coupled with a finance intervention (viz. by a typical Microfinance Institution or Self-help Group forming committee—more on this has been

Abbreviations: AIDIS, All India Rural Credit Survey; BPL, below poverty line; CHP, combined heat and power; ESMAP, Energy Sector Management Assistance Program; ESCO, Energy Service Company; GAIL, (erstwhile) Gas Authority of India Limited; GHG, Green House Gas; GDP, Gross Domestic Product; GLP, gross loan portfolio; HH, household; ICS, improved cook stoves; IREDA, Indian Renewable Energy Development Agency Ltd; kWp, kilowatt peak; LPG, liquefied petroleum gas; MW, megawatt; MEU, microenterprise unit; MNRE, Ministry of New and Renewable Energy; MNES, Ministry of Non-Conventional Energy Sources; MPCE, monthly per capita expenditure; NABARD, National Bank for Agriculture and Rural Development; NPIC, National Program on Improved Chulhas (cook stoves); NSSO, National Sample Survey Organization; NGO, Non-Governmental Organization; ONGC, Oil and Natural Gas Corporation; RRB, Regional Rural Bank; REDCO, Renewable Energy Development Company; RET, renewable energy technology; SHG, Self-help Group; SIDBI, Small Industrial Development Bank of India; S^3IDF, Small-Scale Sustainable Integrated Development Fund; SELCO, Solar Electric Light Company; SPV, solar photovoltaic; Sq. m, square meter; WTP, willingness to pay.

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[1] Census of India: http://www.censusindia.gov.in/Census_Data_2001/India_at_glance/rural.aspx (Last accessed on: 01/01/2008).

[2] In 1992, the Ministry of Rural Development, Government of India, undertook the task of identifying below poverty line households in rural India through periodic (approximately five-yearly) village censuses (Jalan and Murgai, 2007).

[3] The poverty ratio is as of the year 1999–00 (*Source*: Ministry of Health & Family Welfare, Government of India, http://www.indiastat.com).

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explained in the Microfinance section) primarily targeted towards the below poverty level members could have a lasting impact on the marginalized population. Further, the energy-finance linkage would have to focus increasingly on working with other sectors (health, gender etc. as mentioned in the above paragraph) to ensure that the poor benefit as much as possible from greater access to energy supplies.

A lot of institutions/individuals have examined the importance of energy-poverty linkage but few have observed the role of finance (esp. microfinance) in improving energy access. This paper will primarily address that concern.

The paper is divided into four sections. The first section defines the concept of below poverty line households in India. The next section is on 'Energy' and examines energy use in rural/urban India, fuel sources used for cooking and lighting in rural/urban India, expenditure on energy in rural India and lastly discusses the role played by renewable energy in India. The third section on 'Microfinance' imparts information on access to finance in rural India, microfinance in rural India, different microfinance models employed in India and the outreach of microfinance in India. In the fourth and final section we propose energy-microfinance intervention that offers innovative energy solution viz. clean lighting and improved cook stove along with the provision of much needed finance that is catered towards the needs/requirements of the low-income household population. A case study highlighting the different features/entities of an energy-microfinance intervention serves as a suitable example to the reader.

2. Below poverty line population

Poverty in India remains predominately rural: three out of every four poor persons live in rural areas. Changes in urban and rural poverty followed a similar path over most of the last 25 years, with progress actually more rapid in rural India through the seventies and eighties. By 1990, urban and rural poverty rates had nearly converged; an unusual pattern compared to other South Asian countries. In the early 1990s, poverty rose faster in the rural than the urban areas, and then did not decline as rapidly (World Bank, 2000).

In 1992, the Ministry of Rural Development, Government of India, undertook the task of identifying "below poverty line" (BPL) households in rural India through periodic (approximately five-yearly) village censuses. The first such census used self-reported household incomes to identify BPL households. However, given the difficulties of measuring income, particularly when incomes come largely from self-employment in agriculture, the self-reported income approach was abandoned in the 1997 BPL census (Jalan and Murgai, 2007).

In the modified format, a set of five questions—(i) whether operated size of land was more than two hectares; (ii) whether owned a *pucca*[4] house as defined in the Population Census; (iii) whether annual income was more than Rs. 20,000 ($550); (iv) whether owned any of the following consumer durables: television, refrigerator, ceiling fan, motor cycle/scooter and three wheelers; and, (v) whether owned farm equipment such as tractor, power-tiller, or combined thresher/harvesters—were asked of each and every household in the village.

If households answered in the affirmative to any one of the five questions, they were declared to be visibly non-poor. This was done to differentiate the "visibly poor" from the "visibly non-poor" households in the village relatively quickly and in an inexpensive manner (Jalan and Murgai, 2007). Visibly non-poor households were excluded from the more extensive BPL survey.

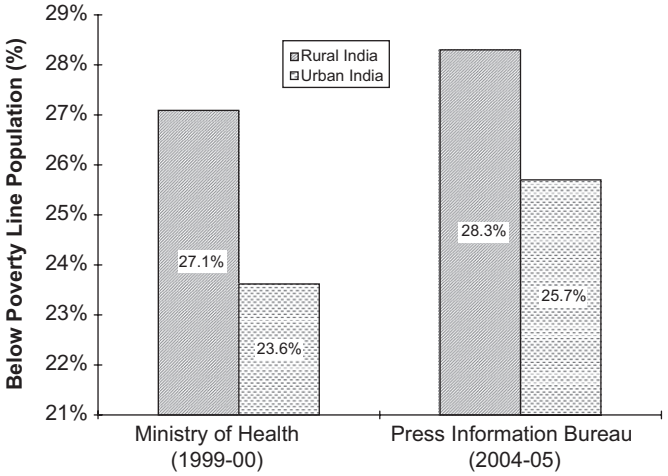

Fig. 1. Measure of poverty in rural and urban India (*Source*: http://www.indiastat.com).

The afore-mentioned methodology was also abandoned to adopt a more stringent approach in defining BPL household. In the last extensive state wide survey held in 2002 each household was given a score of one to four for each of 13 'score-able' indicators and the scores were summed to an aggregate index ranging between zero and 52. The 13 indicators included size of land holding, type of house, availability of clothing per person, food security, sanitation, possession of consumer durables, literacy, status of household in labor force, means of livelihood, status of children between 5–14 years, type of indebtedness, reasons for migration in case of a migrant household, and preference for assistance from among various government schemes. After tallying the points awarded to a household if a household's total score was found at or below 16 points it was categorized as BPL-1, a household scoring in the range 17–20 was labeled BPL-2 and any household scoring more than 20 points was treated as above poverty line.[5]

Of the total India's population[6] 27.1–28.3% and 23.6–25.7% of the rural and urban population has been designated as living below the poverty line. Fig. 1 depicts this trend. The authors believe that both the government agencies viz. Ministry of Health and Press Information Bureau adopted different census data to arrive at the respective figures. Therefore, we observe the discrepancy of data reported by the two different government agencies. The authors also suspect that there could be possible political motivation to increase the number of beneficiaries. In this paper all of the suggested interventions recommended by us are targeted towards BPL households.

3. Energy

As the primary motivation of this paper is to examine the energy-microfinance intervention for the BPL households we now

[4] Indian low cost housing terminology is always liberally sprinkled with two words *pucca* and *kutcha*. *Pucca* means "cooked" and refers to the use of fired materials for the walls, like bricks or blocks; it also assumes, more often than not, a concrete or firm tile roof and all the ancillary specifications such as good flooring, doors and windows. *Kutcha* conversely means "raw" and implies mud walls, a temporary roof of thatch or country tiles (Khosla, 1983).

[5] The authors are indebted to Mr. F. M. Saiyed and Mr. Rajni Bhai Patel, Extension officers (Gram Sewaks or Village Development Officers), Suvarna Gram Swarozgar Yojana (Golden Village Employment Scheme), Sinor Taluka Panchayath Office (Sub-Divisional Office), Vadodara, Gujarat who communicated and shared the necessary literature on the new BPL methodology.

[6] According to the 2001 Census of India the population stood at 1028.7 million. http://www.censusindia.gov.in/Census_Data_2001/National_Summary/National_Summary_DataPage.aspx (Last accessed on: 01/15/2008).

examine the energy sources and the corresponding expenditures incurred on them by the impoverished households. We begin our discussion by examining the fuel sources used for cooking and lighting in rural and urban India. Next, we explore the existing monthly energy expenditure incurred by the low-income clients on household cooking and lighting purposes. Later we share the experiences of two organizations in introducing new and innovative renewable energy technology interventions that are being employed by these households.

3.1. Fuel sources for cooking energy in rural India

Although the fuel sources used by households in rural India are changing, traditional fuels, such as fuel wood, crop residues, and dung are still the main sources of household cooking energy. Because cooking requires the largest amount of household energy, traditional fuels dominate the aggregate energy consumption for typical rural households. Fuel wood, kerosene, liquefied petroleum gas (LPG), biogas and biomass are the main energy sources employed for cooking (Pohekar et al., 2005). As indicated in Fig. 2, traditional fuels account for more than 90% of total energy use in rural India. Kerosene and electricity are reserved for such purposes as lighting, cooling, and other non-cooking uses. However, traditional fuels dominate overall share of rural energy use (World Bank, 2002).

The trend in rural energy is reiterated by the National Sample Survey Organization (NSSO). NSSO's 2007 survey found that despite the energy used by households in rural India was changing; traditional fuels such as firewood and chips, dung cake were the main sources of household cooking energy. The study found that firewood and chips, dung cake and liquefied petroleum gas dominate cooking fuels used in rural India (NSSO, 2007). As described in Fig. 3, firewood and chips were used by three-fourths of the rural households. However, there was a marginal decrease in the percentage of households using firewood and chips over the period 1999–2005—the percentage decreased by 50 basis points over 1999–2005 (as shown in Fig. 4). During the same time consumption of LPG increased by 3.2% because of its improved availability and convenience to use.

3.2. Fuel sources for cooking energy in urban India

In urban areas of the country, the primary fuel sources for cooking energy are LPG (57% of households), firewood and chips (22%), dung cake (10%) and coke and coal/charcoal (6%). Fig. 5 highlights the cooking energy distribution of households in urban India by source of fuel.

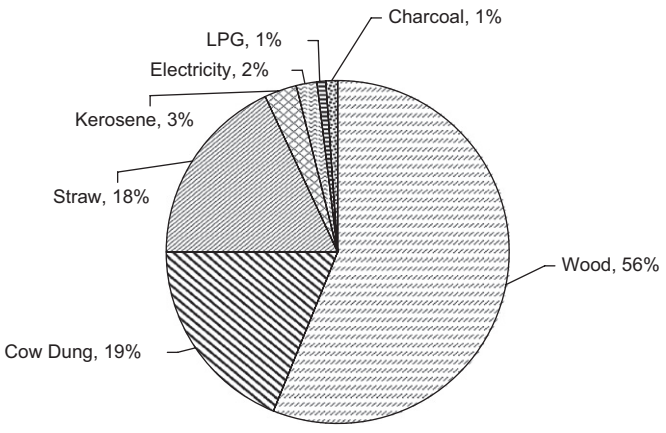

Fig. 2. Energy used by rural households in six states of India, 1996. (*Source*: World Bank, 2002).

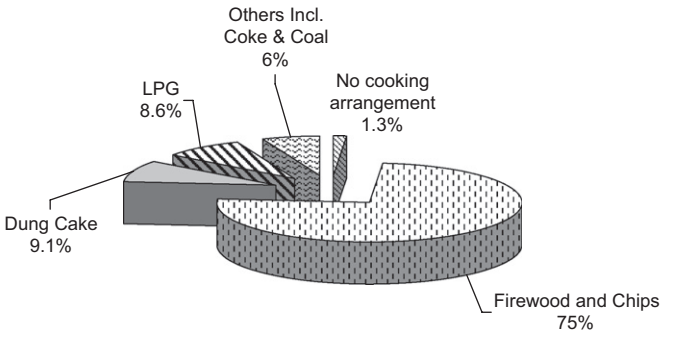

Fig. 3. Percentage distribution of households by primary source of energy used for cooking in rural India, 2004–05 (*Source*: NSSO, 2007).

