1 ENERGY PROVISION FOR THE URBAN POOR

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1.1 INTRODUCTION

This study on Energy Provisions for the Urban Poor, is a part of an international study to understand urban energy issues, specially those related to the urban poor, and the impacts of various policy interventions in this area. The outcome of this study, which includes case studies from India, Kenya, South Africa, Peru and Mali, would help various government and funding agencies to understand these issues and promote a more sustainable and acceptable solution to problems of energy provisions in urban areas.

Urban areas are the biggest consumers of energy, and availability of various energy sources as well as access to them becomes a key issue that determines the current consumption patterns. This holds true specially for the urban poor, who, severely constrained by poverty, do not have access to energy sources preferred by them, and have to do with sources which are inefficient and more polluting. Current Government policies are also not really helping the poor to access cheaper and cleaner sources of energy.

This study firstly looks at the process of urbanisation in India, status of urban poverty, and the changes and trends in energy consumption patterns in urban areas. It then focuses on the urban poor and their specific problems related to access to energy, and the impacts of current government policies on energy provisions on them. The study goes on to suggest some policy recommendations on improving access to higher grades of energy for the poor. Three case studies are included:

- Access to Energy: A case of slums in Delhi
- Decentralised energy systems India (DESI) Pvt. Ltd.
- SELCO Photovoltaics Electrification Pvt. Ltd.

1.2 LAYOUT OF THE REPORT

Section 2 looks at urban poverty in India
Section 3 focuses on energy consumption patterns in urban areas
Section 4 analyses the issues related to access to energy for the urban poor, and presents the first case study
Section 5 looks at energy options for the urban poor, and presents the second and third case study
Section 6 puts forward policy recommendations

2 URBAN POVERTY IN INDIA

This section looks at the trends in urbanisation in the country and the extent of urban poverty in India, and its incidence. It highlights the problems in identifying the poor according to different definitions

2.1 URBANISATION IN INDIA

With the fast pace of economic development in the country, India has emerged as a nation with one of the largest urban population in the world. About 217.6 million of the Indian population live in urban agglomerates and towns. The urban population in India constitutes 26% of its total population and is increasing at the rate of 3% per annum.

In the post-Independence period, the process of urbanisation picked up pace. From an urban population of 62 million in 1951, it has increased three and a half times in four decades. Figure *2.1a* shows the growth in the urban population of India after five decades since independence in 1947.

The two major contributors to this trend of rapid urbanisation have been the following:

- *The construction of new industrial cities:* Industrial growth in India during the past four decades has shown an increasing trend. This has had considerable impact on urban development. In the post-Independence period, more than one hundred industrial cities have been developed together with more than 500 industrial estates on the periphery of the large cities. Figure *2.1b* shows the trend in growth of the number of urban agglomerates in India.

- *Rapid growth of Class I cities:* There has been a sharp rise in the number of Class I cities (cities with more than one lakh population) in the last four decades. The number of such cities has increased from 76 in 1951 to 309 in 1991. The proportion of urban population living in such cities has increased from about 45% to more than 65% in the same period. The pattern of urbanisation in India (Figure *2.1c*) has been characterised by growth of large cities and decline of small towns.

The growth in urbanisation in India has had significant implications for the Indian economy as a whole. Two of the major implications which are significant for the present study may be summarised as the following:

- *Stagnation and decline of small towns:* A significant fallout of the rapid growth of Class I cities is the stagnancy and decline of small towns. The decline has been most conspicuous in case of towns with a population of less than 10,000. While the total number of urban agglomerates has increased from 2843 in 1951 to 3768 in 1991, the number of small towns has decreased from 1723 to 950 in the same period. This is evident from the

growing concentration of the urban population in larger cities as shown in Figure *2.1c*. Since the cost of living in the Class I cities is significantly higher than in the smaller towns, this trend has implications on the overall economic profile of the urban population.

- *Growth of slums and the rural urban fringe:* Another result of the rapid growth of urbanisation in the Class I cities, has been the emergence of a severe shortage of housing facilities for the economically poorer section of the urban population. A large section of the urban poor are rural migrants working as unskilled labour. Unavailability of affordable housing opportunities for them results in the mushrooming of slums and illegal clusters in public and private lands. Further, big cities have expanded physically into the peripheral villages in an unplanned and indiscriminate manner that has given rise to the rural urban fringe around most of the larger cities.

2.2 URBAN POVERTY IN INDIA

2.2.1 Identifying the Urban Poor

Although it is impossible to create an indicator of poverty that is strictly comparable across countries, the use of a standard, international poverty line helps to reduce comparability problems in several ways. The following two definitions of poverty are widely used:

- World Bank's definition of poverty: The poverty line is defined as the percentage of people living on less than $1 a day (PPP) at 1985 international purchasing power parity is used as the measure of poverty. A person is said to be poor if he or she lives in a household whose total income or consumption per person is less than the poverty line.

- Planning Commission of India's definition of poverty: The poverty line for the urban population is defined as an expenditure of Rs. 264.1 (1993-94 prices) per capita per month. Any person living in an urban agglomerate or town with a monthly expenditure below Rs. 264.1 is defined as poor.

However, social indicators such as access to safe drinking water, sanitation and health care, housing facilities as well as mortality rates, life expectancy, nutrition levels and enrolment ratios for primary and secondary education are also considered as indicators of poverty. For the purpose of this study an appropriate definition is established in section *2.2.3*.

2.2.2 Extent of Urban Poverty

In the fifty years since Independence, India has achieved a fairly steady, albeit slow, reduction in the incidence of poverty. The official estimates of urban poverty based on consumption expenditure data as per the national Sample Survey, clearly indicate the declining trend of incidence of urban poverty in India. Percentage of urban population living below poverty line has decreased from 41% in 1972-73 to 20% in 1987-88. The Planning Commission of India has estimated a higher incidence of urban poverty. However, Planning

Commission estimates also indicate a declining trend – from 50% in 1973-74, the incidence of urban poor has decreased to 40% in 1987-88. Table *1.2a* shows the distribution of urban poverty across different parts of India.

Table 2.2a Distribution of urban poverty across states in India

States	Officially released estimates				Planning Commission	
	1972-73		1987-88		1987-88	
	Number (Lakhs)	Percentage	Number (Lakhs)	Percentage	Number (Lakhs	Percentage
Andhra Pradesh	38.5	43.8	42.6	26.1	72.8	44.6
Assam	4.9	33.8	2.5	9.4	4.6	17.3
Bihar	25.9	43.4	36.1	30.0	69.5	57.7
Gujarat	26.6	34.0	17.1	12.9	52.6	39.6
Haryana	5.6	29.9	4.7	11.7	7.2	17.8
Himachal Pradesh	0.3	12.5	0.1	2.4	0.3	6.2
Jammu & Kashmir	4.7	51.6	1.4	8.4	2.4	14.8
Karnataka	34.3	45.8	33.7	24.2	68.4	49.1
Kerala	19.2	52.7	11.6	19.3	26.0	43.4
Madhya Pradesh	32.5	44.8	30.9	21.3	70.0	48.2
Maharashtra	56.7	34.3	47.2	17.0	108.6	39.0
Orissa	8.5	43.3	11.9	24.1	19.9	44.1
Punjab	7.3	21.8	4.3	7.2	7.8	12.9
Rajasthan	18.8	39.3	19.0	19.4	38.2	39.0
Tamil Nadu	67.8	52.2	38.5	20.5	82.5	43.9
Uttar Pradesh	66.4	51.6	75.2	27.2	125.0	45.2
West Bengal	41.6	35.9	36.3	20.7	57.6	32.8
Small States & UTs			4.9	4.7		
All India	473.3	41.2	417.0	20.1	833.5	40.1

Source: Report of the Expert Group on Estimation of Proportion and Number of Poor (1993), Planning Commission.

More recent estimates by the World Bank show that 36% of the Indian population is under the poverty line . Of them 76 million people constitute the urban poor in India accounting for 36% of the urban population

Since most of the above statistics identify poverty in terms of per capita expenditure and do not take into account the access to minimally acceptable material requirements for fulfilment of human needs, the incidence of poverty is far higher than reflected by these figures. Inadequacy of these measurements of poverty is brought into sharp focus when the statistics on slum population are compared with the incidence of urban poverty.

2.2.3 Slums and the Urban Poor

There is a lack of secondary data on urban poverty below the state level which makes it difficult to identify the patterns in the nature and locational characteristics of urban poverty at the city / town level. However, incidence of urban poverty is generally considered to be high in slums and squatter settlements. Slum population as a proportion of urban population comes to about 26% (refer to Table *2.2b*). This population, as estimated in 1990, comes to 48.8 million. Almost three quarter of the total slum population in the twelve metropolitan cities in India live in the four largest cities: Calcutta, Mumbai, Delhi and Chennai. However, significant variations in the distribution of slum

population and urban poverty do indicate that not all those who reside in slums are poor as per the definition of poverty in India, and conversely, not all of the urban poor live in slums. *Table 1. 2* provides the variation in slum population and urban poverty incidence for the different states of India. From the table it can be inferred that in a number of cases, the slum population is lower than the incidence of urban poverty.