When the results from the NSSO 61st round was compared with an earlier survey conducted by the same organization (55th round) we found that barring LPG and no cooking arrangement all other forms of cooking fuels had undergone a reduced consumption/preference. LPG and 'no cooking arrangement' increased by 29% and 600%, respectively. At the same time firewood and chips, dung cake and coke and coal preference decreased by 3%, 53% and 45%, respectively. Fig. 6 compares the two survey results. As stated earlier, only 44% households were using LPG as primary cooking fuel in 1999–2000 whereas this number rose to 57% in 2004–2005.

3.3. Energy for lighting in rural and urban India

When it comes to lighting, kerosene is the most important form of energy for rural households. In the absence of electricity, it provides lighting (even when electricity is available, it is often used as a backup during power failures), and, in small quantities, it is used as a fire lighter to aid in the combustion of wood and dung. Until recently, kerosene supplies were tightly regulated in India. They were strictly rationed at administered, subsidized prices through a public distribution system operated by the Ministry of Civil Supplies. Since the available supplies rarely met demand, black markets developed in which supplies were diverted to higher price markets. These unsatisfactory conditions stimulated the change in government policy toward liberalizing the kerosene market (World Bank, 2002).

According to 2001 Census of India, 56% of households in the rural areas of India depended on kerosene compared to the urban areas which had approximately 12% of its population depending on it. Fig. 7 depicts the kerosene consumption trend for lighting in the rural and urban regions of India.

Kerosene-based lighting devices used widely in rural areas include kerosene wick lamps, hurricane lanterns, kerosene petromax, and non-pressure mantle lamps. As no quality standards are maintained these devices have low luminous efficiency and high specific fuel consumption.[7]

Despite a large number of households consuming kerosene one of the interesting findings has been that the actual consumption of kerosene has been decreasing over the years. Fig. 8 describes the decreasing trend of kerosene consumption. The total sales of kerosene by both public sector units as well as private companies

[7] Specific fuel consumption is an engineering term that is used to describe the fuel efficiency of a device with respect to the mechanical output. In the case of the kerosene lamp the mechanical output will be the amount of luminous output emitted. http://www.britannica.com/eb/topic-558698/specific-fuel-consumption (Last accessed on: 01/15/2008).

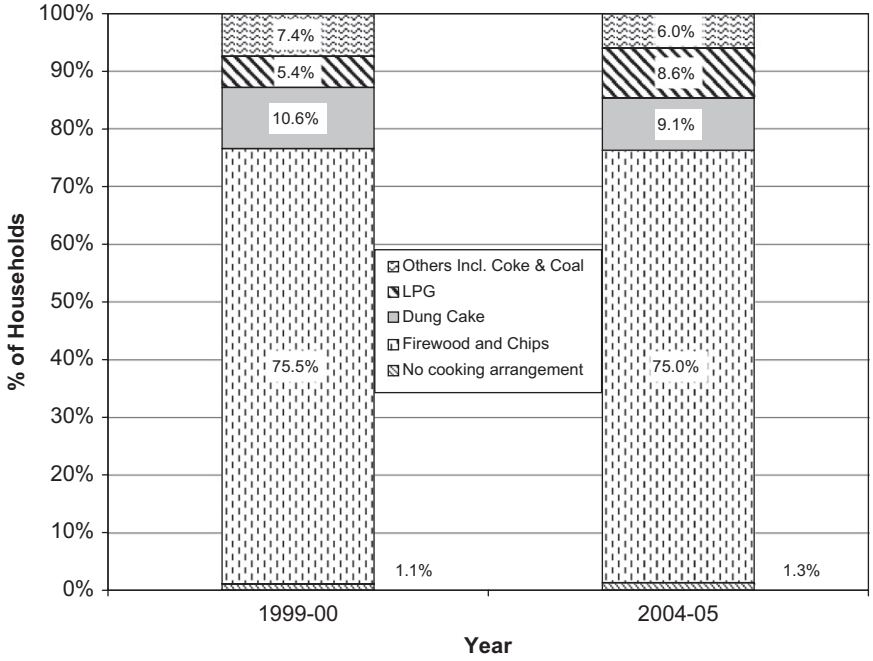

Fig. 4. Distribution of households by primary sources of energy used for cooking in rural India in two different years (*Source*: NSSO, 2007).

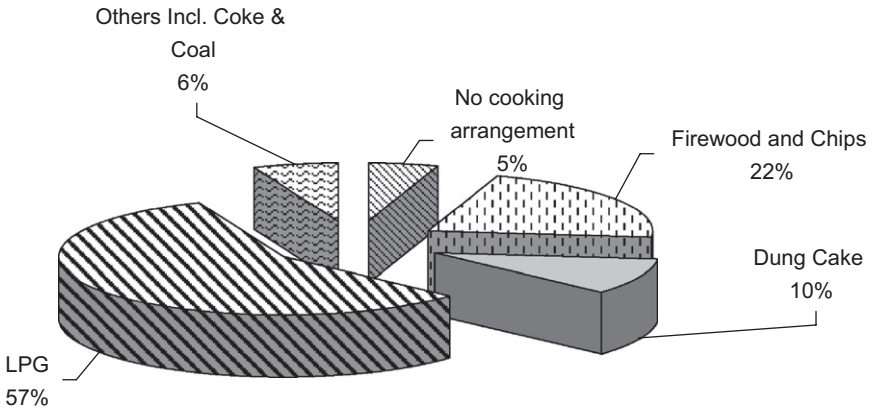

Fig. 5. Percentage distribution of households by primary source of **e**nergy used for cooking in urban India, 2004–05 (*Source*: NSSO, 2007).

decreased on an average by 1.1% every year from 2001–2004. The quantity of superior kerosene oil sold by public and private sectors stood at 10,431,000 and 10,207,000 metric tons for 2001–2002 and 2003–2004, respectively.

In 1978/79, 95% of the rural households in the country were using kerosene for lighting. In 1993/94, this reduced to 62%. The total kerosene consumption in India during 2000/01 was estimated at around 11.5 million tons out of which about 60% was for rural areas (Rehman et al., 2005). From Fig. 9 one can observe that the consumption of kerosene has been decreasing since 1998–1999. A 3.7% decrease (per year) in the rate of consumption has been observed from 1998–2006. Fig. 9 also captures the decreasing contribution of the central government towards kerosene subsidy which has decreased from a high of $1.1 billion to 221 million—an 80% decrease over the last five years. The decrease in the government contribution has been countered by an increase in the subsidy provided by the public sector oil and gas companies viz. Oil and Natural Gas Corporation Ltd. (ONGC), GAIL (India) Ltd. (GAIL), Bharat Petroleum Corporation Ltd. (BPCL), Indian Oil Corporation Ltd. (IOC) and Hindustan Petroleum Corporation Ltd (HPCL) whose combined effect has lead to an increase/growth in the total kerosene subsidy. ONGC is an oil producer, GAIL (erstwhile Gas Authority of India Limited) is gas transporter and the other three public sector utilities are fuel retailers.[8] As part of the reforms in the oil sector, since 2002–2003 the central government's contribution has decreased to 33% of the total kerosene subsidy whereas at the same time the public sector oil and gas units have borne the greater portion of the subsidies in the form of under recoveries (Gangopadhyay et al., 2004).

Over the years, a decline in the consumption of kerosene has been reported as against a corresponding increase in the rate of rural electrification. At the macrolevel, very little information is available on kerosene use in rural areas. Whatever information is available exists in the form of case studies, on the basis of which several projections have been made on kerosene use for lighting in rural areas. The 1994 occasional paper by office of the registrar general and census commissioner of India found that only 1.2% of rural households used kerosene for cooking highlighting that the

[8] *Source*: http://www.expressindia.com/news/fullstory.php?newsid=33977 (Last accessed on: 12/24/2008).

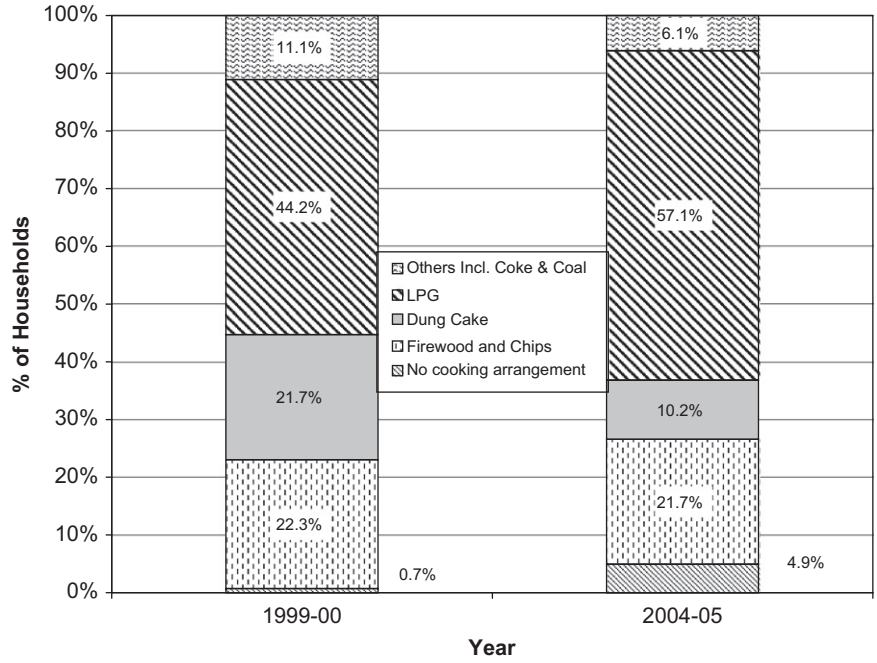

Fig. 6. Distribution of households by primary sources of energy used for cooking in urban India in two different years (*Source*: NSSO, 2007).

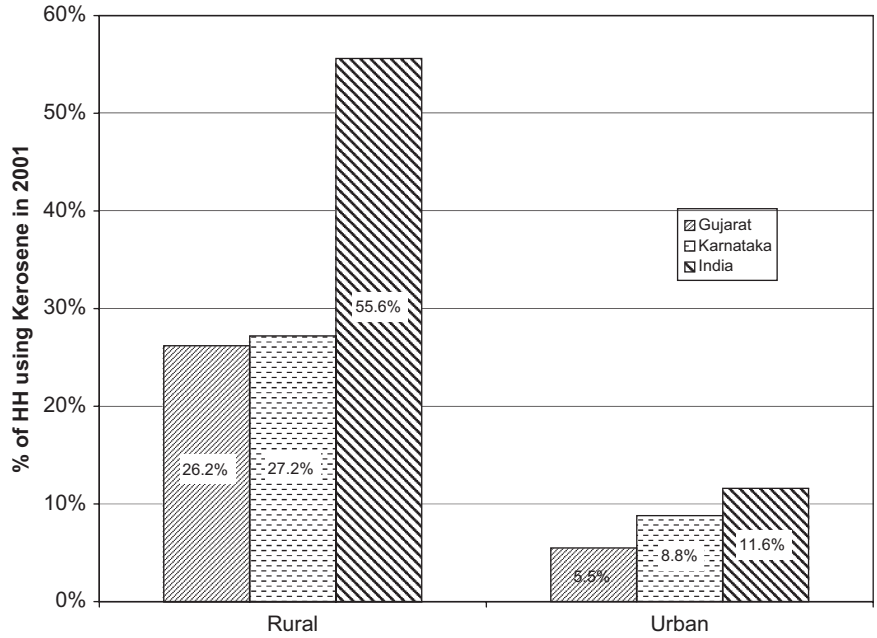

Fig. 7. Percentage of household using kerosene for lighting (*Source*: Census of India, 2001).

primary use of kerosene in rural areas is for lighting (Rehman et al., 2005).

Further, the NSSO's 61st round held between July 2004 to June 2005 found that access to electricity in the rural areas had gone up by 13% and the consumption of kerosene had gone down by 12.2% compared to the NSSO 55th round held between July 1999–June 2000 (NSSO, 2007). Fig. 10 captures this trend. This ascertains our finding that an overall decrease in rate of kerosene consumption can be attributed only to the increase in the rate of rural electrification.