Characteristics of Urban Slums in India

- There are about 57000 slums in India, of which 37 % are notified ones.
- More than 65% of the slums have no access to hygienic and safe drinking water.
- 54% of the slums have no toilet facilities.
- 83% of the slums have no underground sewerage facility.
- About 77% of the slums do not have drainage facility.
- Garbage disposal facility is not available to 35% of urban slums.
- Seventy-five percent of the slums are reported to have access to electricity

Moreover, in the Class I cities such as Mumbai and Delhi, the cost of living is in general higher than in smaller cities and towns. Hence, most of the slum population in the Class I cities may not be defined as poor in terms of their income and expenditure levels, but they comprise the economically weakest section of the city, and hence are considered as poor for the purpose of our study. Moreover, in terms of the access to basic amenities that are required for minimally acceptable fulfilment of human needs *i.e.*, health & sanitation, drainage etc., the slum

The pavement dwellers and the homeless are not confined to a particular location in cities but are poorest among the urban poor. However because because of their dispersed location, there has been no systematic collection of data on their socio-economic profile and consumption patterns. The limitation of data on this section of urban poor also constraints this study.

Table 2.2b Slum Population and incidence of poverty across states in India

States	Percentage of poor	Percentage of Slum Population	Share in total poverty	Percentage of total urban poor	Degree of urbanisation (%)
Andhra Pradesh	26.1	33	8.2	10.2	26.8
Assam	9.4	20	2.2	0.6	11.1
Bihar	30.0	40	14.2	8.6	13.2
Gujarat	12.9	21	3.1	4.1	34.4
Haryana	11.7	18	0.8	1.1	24.8
Himachal Pradesh	2.4		0.2	0.0	8.7
Jammu & Kashmir	8.4		0.4	0.3	23.8
Karnataka	24.2		5.7	8.1	30.9
Kerala	19.3	16	2.1	2.8	26.4
Madhya Pradesh	21.3	10	9.5	7.4	23.2
Maharashtra	17.0	18	9.0	11.3	38.2
Orissa	24.1	35	5.7	2.8	13.4
Punjab	7.2	22	0.6	1.0	29.7
Rajasthan	19.4	27	4.2	4.6	22.9
Tamil Nadu	20.5	16	7.4	9.2	34.7
Uttar Pradesh	27.2	22	18.9	18.3	19.9
West Bengal	20.7	20	7.3	8.7	27.3
Small States & UTs	4.7	34	0.6	1.2	
All India	21.1	26	2376.7 (100)	417.0 (100)	25.7

Source: Planning Commisiion. 1993. Report of the Expert Group on Estimation of Proportion and Number of Poor .
Task Force Report on Housing and Urban Development, 1983

Census of India, 1991

3 ENERGY CONSUMPTION PATTERNS IN URBAN AREAS

This section first looks at the changes in the energy consumption patterns in the country, in both rural and urban areas, and then focuses on the urban poor. It traces the trends in consumption levels and consumption patterns of different fuels, commercial and non-commercial, the different end-uses for which energy is consumed by the urban poor, and highlights the key issues related to urban poor and energy provisions.

3.1 THE NATIONAL CONSUMPTION PATTERN

The last most comprehensive national survey of energy, specially domestic fuel, was conducted by the National Council of Applied Economic Research (NCAER), way back in 1985 in 18 major states and Delhi. Though the figures may be outdated, the trends that emerged in that survey are still valid today. The following were its main findings on national energy consumption patterns:

- The per capita and per household consumption of energy was less in the villages than in the towns.
- In terms of per capita consumption, the state of Delhi was the highest at 342 kgcr. The hill states of Himachal Padesh, Jammu and Kashmir and Meghalaya were next followed by Maharashtra.
- The lowest per capita consumption of energy was in Orissa, followed by Assam, Haryana, Tamil Nadu and Bihar in that order.
- A bulk of the non-commercial fuels consumed in the country were in villages, while two-thirds of the commercial energy consumed in the country was by urban households. 89.3% of rural households' energy was from non-commercial sources, while the corresponding figure for the urban areas was 43%
- Household energy consumption was positively correlated with income, for both rural and urban areas. The per capita energy consumption rose from 192 kgcr for annual household income of below Rs 3000 to 284 kgcr when the income was over Rs 18000.
- The relatively richer states of Delhi, Gujarat, Maharashtra and West Bengal met 40% of their energy consumption from commercial sources, while the poorer states like Orissa met more than 90% of its energy needs from non-commercial sources.

3.2 ENERGY CONSUMPTION PATTERN IN URBAN AREAS

The NCAER study (1985) showed that 43% of the urban energy needs were met by non-commercial sources. The National Sample Survey Organisation (NSSO) surveys also comes up with similar trends. While consumption of firewood and chips decreased between 1987-88 and 93-94, the consumption of

all the commercial fuels-LPG, Kerosene and electricity increased, with LPG recording the highest increase.

Table 3.2a Monthly per capita consumption by energy sources-Urban

All India	1987/88	1993/94	%change
Firewood & chips (kg)	7.40	6.09	-17.7%
Electricity (kWh)	7.18	9.67	34.6%
Kerosene (litre)	1.29	1.42	10.1%
LPG (kg)	0.39	.88	125.6%

Source: NSSO.1997. Energy Used by Indian Households. Report No: 404, New Delhi, NSSO, Department of Statistics, Government of India

3.2.1 End Uses of different fuel in urban households.

The Tata Energy Research Institute report on urban household energy in 1988 analysed the share of each end use in the consumption of different fuels in urban households. The analysis showed that 96% of LPG was being used for only cooking, while the use of kerosene, firewood, soft coke and dung cake was primarily divided between cooking (between 70-90%) and water heating and lighting. The exception was electricity, where only 1 % of the consumption was being used for cooking, and the primary uses were for lighting (34.7%) and space cooling (25.3%).

Table.3.2b End use of different fuels in urban households (%)

Fuel	Cooking	Water Heating	Lighting	Space cooling	Space Heating	Others	Total
Liquid Petroleum	96.3	3.7	-	-	-	-	100.0
Kerosene	71.2	20.6	8.2	-	-	-	100.0
Soft coke	90.7	9.2	-	-	-	-	100.0
Firewood	85.6	14.4	-	-	-	-	100.0
Dung Cake	82.1	17.9	-	-	-	-	100.0
Electricity	1.0	7.6	34.7	25.3	3.8	27.6	100.0

Sources: Tata Energy Research Institute (TERI). 1988. Report on Urban Household Energy Policy submitted to Advisory Board on Energy, Government of India, New Delhi:TERI
The Times Research Foundation (TRF). 1993. Managing Urban Environment in India: Towards an Agenda for Action, Chapter 13, Vol 3, pg 81, New Delh: TRF. K.C. Sivaramakrishna.

3.3 ENERGY CONSUMPTION PATTERN OF THE URBAN POOR

An analysis of the pattern of the energy used by different categories of income groups in urban areas reveals that while 66.1% of the lowest income category of urban households use non-commercial source of energy, like firewood, dung cake and vegetable waste, 84.7% of energy used by the highest income category comes from commercial sources, such as soft coke, LPG, electricity, kerosene and charcoal, and only 15 % from non-commercial sources.

Table 3.3a Pattern of Fuel Consumption by Income Group in Urban Households

Income Group (Rs.)	**Fuel Consumption**	
	Commercial	Non-commercial
Upto 3,000	33.9	66.1
3,001-6,000	55.0	45.0
6,001-12,000	69.9	30.1
12,001-18,000	77.1	22.9
Over 18,000	84.7	15.3
All	**56.9**	**43.1**

Source: NCAER.1985. Domestic Fuel Survey with Special Reference to Kerosene, Vol 1, New Delhi:

3.3.1 Consumption of different fuels

According to the NCAER study, 54.9% of the lowest income group urban household dependent on firewood for fuel, and this percentage decreased with rise in income. The highest income category (over Rs 18,000 per annum) had 13.9% households using firewood as the source of fuel. The use of LPG and electricity as fuel was virtually non-existent in poor urban households, and only 19.4 % of poor households used kerosene. The higher income categories showed a significant increase in use of LPG, with over 41 % of household using LPG.

The NCAER study also shows the consumption patterns of fuel of households in different income categories , and trends remain valid in the 90's, as is evident from the following:

Commercial fuel consumption

- Electricity: The per capita annual consumption of electricity rose from 12.1 kwh for the lowest income category to 107.9 kwh for the highest income category in . Percentage users of electricity rose to 31.8% for the lowest income category and to 97.6 % for the highest.

- LPG: Only 1% of the poorest households used LPG. This percentage rose to 56.3% in the highest income category. The unequal per capita consumption is clearly visible, which was 0.3 kg among the lowest income households and 11.1 kg in the income category of more than Rs 18,000 annually. The lower per capita figures are due to the fact that both consuming and non-consuming populations have been taken together as the denominator.

- Kerosene: Kerosene undoubtedly emerged as the most used fuel, specially by the poor. Among .2% of the lowest income category, 91.2% used kerosene and this figure gradually dipped to 78.3 % for the comparatively better off amongst the poor. The intensity of use of kerosene was not uniform . The overall annual average was 38 litres, though two-third

household had an average consumption below this level. On the other hand 1.3% households had an annual consumption of over 250 litres.

Non-commercial fuel consumption:

- Fuelwood: Fuelwood consists essentially of logs and twigs. The urban poor consumed more logs than the richer households. The annual urban household consumption of logs was 547 kg for the lowest income category , while it was 282 kg for the highest income category. The percent share in total energy consumed also fell from 41. 7% for the poorest households, to 8.4% for the richest households. A similar trend was evident for twigs.

- Dung cake: The poorest households had an annual per capita consumption of 38 kg, i.e., only 22 kg in the highest income category. Similarly, the percentage share of dung cake in the total energy use of the poor was 5.1% and only 1.9 for the richest households.

The TERI report on urban household energy in 1988 also brought the annual per capita consumption of different fuels for different income categories, and the share of each fuel source. Firewood comprised more than 50% of the annual per capita fuel consumed by the lowest income categories, followed by kerosene. The share of both firewood and kerosene sharply declines with increase in household income, and gets replaced by LPG, and electricity. In fact electricity consumption comprises more than 60% of the annual per capita fuel consumption by highest income households. Soft coke shows an initial rising trend, after which it also declines. Dung cake shows a similar trend as firewood and kerosene, of decline in use with rising incomes.

Table.3.3b Annual per capita consumption (in million joules) of fuels in urban households of different income categories.

Annual HH Income (Rs)	**LPG**	**Kerosene**	**Soft Coke**	**Firewood**	**Dung cake**	**Elect-ricity**	**Gross**	**Useful**	**Effi-ciency**
<500	227 (5.2)	675 (15.3)	134 (3.0)	2552 (57.8)	419 (9.5)	405 (9.2)	4412	1313	30
500-1000	553 (12.4)	715 (15.9)	286 (6.4)	2249 (50.3)	211 (4.7)	460 (10.3)	4474	1547	35
1000-1500	828 (17.9)	642 (13.9)	413 (8.9)	1801 (38.9)	275 (5.9)	669 (14.5)	4628	1855	40
1500-3000	1370 (35.7)	474 (12.4)	118 (3.1)	653 (17)	24 (0.6)	1196 (31.2)	3835	2373	62
3000-4500	1970 (46.7)	193 (4.6)	18 (.4)	219 (5.2)	5 (0.1)	1817 (43)	4222	3130	74
4500-6000	2113 (43.6)	182 (3.8)	20 (0.4)	281 (5.8)	177 (3.6)	2071 (42.8)	4844	3494	72
> 6000	2111 (35.1)	120 (2.0)	- -	149 (2.5)	- -	3635 (60.4)	6015	4982	83
ALL	**1285 (29.8)**	**469 ((10.9)**	**166 (3.8)**	**1041 (24.2)**	**115 (2.7)**	**1235 (28.6)**	**4311 (100)**	**2433 -**	**56 -**

Sources: Tata Energy Research Institute (TERI). 1988. Report on Urban Household Energy Policy submitted to Advisory Board on Energy, Government of India, New Delhi: TERI

The table also throws light on the fact that the poor households use less efficient sources of fuels, primarily non-commercial, while the rich have access to more efficient sources of fuel. The efficiency level rises from 30% for the lowest income category, to 83% for the highest income category.

3.3.2 Energy Consumption for different end-uses for the urban poor

The study done by TERI in 1988 showed that more than 75% of the energy consumed by the lowest income category is for cooking purposes and the remaining amount on activities such as water heating, space cooling, lighting and others. As income increases, the percentage of energy used for the purposes of heating, cooling and lighting increases, and the percentage share of energy used in cooking drops to 36.7%.

Table.3.3c Energy Consumption (in % share) for different end-uses in urban households of different income categories.

Annual Household Oncome (Rs)	Cooking	Water Heating	Space heating	Space cooling	Lighting	Others	All Uses
Upto 500	78.9	9.8	-	2.6	6.3	2.4	100.0
500-1000	78.5	9.1	0.1	3.0	6.1	3.2	100.0
1000-1500	72.7	10.4	0.4	4.4	7.4	4.7	100.0
1500-3000	61.3	7.9	0.8	7.9	12.4	9.7	100.0
3000-4500	52.2	8.5	1.3	12.1	13.7	12.2	100.0
4500-6000	50.9	11.7	1.6	11.1	13.9	10.8	100.0
Over 6000	36.7	13.5	6.3	12.0	19.8	11.7	100.0
All Categories	62.1	9.7	1.1	7.5	11.3	8.3	100.0

Sources: Tata Energy Research Institute (TERI). 1988. Report on Urban Household Energy Policy submitted to Advisory Board on Energy, Government of India, New Delhi: TERI pg 64
The Times Research Foundation (TRF). 1993. Managing Urban Environment in India: Towards an Agenda for Action, Chapter 13, Vol 3, pg 81, New Delh: TRF. K.C. Sivaramakrishna. P 166

3.4 CONCLUSIONS

This section provides evidence that

- The urban poor still depend quite substantially on traditional fuels, such as firewood and dung-cake to fulfil their energy needs. The price of firewood has increased dramatically in the last ten years. Thus the poor pay a much higher price per equivalent unit of energy than the rich.

- The other available commercial sources of energy to poor mainly consist of kerosene and coal, which are inefficient sources of energy compared to the LPG and electricity, which are mainly available to the richer urban population, and

- The major use of energy for the urban poor is essentially for survival, that is for cooking.

It is essentially concluded that given a choice, the urban poor are unlikely to choose the most efficient and more expensive forms of energy and that too mainly to ensure their survival. Clearly, the unavailability and their ability or inability to access other forms of energy must play a role in making such choices. The question of access of urban poor to various forms of energy is explored in the next section.

4 ACCESS TO ENERGY FOR THE URBAN POOR

While patterns of energy use by the urban households, and the urban poor, has been researched and documented, the whole issue of access to energy has been hereto neglected by researchers and policy analysts. The present energy consumption of the urban poor may have more to do with the availability of, and the poor peoples' access to, different energy sources, than to do with their preferences of different sources. Hence access to energy becomes an important research and policy question.

The NCAER study looks at two aspects of access:

- The purchase versus collection of fuel
- The reasons for the current choice of fuel.

4.1 PURCHASE VERSUS COLLECTION

In both rural and urban area, practically all the commercial fuel was purchased, with the exception of coal and soft coke. On the other hand, the study concludes that nearly three-fourths of the non-commercial fuels consumed was collected. While the pattern was same for urban and rural areas in terms of purchase of commercial fuels, there was wide divergence on the issue of non-commercial fuel. While in the rural areas, 89% of the non-commercial fuel was collected, in urban areas only 16.4 % was collected. This would be explained by the fact that the non-commercial fuels like firewood, and dungcake were not available easily in urban area. The former is dependent on the fast depleting tree cover and green belts in cities, and dungcake is difficult to collect as livestock in cities cannot be kept in sheds etc. because of lack of space, and are therefore left to roam about freely. Hence in urban areas, even fuelwood and dung cake are being purchased at substantially high prices (firewood @ Rs. 3-4 per kg.) and their access is limited.

4.2 FUEL PREFERENCES

The following qualities were considered important by households while choosing a fuel :

- Convenience
- Easy ignition
- Cleanliness and less time to cook
- Hygienic conditions and tasty food preparation
- Non-smoky and
- Easy to store

However, the NCAER survey found out that these qualities were compromised before the consideration of easy availability and price. A large number of households were in fact using fuels they actually did not prefer. This was particularly true in the case of kerosene (70%), dung cake and crop wastes. About 15.2 % households could not use the fuel they preferred. In urban areas, 79 % of the households preferred LPG. followed by kerosene (8%).

The major reasons for not using LPG, the preferred fuel was price as well as the non-availability. Even households in the highest income category, for whom the price was not a constraint, reported non-availability of LPG as the major constraint.

Table.4.2 Distribution of Households preferring LPG and Kerosene by reasons for not using the preferred fuel for cooking (per cent)

Annual	LPG			Kerosene		
Income (rs)	Costly	Not easily available	Others	Costly	Not easily available	Others
< 3,000	27.31	70.25	2.45	66.12	33.88	-
3,001-6,000	23.36	73.28	3.37	68.63	31.47	-
6,001-12,000	11.14	81.04	7.82	72.81	25.33	1.85
12000-18000	9.60	84.08	6.32	65.10	24.13	10.76
>18,000	6.15	91.76	2.09	100.00	-	-

Source: NCAER.1985. Domestic Fuel Survey with Special Reference to Kerosene, Vol 1, New Delhi

Access to various energy source therefore is a vital factor which governs the present use pattern, specially for the urban poor. As there is hardly any recent study that tries to understand this all important issue, ERM decided to conduct a household survey of slum areas in the city of Delhi to specifically look at the access to various energy sources for the urban poor.

4.3 *CASE STUDY 1: A CASE OF THE DELHI SLUMS*

4.3.1 Objective of the study

The case study of slums in Delhi was undertaken to analyse the following issues:

- Different sources and end uses of energy among the poor living in slums and squatter settlements *in* Delhi.
- Availability, access to, and cost of different sources of energy.
- Availability, cost and end uses of electricity
- Formal / informal institutional arrangements for supply and maintenance of electricity
- Policy implications of Government policies regarding slums and their electrification, as well as energy options

As a part of this study on the access of energy for the urban poor, and within the framework of the Terms of Reference, the case study focuses on:

-a particular section of low income urban population, i.e. slum dwellers
-a particular policy or strategy- of the government not providing electricity to slums, and illegal colonies and
-different types of ownership and management in the supply of electricity

For the case study and selection of household for the primary survey, ERM decided to focus on urban slums in Delhi. As slums have a very high incidence of poverty, ERM believes that the case study would reflect the macro picture of the urban poor and their access to energy.