4. Expenditure on energy in rural India

Likewise, because most households – rich and poor alike – take advantage of the kerosene subsidy for lighting, the percentage of income spent by poor households on lighting is about 4%, while wealthier households spend less than 0.5% (World Bank, 2002, p. 43).

In rural areas where wood is scarce, poor people may pay for fuel wood or shift to less efficient energy sources such as crop

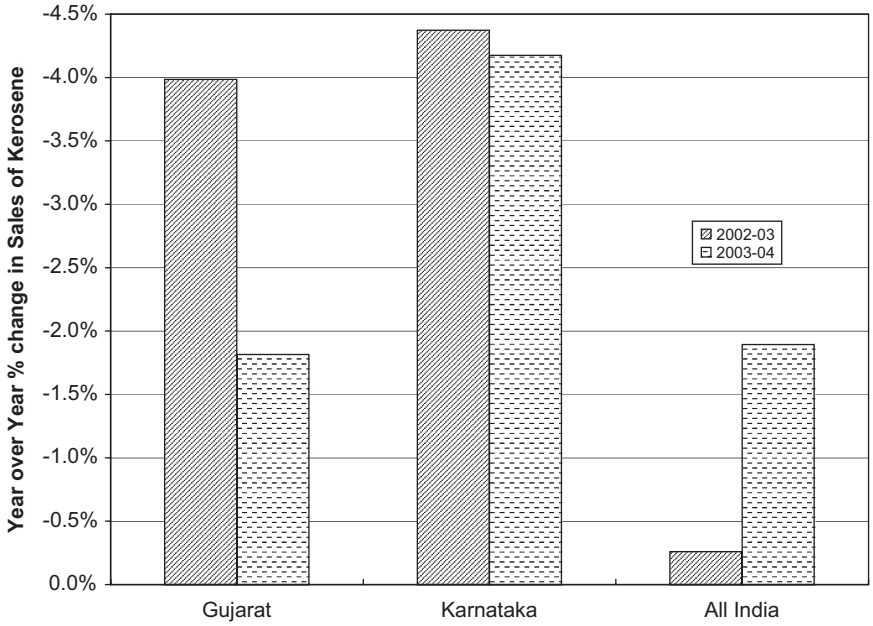

Fig. 8. Year over year percent change in state-wise sales of kerosene by public sector units as well as private agencies in India (*Source*: http://www.indiastat.com).

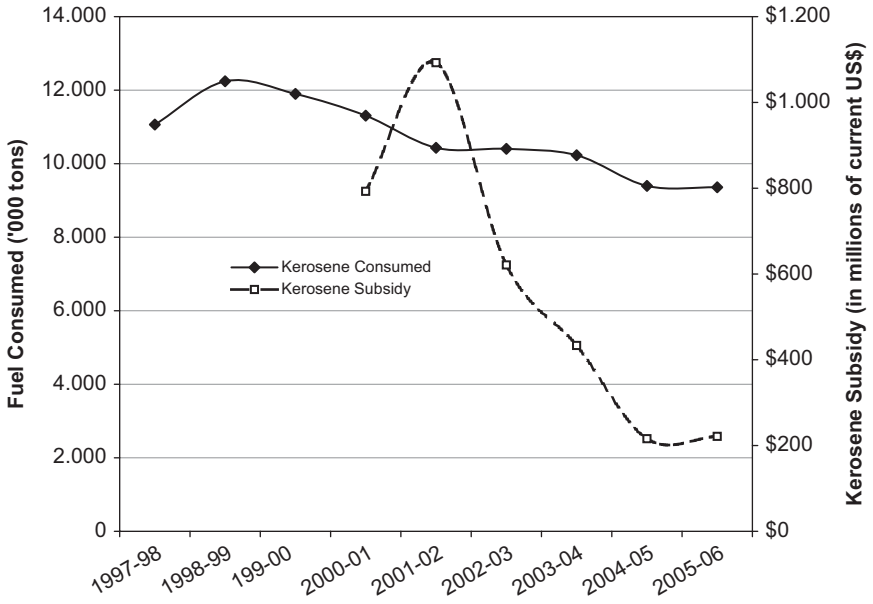

Fig. 9. Consumption of cooking and lighting energy fuels and the corresponding subsidies. *Source*: http://petroleum.nic.in/petstat.pdf (Last accessed on: 01/17/2008).

residues or dung. It is not unusual for a rural household in a developing country to spend an hour or more a day collecting wood or other fuels. That often means forgoing other productive activities. So the traditional fuels used by poor people are not free; to the contrary, they come at a high cost in cash or in labor. Moreover, poor households spend a much greater share of their income on energy than do wealthy households. The cash income of the poor is so small that the meager amounts of energy they use account for an important part of their cash expenditures (Saghir, 2005).

Rural people's cash incomes are still relatively low. An Energy Sector Management Assistance Program (ESMAP) study of the World Bank in 1996 found that the average monthly income for the sample containing 5000 household in the six states of India viz. Andhra Pradesh, Himachal Pradesh, Maharashtra, Punjab, Rajasthan and West Bengal was about Rs. 2300 (US$65) per family. Consequently, the study found that the people did not have much cash to spend on energy, and were content to use the fuels they collect, such as fuel wood, straw, and dung, to meet their cooking needs. However, for such uses as lighting and appliances, people were compelled to purchase some form of commercial energy, usually kerosene or electricity (World Bank, 2002).

The NSSO 61st round survey also examined the distribution of households by primary source of energy used for cooking and lighting for each monthly per capita expenditure (MPCE) class at all-India level. The MPCE classes correspond broadly to 5%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 95% and 100% of the population. Fig. 11 presents the distribution of rural households for each MPCE class. It brings out the fact that rural households belonging to lower MPCE classes use more firewood and chips as

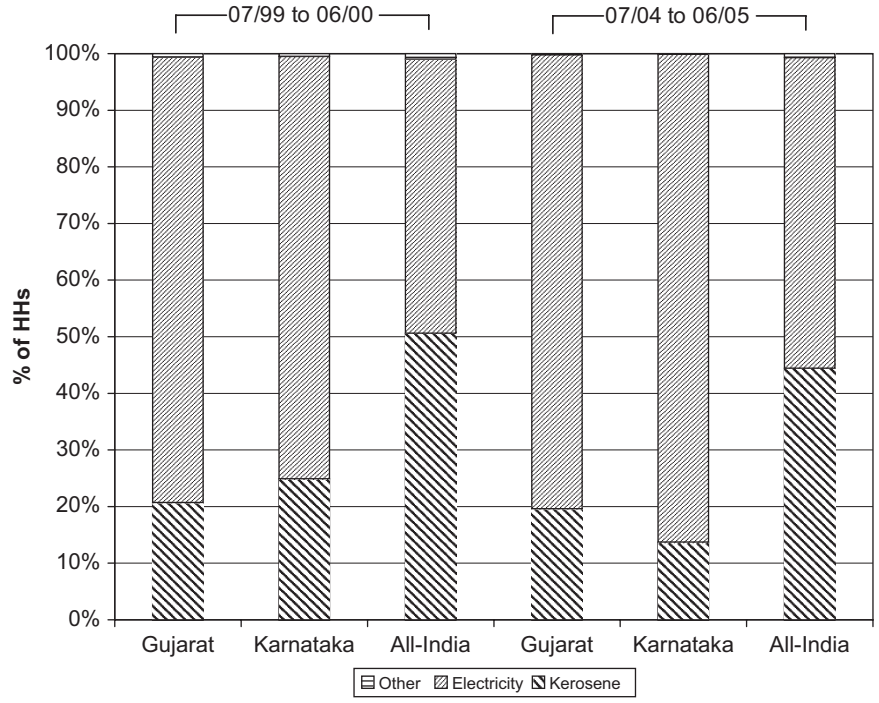

Fig. 10. Household lighting by type of source in rural areas of India (*Source*: NSSO, 2007).

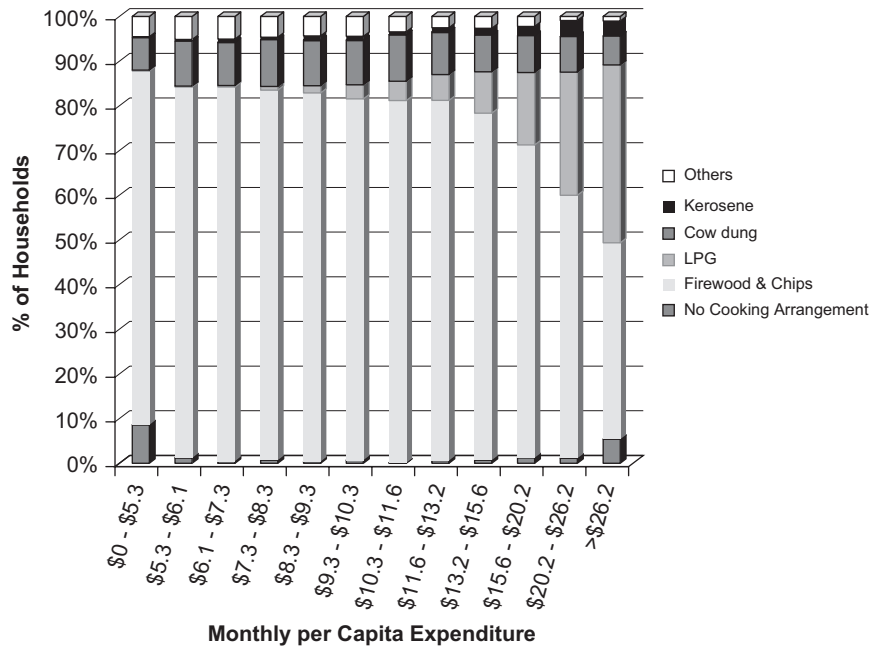

Fig. 11. Distribution of households by primary source of energy used for cooking for each MPCE class at all-India level (1US$ = Rs. 44.1; year 2005 exchange rate) (*Source*: NSSO, 2007).

well as dung cake. The reduction in consumption of firewood and chips as well as dung cake is clearly visible from the $13.2–15.6 MPCE category. The first eight MPCE classes comprise on an average 80.7% and 9.6% of the total households that consume firewood and chips and dung cake whereas the last four classes consisted of 61.5% and 7.6% consuming the afore-mentioned fuel sources of energy. At the same time LPG was popular among 39.2% of the highest MPCE class but only 0.2% of the lowest MPCE class had access to it. A notable feature of the lowest MPCE class was the no cooking arrangement option. A total of 8.5% of this category of households adopted this arrangement. The average MPCE for the households having access to firewood and chips, cow dung and LPG stood at US$11.7, $11.77 and $23.31, respectively. On a pan-India level Rs. 559 (US$12.7) was the average MPCE of all the class of households that were surveyed.

The distribution of households in each MPCE class by primary source of energy used for lighting is described in Fig. 12. We find that kerosene and electricity are the main sources of energy consumed by 99% of the households in all the MPCE classes. We also find that greater than 50% of the households employ kerosene in the MPCE category $9.3–10.3 and lower. Further, the average

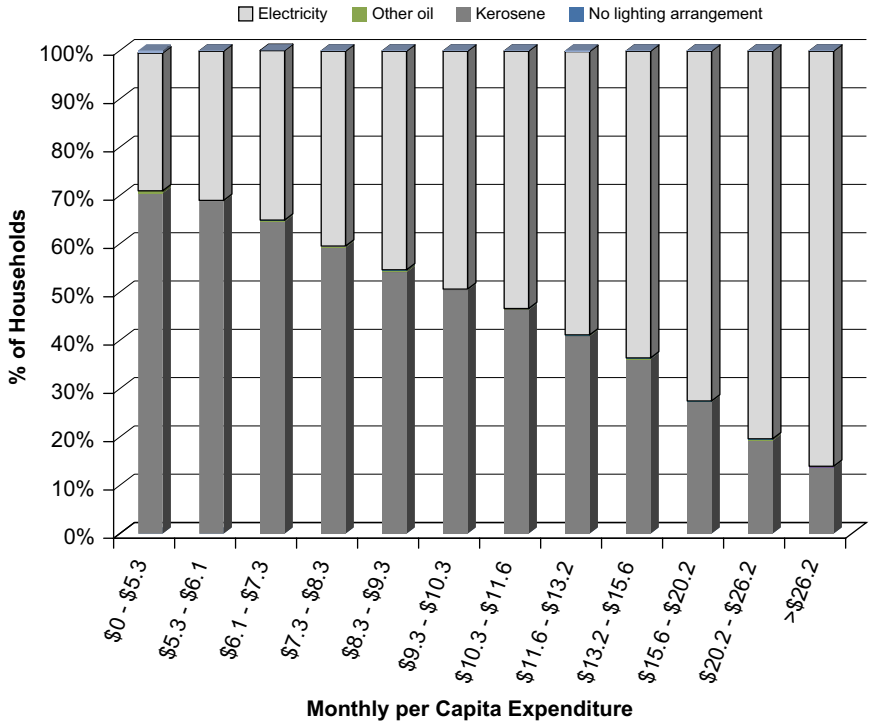

Fig. 12. Distribution of households by primary source of energy used for lighting for each MPCE class at all-India level (1US$ = Rs. 44.1; year 2005 exchange rate) (*Source*: NSSO, 2007).