4.3.2 Case Study Setting: An overview of Delhi Slums

Status of slum and unauthorised colonies in Delhi

Squatter population has grown from 12,749 families in 1951 to 98,438 families in 1973. After a massive resettlement of 1.5 lakh families in 1975-77, the number of families significantly dropped to 20,000. However, with increased construction activity in the city, mainly because of infrastructure being built for the Asian Games held in 1983, there was yet again a big influx of migrant population, and number of squatter population again rose sharply.(Delhi Development Authority, 1985)

Beside slums, there are 612 unauthorised colonies, and resettlement colonies that also face problems of lack of basic amenities and services, as well as unhygienic living conditions. Nearly 4.7 million people live in all the above sub-standard areas in Delhi, and constitute nearly 50% of the total population of Delhi. These are also the areas with highest incidence of poverty. It must however be noted that not all people residing in these sub-standard areas are poor, within the conventional definitions. Slums and squatter settlements were specifically chosen for the case study, as they have perhaps the maximum concentration of poor living in them, and most truly reflect the problems faced by the urban poor in accessing and using energy.

Table.4.3a Population of slum and other substandard areas of Delhi

Type of settlement	Population (in millions)
Jhuggi jhopri clusters	1.2
Slum designated areas	1.8
Resettlement colonies	1.2
Unauthorised colonies	.5
TOTAL	4.7

Source: Tata Energy Research Institute, 1993. Study of the Energy Needs of Slum Areas of Delhi.

The growth of slums coincides with the recent growth of Delhi. As the capital city and a centre of growing work opportunities, Delhi has grown phenomenally over the last 2-3 decades. The 1991 census puts the population

of Delhi at 9.37 million, and at the present growth rate, the urban population of Delhi could be projected at 14.43 million by the year 2001.Added to this would be a rural-urban fringe population of nearly half a million. (Tata Energy Research Institute, 1993)

A major reason for this growth has been the continuous influx of migrant populations, especially from rural areas. For these migrants, Delhi offers increasing opportunities of employment, specialisation, and scope for formal/informal support services. Not surprisingly, Delhi faces acute shortage of land, housing, transportation and provisions of basic amenities and services. Unable to find housing facilities commensurate with their low income levels, these migrants are forced to settle down (squat) on unused plots of land, preferably close to their place of work. These cluster of settlement are locally called *jhuggi jhopri* and are characterised by temporary living structures made of straw, mud, loose bricks, tin, wood, corrugated sheets, without a regular foundation. Ten or more jhuggis in close proximity are identified as *jhuggi jhopri* (JJ) clusters. With the Government unable to provide the growing demand for basic amenities, many of these settlements grow into permanent slums. Studies have shown that growth rate of squatter households in Delhi was much higher than the growth rate of Delhi as a whole (11.8% as compared to 4.5 % between 1950-70)

Occupational status of slum dwellers and squatters

According to Socio-economic Survey Division, Slum and JJ Department, Municipal Corporation of Delhi, 1997-98, a major proportion of slum dwellers work as labourers, dependent on daily wages. Rag picking is another common occupation, while skilled and semi-skilled workers constitute a small percentage.

Table4.3b Occupational Profile of Slum Dwellers

Occupation	Percentage
Government Service	3.64
Private Service	16.42
Labour	32.66
Rag-pickers	26.73
Skilled workers	8.71
Self employed	6.68
Others	5.16

Source: Socio-economic Survey Division, Slum and JJ Department, Municipal Corporation of Delhi, 1997-98.

Income Profile of the slum Dwellers

Slum population reflects a wide disparity in incomes. While nearly 75% of the people have income less than Rs.1500 per month, or Rs. 18,000 annually, some slum dwellers earn more than Rs. 42,000 annually, and cannot be called poor on the basis of their income. This disparity of income is again reflected in the household survey conducted by ERM. Notwithstanding income levels, the

conditions in which the slum dwellers reside, without access to even basic amenities like regular water, drainage and sanitation or electricity, and very poor environmental conditons, nearly all the people can be categorised as poor as far as living conditions are concerned.

Table.4.3c Income distribution of slum dwellers

Income Group (Rs. per month)	Percentage of slum population
0 – 500	0.17
501 – 1000	15.48
1001 – 1500	59.81
1501 – 2000	19.71
2001 – 2500	3.64
2501 – 3000	0.59
3001 – 3500	0.43
> 3500	0.17

Source: Socio-economic Survey Division, Slum and JJ Department, Municipal Corporation of Delhi, 1997-98.

Government Policy on Slum Improvement and Regularisation

Till the 1980's the only notified slum in Delhi was Shahjahanabad in the walled city of Old Delhi. The others remained slum areas with no legal recognition. However, in the late 80's and early 90's, there was a concerted effort by the Delhi Government to regularise, and legally notify selected slums, largely due to political pressures. Presently about 100 slums have been notified and process of notification of several others is on. (S D Sehgal, 1998). Notification gives slum dwellers the right to have:
-a ration card and access to the public distribution system
-Government water supply and sewerage
-access to subsidised public health care systems
- eligibility for electricity connection
However, in many cases, these rights exist on paper only. Water supply is limited and environmental and sanitation conditions in slums remain extremely poor.

Resettlement of Slums

Simultaneously, the Government is also trying to relocate and resettle slums from congested heartland of the city to the peripheral areas, or in areas earmarked as slum areas. The Government, under the Slum Areas (Improvement and Clearance) Rules, 1957, provides alternate location, compensation to meet the cost of rebuilding the houses and transportation of goods, as well as basic amenities. However, the process has met with resistance as relocation sites are far away from sources of work, and little or no provisions are made to ensure occupational rehabilitation.

Energy Consumption Patterns in Delhi slums

According to a slum level survey conducted by Tata Energy Research Institute (TERI), energy consumption from nearly all the sources increases with income levels.

Table.4.3d Average household monthly energy consumption in Slum Areas of Delhi (In '000 kCals)

Income Categories	ck	Cf	Cd	ce	cc	Te
< 750	137.7	76.6	22.26	11.08	3.1	250.84
750-1500	155.4	111.4	30.6	14.9	3.7	316.06
1500-2250	184.6	147.5	35.02	19.54	7.06	393.72
>2250	199.6	122.62	32.6	21.88	8.56	385.18

Note: ck-Calorific value of kerosene used
cf-Calorific value of dungcake used
ce-Calorific value of electricity used
cc-Calorific value of coal used
te-Total energy used

Source: Tata Energy Research Institute . 1993. Study of the Energy Needs of Slum Areas of Delhi

While consumption of all sources understandably increases with income, the exception remains dungcake, where consumption reduces in the highest income groups. This could be explained by the fact that dung is considered an inferior fuel, and gets substituted by kerosene with rising income levels. Another surprising factor is the drop in the total energy consumption in the above Rs. 2250 range. The plausible explanation could be that with increasing income, people have shifted to more efficient forms of energy, and hence total energy consumed is lower than in the previous income category.

4.4 METHODOLOGY OF THE STUDY

As income disparities within the various slums and unauthorised colonies were wide, ERM decided to focus on notified jhuggi-jhopri clusters. These slums were supposed to have the basic amenities to be provided to notified slums, including electricity. A sample of households from two unauthorised colonies was also taken, which did not have any legal access to electricity. The objective was to analyse the issues in energy source and use patterns in both regularised and unauthorised colonies, with a special focus on impact of electrification, or lack of it.

4.4.1 Site Selection

The total list of notified slums and JJ Clusters were taken from the Slum and JJ Department of the Municipal Corporation of Delhi. According to the existing records, there were approximately 1000 JJ clusters, distributed among 5 zones in Delhi. The ERM survey team visited one site in Sangam Vihar to identify the range of issues related to energy, and a questionnaire was prepared on the basis of the issues identified. A total of 8 clusters and two unauthorised colonies were selected from 3 geographical zones for the household survey. 58 households were surveyed by a simple random sample method.

Table.4.4a Zonewise Distribution and sample size of selected sites

Zone	Name of cluster/colony	Sample Size (No of H.H)
North Zone	• JJ Camp Pratapbagh, Kingsway Camp	10
	• JJ Camp, AM Block, Shalimar Bagh	10
South Zone	• Indira Camp, Okhla	3
	• Baba Bhureshah Camp, Nizammudin East	7
	• Jagdamba Camp, Sheikh Sarai Phase 1	8
	• JJ Camp, Panchsheel Park	4
	• Masood Slum, Vasant Vihar	4
Central Zone Unauthorised colonies (South Delhi)	• Harijan Camp, Meherchand Market, Lodi Colony	6
	• Govindpuri	3
	• Sangam Vihar	3
TOTAL		**58**

4.4.2 Limitations of the data:

There are some limitations in the data collected, which need to be understood before proceeding with the analysis:

- The answers to specific questions on the price of fuel used, and proportion of income spent on it were speculative, and often not very reliable. The prevailing market costs quoted by respondents varied even within clusters. The team has tried to standardise data for some comparability.
- Respondents were hesitant, and very often reluctant to disclose their family income. The surveyors have tried to make a correct estimate on the basis of their occupation, and other sources of income.
- The respondents were unable to give precise answers for the end uses of different energy source. For example they were unable to accurately estimate the proportion of kerosene used for cooking, heating or any other purpose.

4.5 ANALYSIS

4.5.1 Profile of the slums

Most of the people living in the selected slums were immigrants from the neighbouring states of Uttar Pradesh, Madhya Pradesh, Haryana, and Bihar. A majority earned their living as daily wage labourers, and slums were located close to their places of work. There was a marked variance in the monthly income of the households. While a majority were poor, with an income less than Rs. 3,000 per month, with large families, a sizeable number were earning more than Rs. 5,000. However, as discussed in section 1.2.3, the

very poor living conditions in which even the higher income group lives, puts them in category of poor urban dwellers. Average family size is large, with 74% of the households having more than 5 members in their family and 54% with only one earning member.