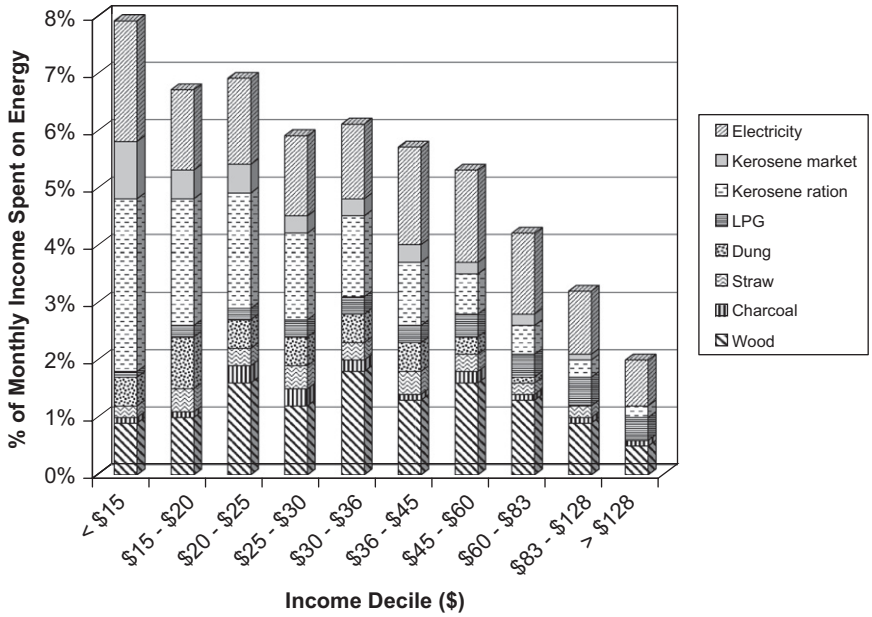

Fig. 13. Expenditure on energy in rural India by monthly income decile (*Source*: World Bank, 2002).

MPCE of kerosene user was $10.64 whereas the same for an electricity user stood at $14.81.

The importance of lighting for poor rural households is even further underscored by the percentage of income they spend on kerosene and electricity. Because their incomes are so low, the Rs. 30–60 ($0.85 to 1.7) that the lowest one-third of rural households spend each month on electricity, kerosene, and other types of energy represent 6–8% of their income (World Bank, 2002). Fig. 13 exhibits this phenomenon. Please note that the income level data has been obtained from the 1996 ESMAP study as the authors were not able to find any other survey which captured this effect in a meaningful way.

A closer examination reveals that although less than half of the poor have electricity in their houses, they spend about 2% of their income on it, mainly for lighting. With increased income, the percentage of income spent on electricity falls to less than 1% of income in wealthier rural households. The percentage of income spent on cooking stood at 6% for low-income households and at 1% for the wealthier counterparts. As expected, lower-income groups spend more time collecting fuel wood, mainly because

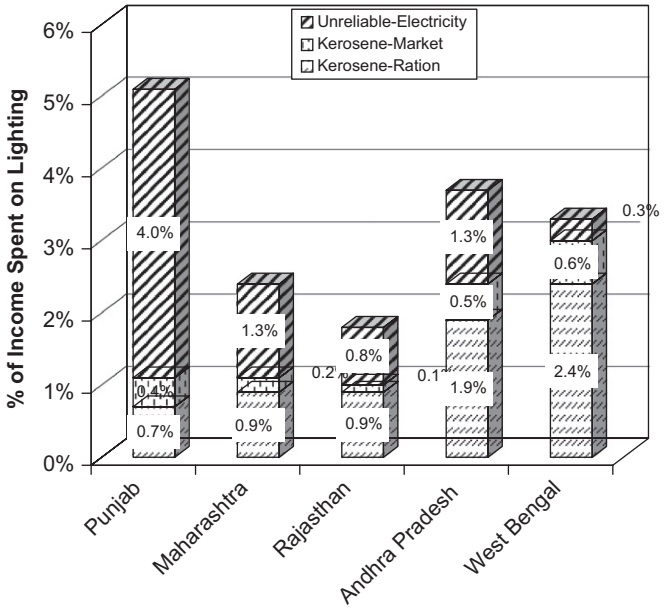

Fig. 14. Income expenditure on lighting (only) in rural India (*Source*: World Bank, 2002).

higher-income households use purchased wood and commercial fuels in far greater quantity. The ESMAP study also found that fuel wood collection by men is significantly higher than collection by women. The typical pattern is that, if fuel wood supplies can be gathered easily from the local environment, then women generally collect it. However, in regions with scarce fuel wood supplies requiring travel of longer distances to collection sites, men become more involved, especially if bullock carts are used for collection.

Now, if one observes the trend across the different states we find that more income is spent on lighting than on cooking. Fig. 14 captures this effect. The states are arranged in a manner representing the richest to the poorest with Punjab being the richest state (in terms of income level) and West Bengal being the poorest. The higher portion of income (4% in the case of Punjab) which is spent on electricity goes towards electricity tariff payments mainly towards agriculture pump sets. Finally, the largest difference in terms of percentage of income spent on lighting and cooking was observed in the case of Punjab (2.2%) and the lowest was observed for Maharashtra (0.1%).

5. Renewable energy in India

In the previous section we examined the expenditure incurred by various categories of rural households on primary energy sources. Considering the energy expenditure norm/trend we believe it is appropriate to introduce renewable energy technology (RET) and other energy efficient technologies. Essentially there are two motives behind this argument:

(a) RETs could be adopted to replace/enhance the conventional fuel sources of energy.
(b) We surmise that the existing energy expenditures could be expended on RETs by engaging a microfinance intervention.

5.1. Ministry of New and Renewable Energy

Before examining the different type of technologies suitable for the low-income households we would like to briefly describe the prominent role played by the central government in the dissemination of renewable energy technology in India. The role of new and renewable energy has been assuming increasing significance in recent times with the growing concern for India's energy security. Energy 'self-sufficiency' was identified as the major driver for new and renewable energy in the country in the wake of the two oil shocks of the 1970s. On March 1981, Government of India set up a high-powered CASE (Commission for Additional Sources of Energy) in the Department of Science and Technology, to draw up plans for achieving a harmonious transition from an economy based on hydrocarbons to one based on renewable energy resources. The Commission was set up on the lines of the Space Commission and Atomic Energy Commission, and to begin with, its mandate was to promote R&D activities in this area (TERI, 2001).

To provide focused attention to this sector, a separate Department of Non-conventional Energy Sources was created in 1982, under the Ministry of Energy, at par with Departments of Coal and Power. After a decade, in 1992, the Department was upgraded to the status of a Ministry, named the Ministry of Non-conventional Energy Sources (MNES) to increase the deployment of RE technologies (TERI, 2001). In 2006, MNES was rechristened to Ministry of New and Renewable Energy.[9]

The Ministry is the nodal agency of the Government of India for all matters concerning the promotion of non-conventional/renewable energy. The span of its activities covers policy making, planning, promotion and co-ordination of various demonstration and commercial programs, designing and implementing fiscal and financial incentives, creation of industrial capacity, promotion of R&D and technology development, intellectual property protection, human resource development and international relations.

Small hydro, biomass gasifiers, solar photovoltaics (SPV), wind energy conversion systems and hybrid systems are the primary renewable energy technologies that are promoted by the ministry. The ministry also deals with emerging areas; such as, fuel cells, electric vehicles, ocean energy and hydrogen energy. All multilateral and bilateral government to government linkages related to renewables are enacted through this Ministry.

In order to provide concessional financial support to the renewable energy sector, the Ministry has set up under its fold a financial institution, viz., Indian Renewable Energy Development Agency Ltd. (IREDA). Table 1 below describes the cumulative installation of renewable energy systems in India. These comprise of both grid interactive as well as off-grid renewable energy systems.

The installation of the MNES and IREDA were the primary drivers of RETs in India esp. in the dissemination of SPV, wind and improved cook stove technology. We now examine different RETs and/or energy efficient technologies that could be employed to replace/enhance the conventional fuel sources of energy. These technologies have been specifically designed to meet the current energy related expenditure by low-income households and are currently being disseminated by various private and non-governmental organizations in rural and urban areas of India.

5.2. Hawkers solar photovoltaic light point

This project is a variation of an innovative project concept, originally conceived by S^3IDF[10] in partnership with

[9] http://mnes.nic.in/pdf/renorder.pdf (Last accessed on: 11/14/2007).

[10] Small-Scale Sustainable Infrastructure Development Fund (S^3IDF) is a 'social merchant bank' that helps small enterprises to provide modern energy and other infrastructural services to poor people in developing countries in ways that are financially sustainable and environmentally responsible. It covers the provision of services in electricity, water, sanitation, transport and telecommunications that are necessary for poverty alleviation. S^3IDF is registered as a non-profit business in both the U.S. and India. For more information please refer: www.s3idf.org (Last accessed on: 01/12/2008).

Table 1
Cumulative installations of renewable energy systems in India (as of 06/30/2007).

Sl. No	Sources/systems	Estimated potential (MW)	Cumulative achievements (MW)
I	Power from renewables		
A	Grid-interactive renewable power		
1	Bio power (agro residues and plantations)	16,881	542.8
2	Wind power	45,195	7230.99
3	Small hydro power (up to 25 MW)	15,000	2013.17
4	Cogeneration-bagasse	5000	634.83
5	Waste to energy	2700	43.45
6	Solar power		2.12
	Sub total (in MW)	84,776	10,467.36
B	CHP/distributed renewable power		
7	Biomass/cogeneration (non-bagasse)		45.8
8	Biomass gasifier	–	86.53
9	Energy recovery from waste		19.76
	Subtotal (in MW)		155.09
	Total (A+B)		10,622.45
II	Remote village electrification	–	3207/830 (villages/hamlets)
III	Decentralized energy systems		
10	Family type biogas plants (in Millions)	12	3.9
11	Solar photovoltaic program	20 MW/sq. km.	
	i. Solar street lighting system	–	61,321 nos.
	ii. Home lighting system	-	317,066 nos.
	iii. Solar lantern	–	565,828 nos.
	iv. Solar power plants	–	1870 kWp
12	Solar thermal program	–	
	i. Solar water heating systems	140 million sq. m. collector area	1.95 million sq. m. collector area
	ii. Solar cookers	–	0.62 Million
13	Wind pumps	–	1180 nos.
14	Aero-generator /hybrid systems	–	608.27 kW
15	Solar photovoltaic pumps	–	7068 nos.
IV	Other programs		
16	Energy parks	–	494 nos.
17	Aditya solar shops	–	268 nos.
18	Battery operated vehicle	–	258 nos.
19	Research, design, development	–	600 Projects

Source: http://mnes.nic.in/ach1.htm (Last accessed on 11/14/2007).