Table.4.5a Income distribution of slum dwellers

Income categories (Monthly income of HH in Rs)	Average Family Size	Percentage Households
Less than 1,000	5-6 members	8.6%
1,001 to 3,000	6-7 members	50%
3,001-5,000	5members	25.9%
More than 5,000	10-11 members	15.5%

4.5.2 Energy Consumption Patterns

Among the households surveyed, kerosene emerged as the most popular source of energy, mostly used for cooking purposes, and also for lighting purposes in case of power cuts. Fuelwood, sawdust, dung cake and sometimes coal were used as supplementary sources of energy for both cooking and heating purposes. Though electricity was available in all the clusters visited, households did not have legal connections, and were merely hooking on to street lighting connections. Hooking is a common practise in areas where households do not have legal electricity supply. Households buy their own wires, make a loop or hook at the end, and attach that hook to the low tension wires running over their houses for street lighting. Electricity thus accessed, it connected to a switch board in the houses and used for various purposes. Meters had not been installed in any of the houses. All the households possessed at least two electric gadgets, mainly for lighting (bulbs and tubelights) and cooling (fans and coolers) purposes. An analysis of the end-use energy consumption pattern is given below.

Table.4.5b Income wise distribution of use of different energy sources

Income categories	Energy sources used (% household)				
	Kerosene	Wood/Saw dust	Dung Cake	LPG	Electricity
< 1000	80%			20%	100%
1001-3000	93%	55%	7%	10.3%	100%
3001-5000	93.3%	60%	6.7%	6.7%	100%
> 5001	88.9%	100%	11%	11%	100%

4.5.3 Kerosene

89% of the total households used kerosene, either as the only source, or in combination with supplementary sources of wood, cow-dung, or LPG, for cooking purposes. As mentioned before, even though none of the households had legal electricity connections, all of them managed to use electricity either through hooking on to street light connections, or through generator sets.

Hence kerosene was used for lighting purposes only during the very frequent power cuts. Commonly used gadgets for lighting are earthen lamps or *diyas,* lanterns, wick lamps etc.

The popularity of kerosene for cooking purposes cuts across the income disparities. While majority of the low income households used only Kerosene, and wood to supplement if needed, the higher income households used a greater variety of energy sources, including wood, saw dust, LPG and dung cake. There were specific reasons that encouraged this diverse use of energy sources. For one, both kerosene and LPG were not reliable sources because the availability is severely constrained. There are also cultural reasons for this diversity. For example, while people cooked vegetable, rice etc. on the kerosene stove, they used wood based *chulhas,* or earthen stoves, to cook their *roties (*bread).

Access to Kerosene

As more than 70% of the respondents had ration cards, they depended on the Public Distribution System (PDS) to get their kerosene supply. The PDS is a government programme to supply essential commodities to the poor at a subsidised price. People are entitled to access the PDS through a ration card, which has the names of the household members, and the residential address. The Government rates of kerosene are highly subsidised, but the amount of kerosene allowed on each ration card is limited to 12 litres per family per month. 50% of the respondents had to buy kerosene from the open market, to supplement their ration supply of 12 litres. The market price at Rs.10 a litre is nearly one and half times the PDS price, and households brought between 2-6 litres at that price every month. Households with large families needed to buy more than 10 litres every month from the open market. There were also a number of families that could not get their due quantity of 12 litres from the PDS, mainly because of frequent shortage in kerosene supply. These people are dependent on wood as their primary source of fuel for cooking.

Table.4.5c Average Monthly Household Kerosene Consumption

Income Categories (Rs.)	Amount of Kerosene (in litres)
< 1000	16
1001-3000	13
3001-5000	16
> 5001	19

The amount of kerosene used by the lowest income category is high because kerosene is the only source of fuel for 80% of the households. On the other hand, higher income group categories use more kerosene as well as other sources.

4.5.4 Wood

Wood emerged as the next popular source of cooking, and heating. Approximately 53% of the households used wood either as the only source or as a supplementary source for cooking and heating. Most of the times, fuel

wood was collected from nearby green belts, or from forests in the Delhi Ridge areas, though at the risk of being caught and fined. Delhi Ridge is a protected forest, and collection of fuelwood or any other Minor Forest Produce is disallowed. Where not freely available, people are forced to buy wood from the open market, at price varying between Rs.3-4 per kilogram. On an average, households buying wood from the open market, spent anywhere between Rs. 70 to Rs 175 every month.

Households in the Indira Camp in Okhla used saw dust, mixed with wood chips, for cooking. This saw dust was freely available because of the proximity to furniture and packaging factories, where saw dust was thrown out as a waste product.

4.5.5 Liquid Petroleum Gas (LPG)

LPG usage is limited among the urban poor, with only 10% of the household having LPG connections. This was largely because the difficulty in getting an LPG connection, and the substantial initial deposit of Rs.3000 that need to be given for a government licensed connection. While gas connections could be brought in the informal / open market with a deposit of Rs. 2200, the cylinder costs were higher at Rs.150 as compared to Rs. 136 from the government supply. However the few households using LPG were of the opinion that it was not only a cheaper cooking fuel, as compared to kerosene and wood, but also cleaner, and much more convenient. On an average, 1 to 1.5 cylinders were sufficient for all the cooking in a month.

4.5.6 Electricity

All the households had access to electricity, even though none of them had legal electricity connections. A common site in all the clusters would be hundreds of wires, emanating from different dwellings, hooked on to the nearest electric pole (please see the photograph). People have tied different coloured threads, ribbons, and cloth pieces to identify their own wires. The load on the overhead wires and the electric poles, is therefore tremendous. None of the households were paying the Government anything for the consumption of electricity. People living in unauthorised colonies did not have access to overhead electric cables, and were dependent on getting supply from generators sets operated by enterprising neighbours.

End Uses of electricity

Households were operating different kinds of electric gadgets, including necessities like bulbs, fans, as well as other items like coolers, television sets, refrigerators, music systems, video games etc. On an average 3 to 5 electric gadgets were being used by the households.

Table.4.5d End Uses of Electricity

Income categories	**End use of electricity (% of households)**		
	Lighting	**Heating/cooling**	**Entertainment**
< 1000	100	100	40

		End use of electricity (% of households)	
1001-3000	100	100	51
3001-5000	100	100	73
> 5001	100	100	78

Note:
Lighting includes bulbs, mercury lamps and table lamps.
Heating/cooling includes fans, coolers and heaters
Entertainment includes television sets, stereo systems, VCRs and video games.

None of the respondents admitted to using heaters for cooking purposes, even though electricity was available, at relatively little or no cost. The reason cited for not using heaters was that the load exerted by heaters often led to the fuse in the nearby transformers being blown off, creating problems for the whole cluster. It was therefore often a community decision not to use heaters, unless absolutely necessary. However, people did complain that many of their neighbours used heaters for cooking.

Cost of electricity.

As none of the houses had meters provided by the Government, no one received any bills for the use of electricity. However in places, some informal systems have been set up within clusters, with one or two people taking the responsibility of installing wires on to the electric cables (hooking) and of maintaining and repairing whenever necessary. Each household paid anywhere between Rs. 25-50 per month as maintenance cost to these middlemen. In other places, families had set up their own wires, and only paid a paltry amount of Rs5-10 for maintenance to local electricians.

Table.4.5e Amount paid to middlemen for illegal electricity connections

Amount paid (in Rs.)	Percentage household
Nil	55%
20-50	40%
Above 50	5%

Most households were willing to pay more, if that ensures them a regular, and legal electricity supply. This was evident by the fact that 41% of respondents had deposited Rs 360 with the Delhi Electricity Supply Undertaking (DESU) to get a meter installed in their homes. Out of these households, 50% were from the low income categories. With a meter, the cost of electricity would obviously increase, but respondents were willing to pay more, and cut down on their consumption of electricity. However, it has been two years since the DESU announced its intention to install meters and give electricity supply to slum areas, but beyond accepting initial deposits, there has been no move yet to fulfil the promises made.

4.6 POLICY IMPLICATIONS

The poor use a variety of sources of energy for cooking, heating, cooling and even entertainment. They face severe hardships because of high costs of

efficient energy sources, and inaccessibility or insufficient availability of cheap sources of energy. This case study shows that there were basically two categories of energy sources:

- Government controlled sources like Electricity (DESU), Kerosene (PDS) and LPG (Public Sector Organisations)
- Sources available in the open market or collected , like firewood, dungcake, coal, saw dust etc.

Government sources are severely limited, and have a tedious process for access. Sources available in the open market are relatively expensive. From the survey, it was clear that the highest cost of energy use was borne by the poorest people, and that the sources they relied on, through collection and open market, are not only expensive, but also more inefficient. They are also fast depleting resources, as in the case of firewood.

A striking feature, with serious policy implications, was that the Government policy was to supply a public utility service only to those people or households which have a legal living structure. The basic question that emerges is that should any public utility be available only to households having a legal living structure, or should it be available for all those who are willing to pay for it. From the case study it is clear that the poor are willing to pay more for better access to energy sources. An absence of a proper Government policy on this issue leads to:

- theft, as is happening with electricity in slum areas
- a growing black market as for LPG or kerosene, where the beneficiaries are unscrupless middlemen, who fleece the poor. In the process the Government also loses precious revenue that is due to it for usage of these public utilities.