SELCO[11] to bring affordable lighting services to poor customers without access to the grid and/or experiencing unreliable grid power. The concept involves the creation of a microenterprise investment, which, located in the un-electrified/under-electrified hawker's (street sellers) community will provide lighting to the hawkers. The hawkers are mostly petty sellers of fruits, flowers, vegetables or cooked food etc. and some even use moveable carts to ply their trade. Most hawkers currently use kerosene-based petromax lanterns, which are comparatively expensive to maintain given the cost of kerosene and frequent replacement of the mantle (S^{3}IDF, 2006).

The light points, which run on batteries charged by solar photovoltaic panels, are charged during the daytime at a centralized charging station run by an entrepreneur and in the evening, the batteries are delivered to the hawkers for their use. The hawkers need the light points for an average of four hours every evening, after which the batteries are returned to the charging station. These are supplied to the hawkers on a daily rental payment for use, which is pre-determined based on their willingness to pay (WTP). The hawkers benefit with better lighting at a lesser cost, thus improving their economic condition. The maintenance of microenterprise unit (MEU), operation of the charging station and the daily distribution and collection of batteries and rental payments is handled by the entrepreneur (S^{3}IDF, 2006).

5.3. Solar photovoltaic lantern scheme

This project concept is about starting and running a micro-enterprise unit of charging and renting out solar lanterns to village households on a daily rental basis, who do not have access to safe, clean quality lighting. The MEU is owned and operated by women self-help group/s or individual SHG members (please refer section on 'Different Microfinance Models' for details on SHG).

The microenterprise will own the solar lanterns, which are run on batteries charged by SPV panels, and will deliver and collect these lanterns to the customers in the village who will make payments based on "pay per charge" concept. Fully charged lanterns will be delivered to the households in the evening so that

[11] SELCO is a private sector, for profit renewable energy development company, based out of Bangalore, India. It was founded in 1995 to market, install, and service solar home lighting systems throughout South India. To date, the company has installed more than 80,000 solar home lighting systems through its network of more than 25 service centers in the state of Karnataka (*Source*: Nova-Hildesley, 2006). For more information please refer: www.selco.com (Last accessed on: 01/17/2008).

they can enjoy clean and efficient lighting at night and returned/collected in the morning for daytime recharge using SPV. The rental charges are pre-determined based on the WTP of the villagers. The villagers' benefit with better lighting as compared to poor grid based lighting or kerosene lighting. The MEU maintenance, operation of the charging station and the daily distribution and collection of solar lanterns and rental payments is handled by the SHG group or the individual who owns and runs the MEU (S[3]IDF, 2006).

5.4. Improved cook stoves

Improved cook stoves (ICS) also referred to as *chulhas* in Hindi, primarily aimed at enhancing the energy efficiency of biomass burning and eliminating the smoke from the kitchen environment, have been in vogue in India since the late 1940s. However, concerted efforts to promote this technology in rural areas began only in the early 1980s in the wake of the rural energy crisis (Kishore and Ramana, 2002).

There are basically two types of ICS: fixed mud *chulhas* (with/without chimney) and portable metal *chulhas*. Within these two categories, there are a number of different models and designs available in different parts of the country. The cost of *chulhas* varies from Indian Rs. 100–300 ($2.38–7.14). The stated objectives of ICS are (Kishore and Ramana, 2002):

(i) Fuel wood conservation;
(ii) Removal/reduction of smoke from kitchens;
(iii) Reduction of deforestation and environmental degradation;
(iv) Reduction in the drudgery of tasks performed by women and girl-children and their consequent exposure to health hazards; and
(v) Employment generation in rural areas.

Fig. 15 displays the two opening fixed mud stove. Here the fuel is fed and ignited in the rectangular opening (referred to as the fire box) on the left hand side of the figure. The two circular openings found next to the fire box are used to place cooking vessels/pans. The opening present at the bottom of the stove is used to collect ash. A chimney is provided at the right hand side to release the flue gas outside the house. A skilled mason is required to construct the stove as any change in dimension (distance between the bottom of the stove and circular opening, distance between the two circular openings, draft enclosure, height of the chimney etc.) in turn affects the efficiency of the stove.

Fig. 16 displays the portable metal *chulha* from Envirofit-India.[12] B1100 and S2100 (as described in Fig. 16) are the two popular models. These stoves reduce fuel consumption by up to 50% and require less cooking time compared to the traditional three stone stove. And, unlike conventional mud stoves that are both fixed at a particular location, require pipe to blow air (as the wood fails to remain ignited continuously because of lack of air flow) these stoves are portable and use an aluminum/cast iron grate at the entrance thus allowing forth continuous air flow through the wood which makes the use of blow pipe redundant. Finally and more importantly these reduce carbon monoxide and particulate matter the two important byproducts of incomplete combustion and the leading source of indoor air pollution by 50%.[13]

[12] Envirofit India was formed in 2007 as a subsidiary of the US-based non-profit organization Envirofit International. Located in Bangalore, Envirofit India markets clean burning biomass stoves to rural areas in India. For more information please visit http://www.envirofitcookstoves.org/ (Last accessed on: 12/19/2008).

[13] More information on the different type of cook stove models can be obtained from http://www.envirofitcookstoves.org/products (Last accessed on: 12/19/2008).

Fig. 15. Improved two opening mud stove with chimney (also known as *Astra wale*).

Fig. 16. Energy efficient metal cook stoves, Model S-2100 (on left) and Model B-1100 (on right) (*Source*: Envirofit-India).

6. Microfinance

In the previous section we discussed the energy scenario in rural and urban India and the different types of renewable energy as well as energy efficient technologies that are being promoted in rural and peri-urban India. We will devote the current section to an important concept, Microfinance or in more general terms access to finance for low-income household population that is generally neglected in the poverty, energy literature. It is this intervention that is the critical missing link whose adoption will encourage rapid dissemination of the afore-mentioned technologies among the below poverty level end-users.

7. Access to finance in rural India

Being subjected to poverty, enhancing access to finance in the rural areas of India has always been a challenge. Developments in India's financial sector, particularly after the late 1960s, resulted in substantial achievements in enhancing access to credit in rural areas. Shortly after independence in 1947, the first survey of rural indebtedness (All India Rural Credit Survey, or AIDIS) prepared by Reserve Bank of India documented that moneylenders and other informal lenders met more than 90% of rural credit needs. The share of banks in particular was only about 1% in total rural household debt. This ratio remained low until 1971 when it was

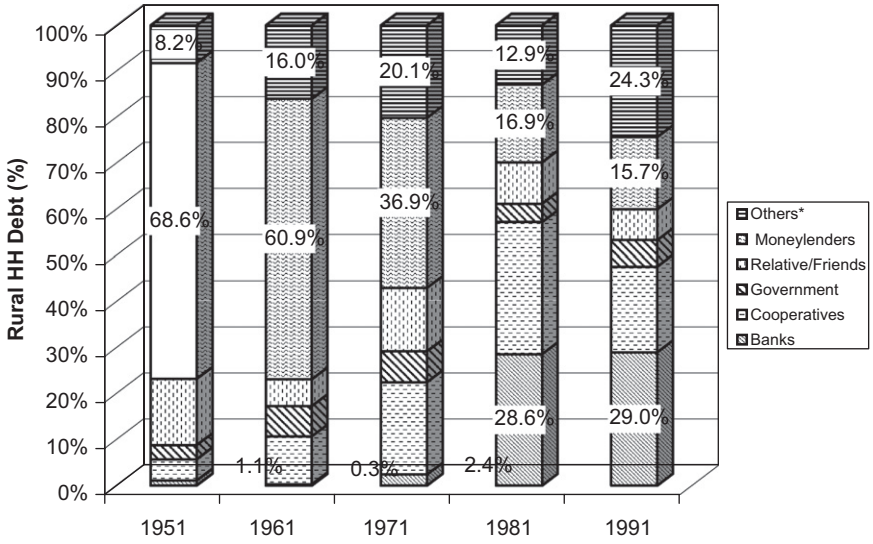

Fig. 17. Share of household debt by source of credit for all India, 1951–1991 (%). *Note*: *"Others" includes non-institutional sources other than friends and relatives and moneylenders, e.g. traders, agriculturist money lender, landlord etc. (*Source*: Basu and Srivastava, 2005).

2.4%, although the share of formal sources of credit in rural areas increased steadily to 29% due to the rising share of cooperatives.

Following bank nationalization, the share of banks in rural household debt increased to about 28.6% and 29% in 1981 and 1991, respectively, while the share of formal or institutional[14] sources in total debt reached 61.2% before declining in 1991 to 53.3%. Fig. 17 highlights the share of household debt by source of credit from 1951–1991. Interestingly, one finds that the share of moneylenders has declined steadily over these four decades from a high of 68.6% in 1951 to a low of 24.3% in 1991 (Basu and Srivastava, 2005).

While achievements over the past decades should not be underestimated, *poorer* households in rural areas in India still have very little access to formal finance. The Rural Finance Access Survey, 2003 conducted jointly by the World Bank and the National Council of Applied Economic Research, India indicates that rural banks serve primarily the needs of the richer rural borrowers: some 66% of large farmers have a deposit account; 44% have access to credit. Meanwhile, the rural poor face severe difficulties in accessing savings and credit from the formal sector: 70% of marginal/landless farmers do not have a bank account and 87% have no access to credit from a formal source. Fig. 18 captures the afore-mentioned trend. Thus, access to formal credit is and still remains a growing concern (Basu and Srivastava, 2005).

8. Microfinance in rural India

Early efforts to provide financial services to the poor tied those services to specific economic activity. For example, between the 1950s and 1970s, governments and donors focused on providing subsidized agricultural credit to small and marginal farmers, in hopes of raising productivity and incomes. During the 1980s microenterprise credit concentrated on providing loans to poor women to invest in tiny businesses, enabling them to generate and accumulate assets and raise household income and welfare (Satyamurti and Haokip, 2002).

The success of some microenterprise credit programs led to bold experiments with product design, delivery methods, and institutional structures, performed mainly by practitioners in developing countries. These experiments resulted in the emergence of microfinance institutions (MFIs), specialized financial institutions that serve the poor. MFIs are called "micro" because of the small size of their transactions (with loans as small as US$50 and savings deposits as small as US$5), and "finance" because they provide safe and reliable financial services to the poor (Satyamurti and Haokip, 2002).

In short, poor people want what many of the less poor already enjoy: reliable, convenient, and flexible ways to store and retrieve cash and to turn their capacity to save into spending power, in the short, medium and long term. And they want it on a continuing, not a one-off, basis (Morduch and Rutherford, 2003).

Thus, one by one, the keywords of the 1980s and 1990s – women, groups, microbusinesses, credit, and graduation – have given way to those of the new century—convenience, reliability, continuity, and a flexible range of services (Morduch and Rutherford, 2003).

9. Different microfinance models

The world of MFIs is diverse—they exist in various legal forms, including non-governmental organizations (NGOs), credit unions, non-banking financial intermediaries, and commercial banks. Their success has shown that poor people can be valuable clients of specially designed financial services—and that serving this niche can be financially viable (Satyamurti and Haokip, 2002).

The typical microfinance clients are low-income persons that do not have access to formal financial institutions. Micro finance clients are typically self-employed, often household-based entrepreneurs. In rural areas, they are usually small farmers and others who are engaged in small income-generating activities such as food processing and petty trade. In urban areas, micro finance activities are more diverse and include shopkeepers, service providers, artisans, street vendors, etc. Microfinance clients are poor and vulnerable non-poor who have a relatively stable source of income.

Access to conventional formal financial institutions, for many reasons, is positively and directly related to income: the poorer you are the less likely that you have access. On the other hand, the chances are that, the poorer you are the more expensive or

[14] The institutional sources comprise of banks, cooperatives and government agencies.

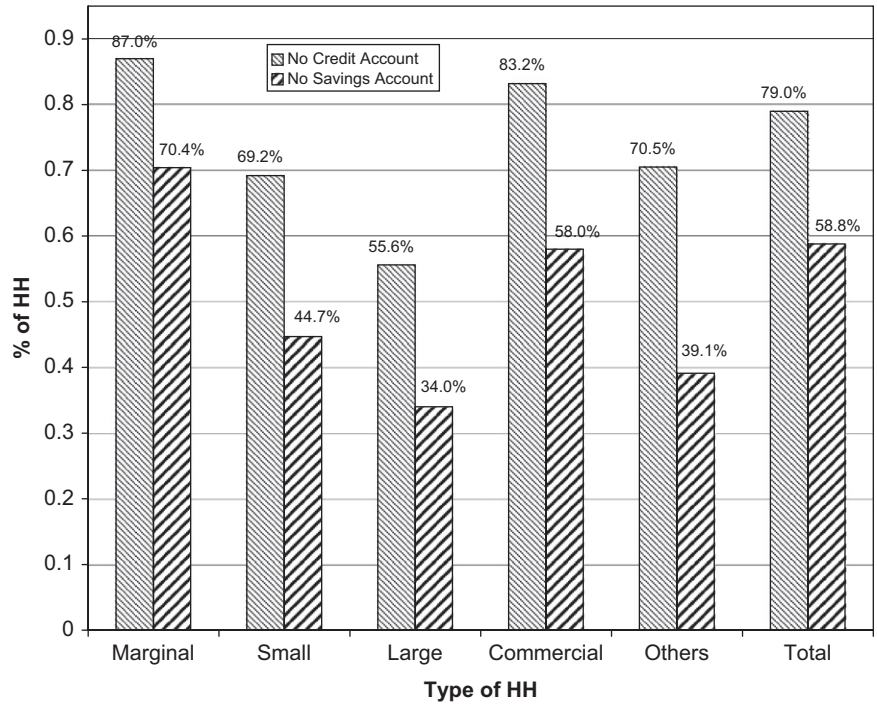

Fig. 18. Access to formal finance for various category of households/enterprises. *Note*: marginal farming households = landholding <1 acre; small = 1 to 4 acres; large farmers = > 4acres; commercial households = with or w/o land but with income from non-farm sources exceeding half of total household income; others = mixed households with land and non-farm commercial incomes but the latter being less than half of their total household income. (*Source*: Basu and Srivastava, 2005).

onerous informal financial arrangements. Moreover, informal arrangements may not suitably meet certain financial service needs or may exclude you anyway. Individuals in this excluded and underserved market segment are the clients of microfinance (Satyamurti and Haokip, 2002).

The microfinance market in India is not uniform and relies on a diverse set of legal, regulatory and organizational systems to provide the poor with access to financial services. The microfinance institutions that currently operate in the market include not-for-profit institutions such as societies and trusts, mutual benefit cooperative societies, for profit non-bank finance companies (NBFC) and local area banks. These institutions use a variety of lending models to deliver microfinance services. Many microfinance institutions fund loan portfolios through borrowings from commercial and state finance institutions. Such re-financers include the National Bank for Agriculture and Rural Development (NABARD) and the Small Industries Development Bank of India (SIDBI) as well as a number of state and commercial banks. Many other microfinance institutions, however, do not provide direct microfinance services and instead facilitate the formation of self-help groups that generate internal funds and link with formal banks for additional financing (MIX, 2006).

That said, there are primarily two kinds of microfinance models (1) Self-help group model; (2) Grameen Bank model that have been meeting the below poverty level households' financial needs in rural/urban India for the last ten to twenty years. The next section describes the two models in detail.

9.1. Self-help Group model

The Self-help Group (SHG) model is unique and distinct to India and constitutes the chief mode of microfinance service delivery in the country. SHGs are self-selected groups of ten to twenty persons that mobilize member savings and provide need-based loans out of the pool of funds created. Members determine the rules and norms of the group (e.g. loan size and interest rate) and rely on microfinance or conventional financial institutions for training and support services. Once internal transactions are strengthened, groups are linked with formal banks for supplementary financing, usually through the intermediation of microfinance institutions. In 1992, NABARD launched the SHG Bank linkage program to assist microfinance institutions with the formation of SHGs and increase the amount of bank loans available to the latter. Between 2003 and 2004, 361,731 new SHGs were formed and received $412 million in bank loans in the context of the program. SHGs often organize into federations to obtain external funds in bulk and hence lower their cost of funds (MIX, 2006).

Despite huge success of the SHG model in India it is not free from critique. Morduch and Rutherford in a critique to the SHG model state that in countries where mass-market pro-poor retailers such as Grameen Bank (more of which has been described in the next section) and BRI (Bank Rakyat Indonesia[15]) have emerged, SHG schemes have not become widespread among the poor. Like the not-so-poor, poor people, given the choice, prefer an individual service, prefer the simplicity of having a reliable retailer look after the bookkeeping instead of having to do it themselves, and prefer to avoid the risks involved in owning and managing their own mini-financial institution. This is especially true of the very poor, who are often illiterate and ill-equipped to maintain a good set of books for anything but the simplest inflexible transactions over short periods (Morduch and Rutherford, 2003).

They also believe that the SHG movement can, at minimum, serve as a quick way to deliver microfinance in an "interim" period, before other institutions can be developed or adapted. The idea is to then graduate SHG members to these other institutions

[15] It is a popular Microfinance Institution in Indonesia. For more information please refer: http://www.bri.co.id/ (Last accessed on: 12/19/2008).

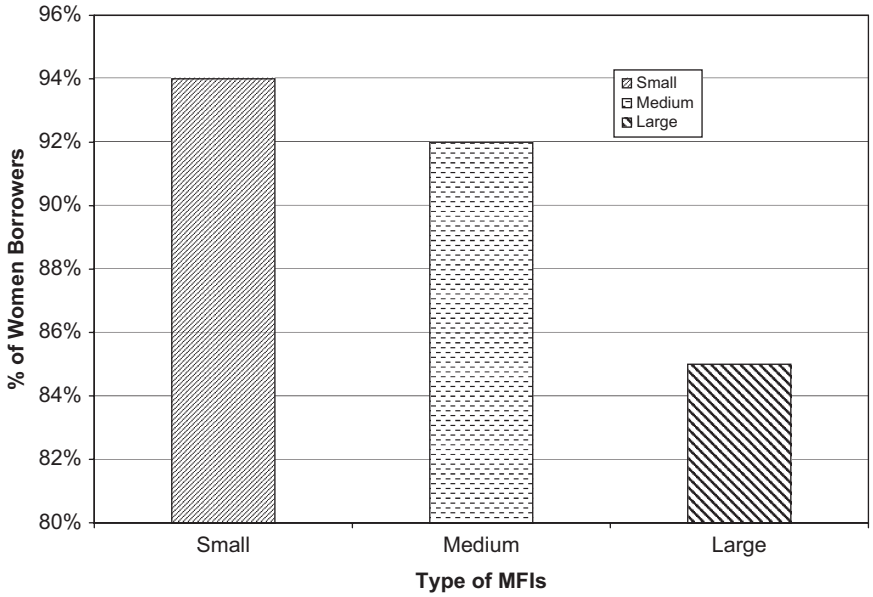

Fig. 19. Share of woman borrowers for various categories of MFIs. *Note*: small MFI: GLP < US$ 1 million, medium MFI: GLP = US$ 1–5 million, large MFI: GLP > US$ 5 million (GLP = gross loan portfolio, *Source*: MIX, 2006).

where they can access standard "individual" loans, possibly on a fully commercial basis. An immediate problem arises in that there are no obvious lenders for SHG customers to graduate to—none yet are close to offering the reliability, convenience, continuity, and flexibility of good microfinance for low-income customers. Nor is the notion of graduation built explicitly into the SHG design (Morduch and Rutherford, 2003).

9.2. Grameen model

While dominant, the SHG model is not the sole mode of microfinance delivery in India. Microfinance institutions also provide credit through the Grameen model. The Grameen model[16] emerged from the poor-focused grassroots institution, Grameen Bank, started by Prof. Mohammed Yunus in Bangladesh. It essentially adopts the following methodology:

A bank unit is set up with a field manager and a number of bank workers, covering an area of about 15 to 22 villages. The manager and workers start by visiting villages to familiarize themselves with the local milieu in which they will be operating and identify prospective clientele, as well as explain the purpose, functions, and mode of operation of the bank to the local population. Groups of five prospective borrowers are formed; in the first stage, only two of them are eligible for, and receive, a loan. The group is observed for a month to see if the members are conforming to rules of the bank. Only if the first two borrowers repay the principal plus interest over a period of 50 weeks do other members of the group become eligible themselves for a loan. Because of these restrictions, there is substantial group pressure to keep individual records clear. In this sense, collective responsibility of the group serves as collateral on the loan.

Grameen Bank also realized that its weekly payment model left out very poor households such as those that depend on seasonal work like agricultural labor, who find it hard to make a fixed value payment week-in week-out for a full year and this problem lay behind the realization that despite much rhetoric about reaching 'the poorest of the poor' it was in fact the case that many such households dropped out of MFIs, or never joined. For those households, more flexible repayment schedules, or shorter term loans, or both, make sense. The desire to match services better to the cash flows of the very poor became one of the motivations behind recent experiments with more variable terms and schedules[17] (Morduch and Rutherford, 2003).

Besides the Grameen model individual loans and joint liability groups are also popular forms of microfinance delivery. But unlike SHGs, these last two groups are not independent entities, but simply serve as a delivery means for the microfinance institution (MIX, 2006).

10. Outreach of microfinance

In India, a large part of below poverty line households credit, savings and insurance demand is currently unmet by the microfinance industry. Annual microcredit demand is estimated at $12 billion, but a very conservative estimate suggests that, at most, just 20% of all poor people have access to financial services from formal financial institutions, microfinance institutions and other such service providers. While it has substantially increased the poor's access to financial services, the recent upsurge in outreach has concentrated in South India and left most areas of the country underserved. As with credit, demand for savings and insurance services remains largely unfulfilled as well (MIX, 2006).

A performance analysis of 28 microfinance institutions conducted by microfinance exchange (MIX) in India found that the share of women borrowers in the sample provides evidence that the Indian MFI sector remains greatly targeted in its service delivery. At 90%, MFIs are heavily focused on women clients. Among *New* MFIs (MFIs established after 1995), virtually all clients are women. For the other age groups viz. *Young* (MFIs established between 1990 and 1995) and *Mature* (MFIs established before 1990), the percentage of women borrowers is around

[16] The literature on Grameen model was obtained from http://www.grameen-info.org/mcredit/cmodel.html (Last accessed on 11/12/2007).

[17] An important innovation of Grameen Bank II is loans that can be paid in weekly installments of different amounts in different seasons (Morduch and Rutherford, 2003).

Table 2
Average MFI outreach by scale.

Scale	Average GLP[a] (US$)	Average number of active borrowers
Large	$18,870,488	148,317
Medium	$2,562,681	35,180
Small	$504,053	13,884

Source: MIX Market 2004 data as of October 18, 2005. Data adapted from MIX, 2006.
[a] GLP = gross loan portfolio.

85%, suggesting that as institutions age they tend to broaden their coverage. As Fig. 19 illustrates, the share of women borrowers also varies by scale, decreasing from 94% and 92% for small[18] and medium scale institutions, respectively, to 85% for larger ones (MIX, 2006).

Further in 2004, the institutions sampled in this study served over 1.5 million borrowers. Outreach, however, varied significantly across institutions. With an average of 148,317 active borrowers, large scale institutions served four and ten times as many borrowers as medium and small institutions, respectively (as described in Table 2). The group of large scale MFIs, which includes just seven institutions, dominated the market, managing 81% of the overall loan portfolio and serving 67% of borrowers. The three largest institutions, which alone covered 54% of borrowers, are all non-bank finance companies that are based in South India. Medium and small-scale MFIs, on the other hand, span the range of institutional forms, are spread across the country and tend to provide a variety of services, including non-microfinance services.

Between the years 2003 and 2004, outreach in the sector more than doubled; the number of borrowers served grew by 108% while the loan portfolio increased by 139%. Young institutions, established between 1990 and 1995, grew the fastest, expanding their number of borrowers by 160% on average. New (established after 1995) and mature (established before 1990) institutions also grew, albeit at more modest rates of 60% and 53%, respectively. Large MFIs, by age, mostly fall in the middle-age group. These institutions counted some of the fastest growing MFIs in the sample and added over half a million new borrowers (i.e. 72% of new outreach).