5 ENERGY OPTIONS FOR THE URBAN POOR

One possible option for redeeming the anomalous situation of the urban poor paying higher price for inefficient energy sources is to bring about a policy change. There is no reason why the legality of a living structure should be a criterion for accessing utilities, specially when the urban poor are willing to pay for it. The whole question of legality of slums itself is ambiguous, as is proven by the fact that several slum colonies have been regularised over the years. It is however clear that the required policy reforms will take a long time to come. In the meanwhile, are there any options which will facilitate access to energy sources for the urban poor?

5.1 RENEWABLE ENERGY TECHNOLOGIES

One possible option is to look at the probable use of Renewable Energy Technologies (RET), which has received considerable attention from the Government of India. The RETs consist of energy through renewable sources of wind, biomass, solar, water (small hydro and tidal), ocean (thermal and wave power) and geothermal. In India, Renewable Energy Programme was started in 1982 with the establishment of the Department of Non-Conventional Energy Sources (DNES), which became a full-fledged and independent Ministry of Non-Conventional Energy Sources (MNES) in 1990. In 1992, MNES adopted a comprehensive strategy and action plan for promoting RETs in India. Together with the Indian Renewable energy Development Agency Ltd. (IREDA), a financing body for RETs, the thrust of the MNES strategy shifted from State supported development and demonstration programme to market oriented commercialisation of technologies by involving the private sector. Despite these promotional measures, the RETs contribute only 1% (1100 MW) to the total electricity generation in the country and are only a minuscule portion of the estimated potential of 126,000 MW of energy through renewable sources. The major constraints in promotion of RETs identified in a study are summarised in the table.

Table 5.1 Constraints of RETs

Nature	Constraints
Institutional	• Little encouragement received from the State Electricity Boards (SEBs) • A top-down centralised government approach for this highly decentralised option • Lack of awareness on advantages and techno-economics of RETs • Lack of serious education and training for operation and upkeep mis-utilisation of incentives, which are related to investment rather than performance of plants

Nature	Constraints
Financial	• Diesel and electricity are highly subsidised for use by agricultural and domestic consumers • The funds allocated to rene2wable energy sector is minimal when compared to fossil fuel and nuclear energy options • High initial investment as compared to conventional energy
Technological	• For optimal utilisation it is necessary to define resource by determining the site and energy availability of each site • Most RETs have not gained maturity within the country and a large proportion is imported • Renewable energy sources are site specific and the supply is not continuous • Technical information is not easily available either for the entrepreneur or the consumer
Infrastructural	• Land requirement of RETs is considerably high • Poor grid availability proves to be a major deterrent • Lack of proper maintenance and servicing facili9ties at the local level

Certain efforts have been made by NGOs and private sector to overcome these constraints by using innovative institutional mechanisms for decentralised applications. These decentralised institutional mechanisms may have a relevance / hope for the urban poor. The two case studies presented in this section provide the details of these approaches.

5.2 CASE STUDY 2: DECENTRALIZED ENERGY SYSTEMS INDIA (DESI) PVT. LTD.

5.2.1 Focus Area for the Case Study

The DESI Power study is an important case study in the context of identifying key issues regarding the question of energy access for the poor urban communities. What makes it especially relevant in this context, is its focus on the following issues:

- Application of a decentralised non-conventional power generation technology.
- Different types of ownership and management in the supply chain
- Community participation in the energy supply project

Although several Renewable Energy (RE) technologies such as Wind, Micro-hydro have been proven to be commercially viable in niche application sectors, Bio-energy has not yet been demonstrated at a commercially meaningful scale. DESI Power Orchha project is the first attempt at utilising local bio-energy resource for electrification using a model which is commercially viable and environmentally sustainable.

The project introduces an innovative institutional arrangement for decentralised generation and supply of reliable electricity to a small community using bio-energy technology. The institution arrangement is called Independent Rural Power Producers (IRPP) which are similar to Independent Power Producers (IPPs) now being established in the centralised power and industrial sectors.

Although termed Independent Rural Power Producers, commercial IRPPs are suitable for operations in small urban centres such as the slum dwellings, micro- enterprises and isolated unauthorised communities, for electrification as well as cooking fuel needs. It is a framework designed to cater to small decentralised loads and is, therefore, more accessible to those who need reliable and good quality power.

The model at DESI Power Orchha is the first of its kind which adequately addresses all technical, legal, socio-economic, managerial, operational and financial aspects of setting-up a project of this kind. Established at a semi urban commercial centre, it provides an example of institutional linkages between all the stakeholders viz.;

- Investors which are primarily in the private sector
- Owners and operators of the power plant
- Beneficiaries and users of power
- Government and statutory authorities such as the SEB
- Local community involved in resource management
- Financing institutions and providers of Green Fund
- Technology providers and equipment suppliers

DESI Power has shown that the profit oriented entrepreneur approach is the probable answer to the question of sustenance of such projects. The project has strongly indicated the requirement of a set-up needed to take the entire techno-commercial package to its end-user in a form which not only provides a single window for all services required to plan, set-up, run and maintain the project, but it also links the technology intervention to monetary or personal benefits. Following the Orchha example, similar setups can successfully be established on a large scale with duel objectives of sustainable development and commercial viability.

5.2.2 Case Study Setting

The Community

Orchha, 19 km from Jhansi in Uttar Pradesh is a famous spot on the tourist map of Madhya Pradesh. Half way between Jhansi and Orchcha lies TARAGram, which is a centre set up by TARA of New Delhi for promoting commercial activities using appropriate technologies. In this centre, hand made paper and low cost building materials are manufactured by employing the local people. The centre is planning to have a mini Industrial Training Institute (ITI) which would be a residential institute to impart skills to local youth on TARA technologies.

Till recently, TARAGram did not have an access to Madhya Pradesh Electricity Board (MPEB) grid supply and hence there was a need for electric supply system to meet the base load for machinery, lighting, fans etc., The total connected load of the site is of the order of 140 kW. Currently, the centre has a 100 kW Biomass gasifier based power plant, in addition to the MPEB connection with 120 hp connected load. The gasifier system takes care of the a few specific machines requiring high starting current as well as it serves as a back up for MPEB supply.

The Technology

DESI Power is currently concentrating on biomass gasifier technology which uses non-forestry weeds or agricultural residue as feedstock. In this technology, biomass is burnt in a partial supply of oxygen to generate a combustible gas called producer gas, which is mostly a mixture of carbon monoxide and hydrogen. This gas is cooled and cleaned before being fed into a modified diesel engine which runs on a mixture of producer gas and diesel resulting in a saving of upto 80% of the diesel oil required by a normal engine. The engine is connected to a generator that produces electricity. The waste heat from the engine can be used as process heat for drying, heating, or boiling, or for running air-conditioning or cold storage plants. At TARAGram, a local weed called Ipomea is used as the feedstock.

Institutional Framework and Project Model

Decentralised Energy Systems India (DESI) Power Pvt. Ltd. is a collaboration between TARA, New Delhi and DASAG of Switzerland and is registered under the Companies Act 1956 as a private limited company. One of its main objectives is “to establish, promote, own, build, operate and, manage decentralised power stations and energy services in rural areas; to commercialise mature technologies which can save energy, reduce pollution and reduce costs; to commercialise renewable energy technologies, to promote the development and commercialisation of indigenous technologies with the overall framework of the primary objectives; to train villagers to operate, maintain and manage decentralised power systems, energy systems and distribution networks.”

The modus operandi of DESI Power includes setting up of Independent Rural Power Producers (IRPP) in different regions of the country. These IRPPs

would be registered companies under the Companies Act with objectives similar to its parent company viz. DESI Power. These local companies will own a cluster of power plants set up in that region

The local companies will be owned by DESI Power, its local power plant partners, who would also be the beneficiaries or users of generated power, and external investors, if any. The financial and operational arrangements will vary from one local company to another. Profile of the local partner includes any individual, group, commercial set-up, co-operatives, gram-panchayats, etc. A part of the capital will also be met from government grants or loans from funding agencies or banks.

There are two broad type of arrangements, which are available with DESI Power for installing biomass-based power plants.

1. Plants which are promoted directly by DESI Power. In this case, the total responsibility to mobilise the capital investment needed to build the plant will be with DESI Power. The plant will be financed by equity to loan ratio of 1: 1. With DESI Power investing 51% of the equity and local partner(s) investing 49%. The loan component will be obtained from the banks and development funding agencies. Advantages will be taken of any grant that may be available for such plants. Specific arrangements on case to case basis will be worked out if third party investors show interest.

2. Plants on Built-Own-Operate-Transfer basis by DESI Power to any interested party. DESI Power will take the 'turn-key' responsibility to build the plant, train the staff, establish the performance norms for efficiency and reliability, and set-up the management systems prior to handing over the plant to the promoter. Subsequently, DESI Power will offer its services under a commercial contract for regular performance audit, plant management services and refresher course

Based on the above model, the first commercial biomass-based gasifier unit for production of electric power has been set up by an IRPP called DESI Power Orchha which also owns and operates the plant. The plant has been commissioned at TARAGram, Orchha in Madhya Pradesh. Equipment supply and engineering of the plant has been done by NETPRO, Bangalore, based on the design of Indian Institute of Sciences. Part of the funding came from equity contributions from DESI Power (26%), TARA (26%) and 48% funds from a society called Renewable Energy Decentralised (FREND) registered in Switzerland. TARA is the local partner, which is also the user of the power. Total cost of the plant worked out to be about Rupees 2.1 Million inclusive of building and sheds.