11. Energy-microfinance framework

This brings us to the final part of our discussion where in we propose an energy-microfinance framework that caters to the energy (lighting and cooking) needs of low-income household population by engaging a microfinance institution. Our model/framework encompasses two independent entities. One has an energy expertise (non-profit organization) and the other possesses finance management skills (microfinance institution). The energy-microfinance model/framework proposed by us is described in Fig. 20. The succeeding paragraphs will highlight the different entities involved in the framework and the corresponding flow of funds/services.

The funds from larger corpus or an individual investor flow to a smaller microfinance institution (MFI) and/or self-help group forming committee. The primary responsibility of the MFI is to supply credit to its members and/or entrepreneur identified by the non-profit (more on the non-profit's responsibility has been described in the next paragraph). It also disseminates information on workshops as well as demonstration camps conducted by the non-profit along with Energy Service Company (ESCO) during its weekly member meetings.

A non-profit organization (energy experts) identifies the Renewable Energy Development Company (REDCO) and/or Energy Service Company which is responsible for designing, installing and servicing the clean energy technology products. It conducts an independent survey of the low-income household members/end beneficiaries to determine their existing energy expenditure. Along with ESCO it conducts a demonstration of the suitable technology and then records the household member's 'willingness to pay' towards the said technology.

The non-profit also identifies the entrepreneur among the set of member beneficiaries, trains him and/or ensures that he is sufficiently experienced with the appropriate technological solution. It is also involved in an independent dialogue with the MFI to understand the institution's assessment of the credit-worthiness of the entrepreneur. Subsequently, it also undertakes monitoring and evaluation of the project. More importantly, the non-profit fosters different institutional, technical and financial engineering approaches to the provision of energy and infrastructure services necessary for poverty alleviation, esp. small-scale solutions that are pro-environment and pro-poor at the same time (S^3IDF, 2008).

The entrepreneur provides the daily energy services, non-engineering level maintenance of the system and is responsible for the collection of the payments (in most cases the payments are collected on a daily basis). He/she also serves as an intermediary between the MFI/SHG and the clients. It is his/her role that ensures the overall sustainability of the project (post-commissioning). The entrepreneur's capital and operating costs are strongly influenced by financing costs that in turn are a function of interest rates, guarantee fees and term of the loan. And further from the entrepreneur's perspective when weighing risks versus return, there is some consideration of short and medium term versus longer term, the former being when the debt is financed and the latter after the debt is paid but the scheme continues and the margins are higher (S^3IDF, 2008).

The members/beneficiaries of the framework are the existing clients of the MFI. They are offered 'energy' loans by the MFI to obtain reliable, renewable and energy efficient lighting and cooking technologies. The loans will be used to meet the high capital costs of renewable energy technology (for lighting) and energy efficient stoves (for cooking) identified by the non-profit agency.

The non-profit and the MFI/SHG network can be treated as a single entity or two independent organizations under one large entity. The latter can be treated as a "special purpose entity" that is better suited to handle the various operations based on the costs of establishment, operating/working costs and other transaction costs required for smooth running of the project.

12. Case study: photovoltaic light points for hawkers in Mysore, Karnataka, India

The following example would help us to better understand the energy-microfinance framework. Small-Scale Sustainable Infrastructure Development Fund (S^3IDF)[19] is an organization whose mission is to foster pro-poor pro-environment small-scale infrastructure services with financing and technical assistance for electricity, water sanitation, and other infrastructure (e.g. transport and telecommunications)—necessary for poverty alleviation. S^3IDF is registered as a non-profit corporation in United States and

[18] Please refer Table 2 for a description on small, medium and large scale MFIs.

[19] This section is derived largely on text provided by Mr. Krishna C Rao, Manager (Operations), S^3IDF-India. It was obtained when one of the authors of this paper conducted a Monitoring & Evaluation of 8 S^3IDF projects between 04/14/2008 and 04/17/2008.

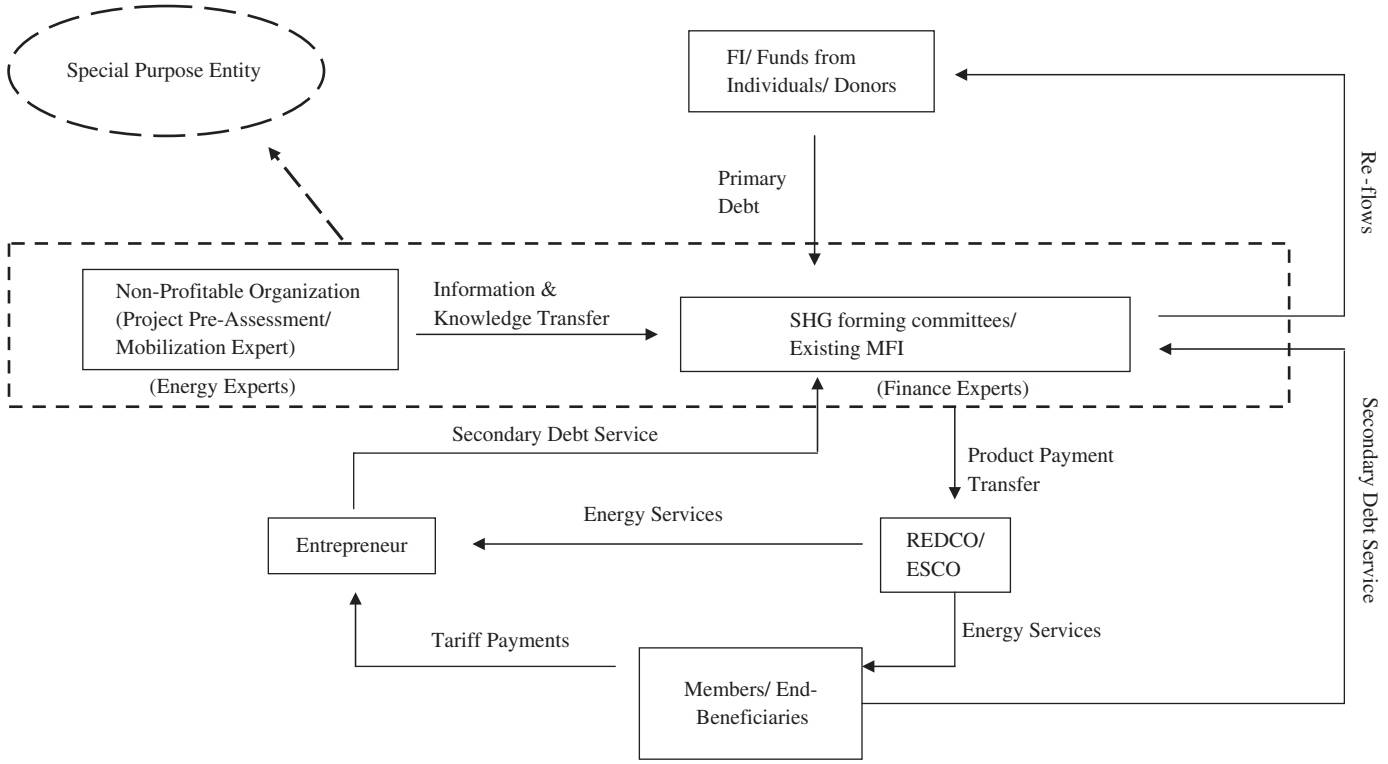

Fig. 20. Energy-microfinance framework (schematic of flow of energy services and funds). *Note*: ESCO = Energy Service Company, FI = Financial Institution, MFI = Microfinance Institution, REDCO = Renewable Energy Development Company, SHG = self-help group.

has been granted 501 (c) (3) public charity status. S^{3}IDF also has a non-profit corporation with the same name and mission in India.

S^{3}IDF is demonstrating that technical innovation and changes in regulatory systems that have taken place in recent years provide an opportunity for small-scale businesses to supply modern energy and other infrastructure services with a degree of financial sustainability. Small-scale enterprises are well-suited to provide utility services at a standard and at a cost that meets the needs of poor people. As described in the earlier sections, in the energy sector poor people represent a significant market for modern services as they spend a high proportion of their cash incomes on the traditional and inefficient energy services that they use, such as firewood, candles, batteries and kerosene.

But more importantly S^{3}IDF is able to demonstrate that financial viability can be increased by linking improved service provision directly to income-generating end-users, such as shop keepers or hawkers, grain millers, farmers using irrigation for high-value crops, women's groups using sewing machines and other small enterprises. Their mission is based on the following premise: modern energy services increase productivity, which can lead to higher incomes, which in turn leads to an increased ability to pay for modern energy services.

"Photovoltaic light points for hawkers with entrepreneur Mr. Rajendra and Mr. Jayaram in Mysore, Mysore district, Karnataka" are two such projects within the S^{3}IDF portfolio of pro-poor, pro-environment small-scale infrastructure service projects. This project was originally conceived by S^{3}IDF in partnership with SELCO,[20] to bring affordable lighting services to poor customers without access to the grid (or reliable grid). The hawkers are mostly petty sellers of fruits, flowers, vegetables, cooked food and garments, and some even use moveable carts to ply their trade. Most hawkers currently use kerosene-based petromax or gas (LPG) lanterns, which are comparatively expensive to maintain given the cost of kerosene and frequent replacement of the mantle. Also, the kerosene lanterns generate considerable heat that is known to damage the fruits, flowers and vegetables that the hawkers vend (S^{3}IDF, 2008).

The light points, which run on batteries charged by solar photovoltaic (PV) panels (supplied by SELCO), are charged during the daytime at a centralized charging station and in the evening, the batteries are delivered to the hawkers for their use. The hawkers need the light points for an average of four hours every evening, after which the batteries are returned to the charging station. These are supplied to the hawkers on a daily rental payment for use, which is pre-determined based on their willingness to pay. The hawkers benefit with better lighting at a lesser cost, thus improving their economic condition. The entrepreneurs have invested a small proportion of the total capital needed and S^{3}IDF's provision of partial guarantee, in the form of a fixed deposit, has allowed the entrepreneurs to access a loan from a local financial institution (S^{3}IDF, 2008). Fig. 21 comprises of the photographs displaying the salient features of the project.

Before we conduct an in depth study it will be good to explain the different organizations/individuals involved in the PV light point for hawkers project in terms of the entities described in Fig. 20. Thus, we have:

- Local branch of State Bank of Mysore representing the "FI".
- S^{3}IDF representing the "non-profitable organization".
- SELCO Solar Light Pvt. Ltd, the PV equipment supplier as "REDCO/ESCO".

[20] Please refer 'Hawkers Solar Photovoltaic Light Point' in renewable energy technology section.

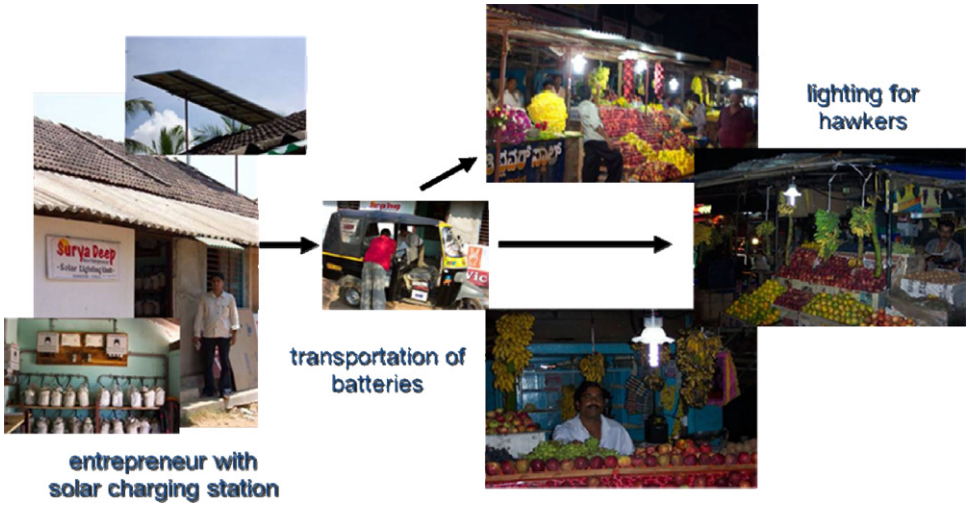

Fig. 21. PV light points for hawkers project in Kundapur, India (*Source*: S^{3}IDF-India).

- Mr. Rajendra Prasad and Mr. Jayaram, the entrepreneurs running the microenterprise units as "entrepreneur(s)".
- Hawkers/vendors representing the "members/end beneficiaries".

The next part of this discussion emphasizes on some of the relevant features of the projects esp. costs and benefits of this project.

12.1. The microenterprise unit

The microenterprise units, these projects have created are owned and operated by local under-employed youth Mr. Rajendra and Mr. Jayaram. The charging stations are located in their residences which are about 6 Km (3.75 miles) from the hawkers community. However, since they have reliable cheap private transport (LPG fit three wheelers as shown in Fig. 21) that is extremely suitable for the transportation of batteries, and since they share transportation costs, this choice of charging station location does not impose a significant operating cost for the MEUs. In addition when this is weighed against the rental payment they would need to make for premises closer to the hawkers community, operating costs would be less if they charged the batteries in their residence (both entrepreneurs live on the same street) (S^{3}IDF, 2008).

The entrepreneurs were identified through the networks of SELCO Solar Light Pvt. Ltd—technology partner for solar. Additionally, the two entrepreneurs are and have been friends from a very long time and have had an almost identical professional history. Both entrepreneurs are serving a common hawkers community. Due to each entrepreneur's restricted ability to pay the "margin money",[21] each entrepreneur serves only 25 garment vending hawkers in the city of Mysore. They have however chosen to treat their individual investments as separate investments (there are two loans from the bank) and operate as separate players rather than entering into a partnership for a single MEU for the combined market. They have both hypothecated their three wheelers to the bank against the loan sanctioned as additional security and stake (as required by the bank). Lastly, they are collecting daily payments towards the light points from the hawkers (S^{3}IDF, 2008).

[21] Margin money is another term for down payment. Typically, a financial institution in India requires an individual/organization to pay margin money that is in the range of 10–25% of the "total capital/investment" as a down payment.

12.2. Project development and pre-investment process

Much of the pre-investment efforts were expended by SELCO's sales personnel. The identification of the market, the identification of the entrepreneurs, the dialogues with the bank have all been carried out by SELCO. S^{3}IDF's pre-investment efforts have been limited to two visits to the project site. The first visit was to conduct an independent survey of the hawkers and conduct due-diligence on the entrepreneurs to ensure that S^{3}IDF's pro-poor criteria are satisfied, the entrepreneurs are reliable and that the appropriate technology solution has been chosen. It also involved an independent dialogue with the bank to understand the bank's assessment of the credit-worthiness of the entrepreneurs. The surveys indicated that the hawkers' households have an average income in the range Rs. 3000/- ($67[22]) to 4000/- ($89) a month while the entrepreneurs have an average monthly income of around Rs. 3000/-. The hawkers expressed a willingness to pay of Rs. 12/ day ($0.27/day) for the lighting services (S^{3}IDF, 2008).

The second visit was to provide the partial guarantee to the bank and ensure financial closure. Subsequently, telephonic monitoring of the project has been undertaken (further detailed monitoring and evaluation is being planned). From S^{3}IDF's perspective, both these projects are a demonstration of the cost-effectiveness that a rightly made partnership can result in (S^{3}IDF, 2008).

12.3. Final costs and financing arrangements

The cost of the project is Rs. 137,500 ($3056). Of this, 15% of the investment cost was borne directly by the entrepreneurs. The remaining 85% ($2597.6) was financed by the Mysore, Vijayanagar Branch of the State Bank of Mysore at 10% interest rate per annum (under the loan scheme for "Small Business Enterprises" in which investments up to Rs 2,00,000/-, $4444, are financed), through a 3 year loan with an equated monthly instalment (EMI) repayment plan. This loan was enabled by the provision of a partial risk guarantee for 25% of the loan amount viz. $649 by S^{3}IDF in the form of a fixed deposit held by the branch.

The ongoing operations, distribution and maintenance costs of the MEU will be covered by the income generated by the MEU. Table 3 describes the financial summary of the project.

[22] 1US$ = Rs. 45; year 2006 exchange rate.

Table 3
Financing summary.

Project	Project cost	Entrepreneur equity (%)	Bank debt (%)	S^3IDF Partial guarantee
Project 1	Rs. 1,37,500.00	15	85	Rs. 29,220.00
Project 2	Rs. 1,37,500.00	15	85	Rs. 29,220.00

Source: S^3IDF, 2008.

12.4. Benefits and beneficiaries

The microenterprise units, operated and managed by the entrepreneurs, have increased income generation for each entrepreneur; thus the entrepreneurs are significant beneficiaries of the projects.

For both projects, the business model enables diffusion of solar technology in such a way that the benefits and beneficiaries are multiple. Apart from the obvious benefit to the entrepreneurs, the main beneficiaries are the hawkers as the light points will result in savings and better lighting. Savings for the hawkers could translate into better quality of living for their families (surveys indicate that the average size of a hawker's family is 5 members). Finally, the projects replace the current usage of kerosene and LPG as fuels for the lanterns, resulting in green house gases (GHGs) benefits as well.

12.5. Project viability: cost versus benefits

The viability of the project is dependent on the following four perspectives:

12.5.1. The hawkers perspective

Pre-investment surveys indicated that the hawkers' current expenditure on kerosene lanterns varied somewhat but was typically about Rs. 12 ($0.27) to 18[23] ($0.4) per day, including lantern part replacement. The preference and willingness to pay studies indicated a clear preference for light points over kerosene lanterns as these were ascertained to better illuminate the hawkers' goods. A willingness to pay of Rs. 12 per day was determined for four hours of use of the light points, as well as a willingness to pay an additional fee for increased usage beyond the stipulated time. The pre-investment analysis suggested that in order to achieve viability from the entrepreneur's perspective, a minimum pay-for-charge fee of Rs. 10 would be required (S^3IDF, 2008).

12.5.2. The entrepreneur's perspective

From the entrepreneur's perspective, the scheme's capital and operating costs fall into four categories: (i) investment financing costs, (ii) other costs for the charging station (premises rent and maintenance), (iii) battery transport (two wheeler transport or hired three-wheeler), maintenance and periodic replacement, and (iv) labor (self or wage employee). The key question is the residual margin or entrepreneurial returns after all these costs are netted from the total revenue. Revenues are obviously a function of the pay-for-charge fee and the number of hawker customers. The entrepreneur's capital and operating costs are strongly influenced by financing costs that in turn are a function of interest rates, guarantee fees and term of the loan. And further from the entrepreneur's perspective when weighing risks versus return, there is some consideration of short and medium term versus longer term, the former being when the debt is financed and the latter after the debt is paid but the scheme continues and the margins are higher. After considering all the above aspects, with the determined willingness to pay from the hawkers, number of hawkers, investment and financing costs it was found that this MEU has a less than one-year equity payback period and the return on the investment, labor and equity is attractive and viable for the entrepreneur to undertake the project (S^3IDF, 2008).

12.5.3. The bank and S^3IDF's perspective

Due to the apparent financial viability of the business, the bank has provided financing for the project on a shorter term loan of three years. From S^3IDF's perspective, it was clear that the investment was feasible from the hawkers' and entrepreneur's perspectives and S^3IDF provided the guarantee to facilitate the bank's participation. The bank's investment is also considerably risk-free given that S^3IDF will provide a partial guarantee and the technology supplier will provide a buyback guarantee under its terms and conditions. At the point of financial closure, based on 25 hawker customers and the three-year financing, the entrepreneur's margin (Rs. 2000 to 2500 per month; $44 to 56 per month) was sufficient for him to take the investment decision (and risk). From the above perspectives, the project was viable and sufficiently pro-poor according to S^3IDF's mission (S^3IDF, 2008).

12.5.4. Initial monitoring and evaluation[24]

Monitoring of these projects in April 2006 has indicated that repayment on the part of the entrepreneurs has been timely and that there have been no significant operational or technical problems encountered. The bank is satisfied with the entrepreneurs' repayments and readily provided loan to one of the entrepreneur's cousin brother for another such project in a different locality in Mysore.

That completes our discussion on photovoltaic light points project(s) for hawkers. A careful examination of the schematic diagram (Fig. 20) revealed two other important features: (i) risk sharing and (ii) logical organization of the various entities. The succeeding section describes these two features.

13. Risk sharing

In our framework the biggest risk taker is the MFI/entrepreneur (if he/she is absent then the responsibility of debt/payment collection falls on MFI's shoulder). The word risk used in this context solely represents the financial risk borne by the entrepreneur/MFI when serving the non-creditworthy members or individuals/groups lacking a credit history.

Non-profitable organization, REDCO/ESCO, FI/Individual investor, MFI and Entrepreneur represents the participants/organizations[25] in the ascending order of the amount of financial risk undertaken. The returns (in percentage and not in absolute numbers) are also earned in the corresponding manner by these participants. Besides the financial risk some of the participants are engaged in handling other forms of risk.

[23] These values are based on the kerosene prices when the survey was conducted. It should be noted that the kerosene prices are showing an upward trend.

[24] It should be noted here that S^3IDF will also get the project evaluated by independent consultants at a later stage.

[25] Please note that we have used organization and participants interchangeably to represent the different entities involved in the energy-microfinance framework.

13.1. Technical risk

REDCO is mainly responsible for handling the technical risk viz. system buyback (if system fails within the warranty period).

13.2. Administrative/political risk

If grid power is made available to the un-electrified members within a few years of availability of renewable lighting services then all the parties involved will be exposed to this form of risk.

Non-profit (true to its nature) undertakes the least amount of risk but it has its credibility at stake to identify the right entrepreneur and REDCO. Finally, as the greatest portion of the risk burden is handled by the MFI it needs to incorporate various metrics/measures viz. diligent project pre-assessment, monitoring and evaluation, government (or Reserve Bank of India) policy/regulation/guidelines etc. to lower/mitigate risk. In conclusion, in the proposed energy-microfinance framework the element of risk is shared by the different entities and thus we observe a true form of risk diversification.

14. Logical organization of the various entities

The second notable feature of this framework is the logical manner in which the different participants have been organized. The schematic can be broadly classified into four divisions beginning from the flow of funds to the end point where the energy services are delivered to the members/beneficiaries. Tracing the energy-MFI framework (Fig. 20) one observes the rationale behind the placement of the different organizations involved in the different processes.

We have an individual investor or financial institution occupying the top most layer. The second layer is comprised of non-profits or a special purpose entity representing a non-profit agency.[26] The third layer is occupied by private interests' viz. REDCOs, entrepreneur (the reason we have grouped these together is that both these entities could hold partial equity stakes in this project). The final layer is that of the beneficiary(s).

We have a non-profit layer sandwiched between two private layers and increasingly one observes a market economy wherein each organization does its best to offer its expertise at a competent price. The price needs to be competent enough bearing in mind the low incomes and/or expenditures incurred on their existing energy set up by the poor/BPL households. Lastly, and more importantly the payments collected will result in overall sustainability and hence long-term involvement of the different stakeholders.

15. Conclusion

The provision of renewable form of energy technology for the below poverty level households who are currently dependent on conventional and unclean form of energy requires intervention at several stages. Considering that we propose an energy-microfinance framework that caters to the energy (lighting and cooking) needs and the corresponding financial needs (to meet the capital costs of the energy technology) of the low-income household population.

The energy requirements will be met by renewable and energy efficient technologies and the corresponding financial arrangements are expected to be delivered by a microfinance institution. Further, these technologies have been specifically designed to meet the current energy related expenditure incurred by the low-income households.

The energy service company, microfinance institution, an entrepreneur and a non-profitable organization that binds all the parties together are the different entities engaged in the energy-microfinance framework. Risk sharing and logical organization of the different entities are two characteristics that are unique to this energy-microfinance framework. A field study that carefully examines the individual stakeholders and also studies the integration of all the parties in unison is warranted.

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[26] Please note that the MFI can be registered as a non-profit or for profit agency.