5.2.3 Technology - Application, Innovation & Dissemination

Generation and utilisation of power

The gasifier is rated at 100 kW, which is coupled to two DG sets of 62.5 kVA rating each. Local weed called Ipomea is used as the biomass feedstock. The dried biomass is fed manually into the gasifier which runs on an average 15 hr. a day meeting the requirement of electric machines which are being

operated in two shifts, from 06.30 hr. to 14.30 hr., and 12.00 hr. to 20.30 hr. The plant is capable of generating 80 kW of electricity at 440 volts, 50 Hz. The total connected load of the site is of the order of 140 kW, primarily consisting of machines in Hand made paper unit and in Construction material unit.

Recently, TARAGram has also acquired the MPEB connection with the connected load of 120 hp for which it is required to consume minimum units of 7200 per month which are charged @ Rs. 4 per unit. The application for MPEB connection was made much before the gasifier plant was commissioned. TARAGram has now taken the permission from MPEB to utilise the gasifier plant as a captive power generation unit.

Load management is done to manage the loads between MPEB and gasifier plant with the dual objective of consuming minimum MPEB units and ensuring a good Plant Load Factor (PLF) to the gasifier plant. On the technical side, load management also ensures that at any given instant of time, neither of the two DG sets are overloaded resulting in tripping of the overall system.

Plant runs on dried weed called Ipomea, which grows, in marshy lands near water bodies. The woody part of the weed is harvested and chopped into smaller pieces which is then dried to low moisture content. Adequate storage is needed for rainy days. Local population is employed to collect the biomass.

Manpower and other infrastructure details

The plant requires one ITI trained technician and two helpers per shift for its running and maintenance. The ITI trained technician has been given in-house training on gasifiers systems.

His main responsibilities are to supervise operational and maintenance aspects, biomass management, data recording and processing, and maintaining inventory of spares. Two helpers are required to undertake small jobs such as feeding of biomass, data recording, changing over switches, biomass drying and storage etc. Extra help is required for biomass drying and storing in preparation for rainy season.

Its partner TARA as a contribution has offered the land on which gasifier plant is commissioned in kind. Similarly, water supply to the plant (65-70 lit per minute) comes free of cost from recycling of wastewater from TARA's paper unit.

Performance aspects

Plant runs at an average efficiency of 25% and has been able to achieve a fuel replacement figure of over 75%. The cost of generated electricity is roughly around Rs. 4 per unit, which is likely to improve with improvement in PLF, reduction in biomass cost and an optimum diesel replacement figure. Original O&M manual supplied with the plant is being modified extensively based on the running experience.

5.2.4 Barriers and their Removal Exercise

Commercial maturity of the technology:

A strong prerequisite for pushing new technologies from demonstration to commercialisation stage has been their attainment of commercial maturity. Strong RD&D, sound industrial support, ability to provide quality of services, and reliable field performance in terms of operability and maintainability are a few factors defining commercial maturity of a technology. Cases of commercially successful technologies such as the Wind and Bagasse based Co-generation have proven that sound industrial and after sales service infrastructure play an important role in overcoming technical and implementation barriers. In the case of Bio-energy for decentralised electrification, the above factors are yet to be established successfully. More projects similar to Orchha would strengthen the industrial base for gasifier technology.

Overall plant profitability:

Currently, overall plant profitability is poor due to mandatory requirement of consuming minimum units every month from the recently acquired MPEB connection. The speedy approval of MPEB connection was not envisaged earlier at the time of designing the plant capacity. At TARAGram site, MPEB supply is very reliable, further reducing the utilisation of gasifier plant. The entire TARAGram load which was designed to be taken care of by DESI Power plant, is now divided between the MPEB and DESI Power. It is envisaged that the overall economics of the plant would improve with an improved PLF.

The above highlights an important constraint which new technologies continue to face in achieving a wider acceptance. The introduction or access to a more reliable and economic energy supply system always threatens sustainability of such projects. It is important therefore to evaluate such scenario, which might occur at least in the immediate future, and plan accordingly.

5.2.5 Management Related Issues

Biomass management:

Effective and economic collection of biomass has been one of the major problems faced by DESI Power. Several arrangements have been tried such as involving nearby villagers on a daily wages, involving a contractor etc. In the first arrangement, biomass was harvested manually and then chopped using manually operated machines provided by DESI Power Orchha in the villages. The villagers delivered the cut biomass at the site where it was sun-dried. The cost of harvesting and chopping was fixed considering the capacity of an average individual to complete the task and the minimum daily wages they should earn. The cost of the transportation of biomass using bullock carts was taken to be prevalent rates per trip of the cart. The arrangement had problems related to monitoring of daily wagers and cost of harvesting biomass turned out to be much higher than the expected rate.

In order to reduce the cost of biomass, the entire work of harvesting, chopping and transporting has been offered on contract to a single party who would be paid per unit of delivered biomass at site. Although there are not many takers for the contract at offered price, this arrangement has worked with one party who has accepted the contract at a higher rate. Biomass is collected and paid for on the basis of unit standardised volume, instead of earlier practice of measuring total weight which used to vary depending on the moisture content.

On the management aspects, effective biomass collection at viable costs has remained the most crucial barrier for the operation of the plant. This would require extensive planning and co-ordination with the local infrastructure in all future projects.

Plant operation:

In the model of IRPP, it is essential that the Company has its own managerial infrastructure with detailed policies and procedures in place for personnel, operation and maintenance, co-ordination with other agencies, future planning and expansion etc. DESI Power Orchha currently lacks this well-defined infrastructure as is it drawing upon the personnel strengths of TARAGram. Plant operation, which ideally should aim at maximising its profitability, is often influenced by the requirements of TARAGram.

DESI Power Orchcha being the first IRPP, is in the process of developing its own manpower while systematically reducing its dependence on TARAGram. The experience will provide relevant inputs to all future IRPPs where such issues are already being addressed at planning stage.

Utilisation of excess electricity:

One of the key factors in deciding the sustainability of IRPP model is its capability to utilise fully the generated power. This requires effective management of power generation and utilisation with respect to captive consumption, third party sale, wheeling and banking policies of the state etc. At Orchcha, the problem in utilisation of power is currently being faced due to several such issues.

Selling the access electricity to the grid is technically not feasible in this case because the generation of power is at 440 volts while MPEB grid would accept the power at 33 kV rating. Third party sale to neighbouring consumers particularly stone crushing industries requires planning at MPEB level with respect to wheeling and banking if its T&D set up is to be used. Alternately, permission would be required from MPEB for setting up a private T&D network. In addition, planning would be required at third party level with respect to mutually beneficial selling price. Such plans have not had much progress in the current case. For all future projects, which are currently planned, ensuring a good PLF and all subsequent planning / permissions associated with sale of access electricity is one of the major objectives.

5.2.6 Strengths & Opportunities

Replicability of Model

Within its broad framework, the IRPP model is applicable to both rural and urban, un-electrified or electrified communities, as it is basically designed to supply reliable and regular power for domestic as well as commercial energy requirements. The model also attracts diverse investors such as:

- Power / energy utilities
- Industries, both big and small
- Development and private banks
- Pension funds, investment financiers
- Private capital

In addition, the project based on IRPP model can be structured to take advantage of new instruments created under the Climate Convention and other global treaties to promote sustainable development. The model is flexible to incorporate any mature and reliable renewable energy technology and would therefore meet environmental goals. The biggest opportunity for this model, hence, lies in its replicability.

Capacity Building

Due to lack of trained personnel, which could be directly utilised by the industry, the Renewable Energy industry with already low profit margins, is forced to invest in training and giving specialised skills to its personnel.

There is also a lack of appropriate training on the operation and upkeep of RE systems which forces the manufacturer or the supplier to invest in a centrally controlled after sales network of its own rather than utilising the services of an already available network with a little extra training.

To bridge the above gap, TARAGram has taken a step towards capacity building. A mini ITI is being set-jup within the campus of TARAGram to train local people on TARA's technologies which have already found a market not only at local level, but also at National and International level. Training of manpower on gasifier technology and specifically on O&M of DESI Power plant would be an integral part of the programme. The MP government has already approved Land for the institute, as it would prepare local youth in generating employment opportunities for themselves.

Beneficiary as Major Stakeholder

One of the novel approaches for sustenance of the project in this case study is the formation of Private limited company called IRPP. The company is similar to IPP but has the advantage of being physically close to the consumers, involving them as stakeholders and attracting Green Funds for cleaner technologies. Involvement of the local beneficiaries and consumers of energy as partners in the project ensures commercial viability without which the future of any technology is uncertain. As compared to the free supply of energy in demonstration programmes or partial payment agreements in

subsidised programme, the beneficiary in IRPP model is involved in the operation as well as the profitability of the project.

Involvement of Local Financiers

The model addresses the problem of financing of RE projects by involving local financiers and inviting them to be co-promoters. In the present case, TARAGram, which is the local partner, has contributed towards the land and the water supply to the plant. Any individual, or a group such as the co-operative, NGO, local industry, Green Fund etc. can come forward to co-finance DESI Power plant. This aspect is of particular significance for development deprived urban sectors such as the slums and unauthorised colonies where private capital is already invested in small entrepreneurial energy supply systems. A well-developed and organised model like IRPP could take advantage of such investments by ensuring a more reliable and economically attractive service. It could also tie-up with other developmental programmes sponsored by local industries, governmental and non-governmental organisations etc. which are already in place.

Opportunity for Monetary and Personal Benefits

With a reliable and higher grade energy supply through models such as IRPP, urban communities may be given an opportunity to initiate several activities linked with monetary and personal benefits. A few of them are as under:

- Creation of new jobs through the power plant such as for supplying fuel, plant management, O&M.
- Opening of night schools, adult education centres, community centres etc.
- Supply of timely and safe drinking water and energy for cooking
- Increased income for small household industries, traders, small shops etc.

Environmentally Sustainable and Reliable Energy Supply

As compared to energy supply systems depending on conventional fuels, IRPP models rely upon renewable forms of energy technologies. With abundance of natural resources in the country, the technologies that are available for IRPP include;

- Biomass-based systems (gasifiers, combustion etc.)
- Biogas systems
- Mini-hydro power plants
- Wind electric generators and pumps
- Solar PV systems
- Solar Thermal systems

These environmentally clean technologies contribute to the global objective of less dependence on fossil fuels and elimination of carbon emissions. Additionally, they also provide opportunity for incorporation of energy efficiency practices such as waste heat recovery from the cooling water and from the engine exhaust. In Orchcha unit, hot gases from the engine exhaust are utilised for paper drying. About 250 sheets of paper are dried in 5-6 hr.

using the exhaust from the engine. For future projects, cold storage units based on waste heat are also planned.

5.3 CASE STUDY 3: SELCO PHOTOVOLTAIC ELECTRIFICATION PVT. LTD.

5.3.1 Study Highlights

The following case study on the SELCO project focuses especially on the following issues:

- Development of a particular non-conventional niche market technology to a commercially feasible and accepted form of alternative energy source.
- A particular energy need giving rise to development of the alternative source.
- A multi-national or bilateral initiative in successful commercialisation of alternative energy trechnology.

The Solar Electric Lighting Company (SELCO), was established in India by SELF (Solar Electric Light Fund), a US multinational energy development company, in 1994. With its base in Mangalore in the state of Karnataka, SELCO began its activities in early 1995, assembling and marketing Solar Photovoltaic (SPV) power systems for semi-urban and rural households and institutions in Karnataka. It has targeted lighting and entertainment (TV / Radio / Cassette player) needs of households and has chosen environmentally clean SPV technology to provide the services affordably in the form of solar home systems.

SELCO is the only private sector organisations that sells SPV households systems in semi-urban and rural households sector, having sold over 700 Solar Home Systems (SHS) and several SPV water pumping systems in southern states. Its target customers are households which do not have regular access to conventional electricity supplies and who are willing to pay for the services provided.

SELCO's initiative has been supported by a grant from the Rockefeller Foundation, USA and India REPSO- Renewable Energy Project Support Office of the Winrock International. It is the first solar energy service company in the world that has been able to generate profits in its second year of operation. Major stakeholders in the company are SELF and Mr. Harish Hande, SELCO's promoter and Managing Director.

In order to facilitate consumer financing. SELCO entered into a collaboration with a rural development bank, the Malaprabha Grameen Bank (MGB), which has a long experience in micro-credit operations. SELCO's success story is an establishment of mutually beneficial relationships among the system supplier (SELCO), its customers, Nationalised bank (Syndicate Bank), MGB, NGOs, IREDA and foreign investors. It is a fine example of entrepreneurship and support of local organisations in the field of Renewable Energy technologies.

SELCO is a pioneer as an Energy Service Company (ESCO) in the field of renewable energy. ESCOs are fast emerging as probable solutions to supply-end related constraints since they could provide single window solutions to most of the implementation-related problems such as:

- Matching customer needs with appropriate options;
- Marketing and promotion of alternative energy solutions;
- Supply, installations and maintenance of systems;
- Payment collection from consumers;
- Extending credits and loans to consumers.

5.3.2 Stages of Development

The Catalytic Phase

Driven by the objectives of providing a few essential watts using alternate technologies to un-electrified and under electrified households, SELCO set-up the task to 'solarise' households in select areas in a profitable manner via commercial channels. SELF, the parent organisation of SELCO, has already implemented / initiated household electrification projects in eleven different countries using SPV technology, thereby proving its techno-commercial viability. On account of versatility in application, quality of electricity provided, reliable local industrial infrastructure to support the venture, and reasonable penetration of the technology in rural areas as a result of MNES programmes, SPV was an appropriate choice for a similar project in India.

SELCO started its ground level activities in southern Karnataka in April 1995, with a small seed capital from Rockefeller Foundation. The capital was channelled through SELF. These funds were utilised in sensitising the market by installing systems on credit and making them run in shops, residences and offices of professionals, pawn-brokers etc. Under this project, either SELCO provided financing or it came from Tata Finance Limited (TFL), with whom SELCO established a partnership. TFL, in turn, accessed loans from the IREDA -WB project. This not only gave publicity to SELCO and its efforts, it also helped in building a confidence level in the technology and its supplier.

These early systems, which were purchased from reputed system manufacturers and were owned and maintained by SELCO, thus, seeded the market.

The Growth Phase

In November 1996, India REPSO supported SELCO by providing conditional grants for select pioneering efforts. Funds were utilised for working capital to build a rolling inventory at its rural service centres. They also helped in upgrading office infrastructure for establishing effective communication network, aggressive advertising material and acquiring a transport for responsive field service.

SELCO cultivated close relationships with local community including bank branch managers, co-operative heads, influential households and opinion

leaders. Sales, which were initially on cash payment basis, were increasing in number with the introduction of consumer finance through Grameen and Nationalised banks.

It established branch offices called Solar Centres at different towns in Karnataka. These centres were equipped with hardware and were capable of installing and servicing systems efficiently. SELCO service branches have their own technicians who are trained in-house and collection agents who work on an income-cum-commission basis. The workforce also doubles as the salesforce. Its operations have now been extended to the state of Andhra Pradesh.

The Sustainable Market Phase

SELCO's market was initially penetrated through supply of systems on credit. Several finance options were made available and this, combined with a responsive field service, contributed to its growth and SELCO is now self-sustaining and expanding. A few marketing mechanisms and financial models, which are currently being used by SELCO, are as under:

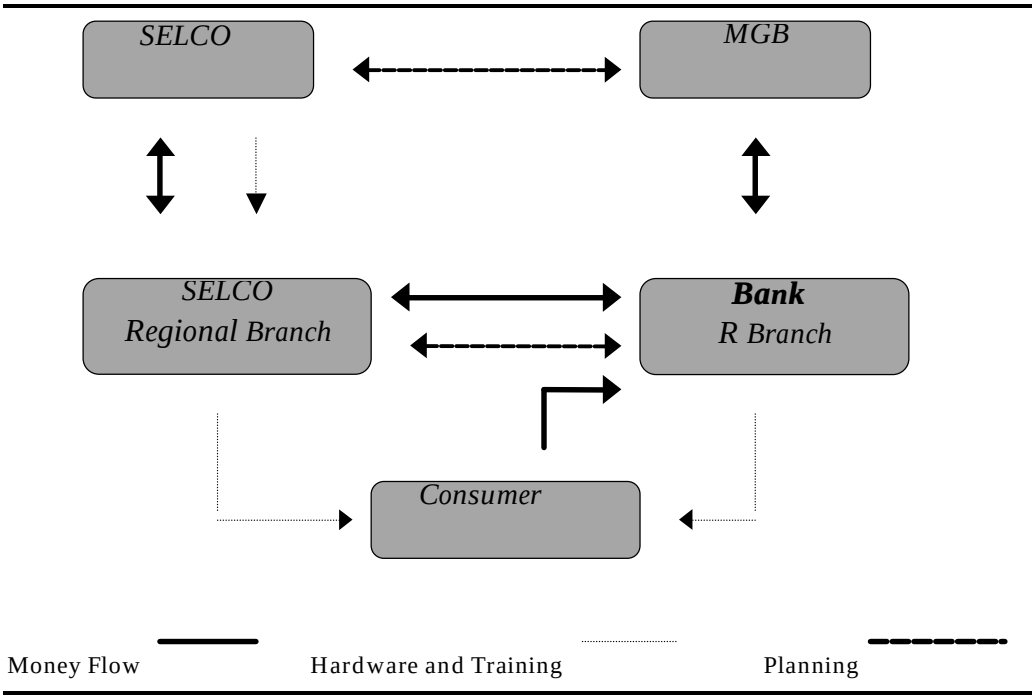
- Cash sales: SELCO installs systems upon placement of order with advance payment from the customer.

- Sales through Nationalised / Grameen bank: These banks offer three-to-five year loans @ 12 to 12.5% to customers for upto 90% of the cost of the system. Application appraisal is as per the bank's own criteria. SELCO's role is to market, install and provide after sales service to the customer.

- Sale through IREDA: In areas where no other financing facility is available, SELCO finances SHS by proving low interest rate with IREDA refinancing @ 2.5% under the World Bank Line of credit. Payment collection is the responsibility of SELCO in such cases.

- Sale through Local institutions: SELCO has tied up with local rural institution such as co-operatives, plantation companies, farmer associations who function like local banks and provide loan to its members for installing SELCO systems.

Figure 5.3a ***SELCO-MGB Collaboration for SPV***



In order to explore international support for extending SELCO's venture in other countries, SELCO International was set-up in April '97 and ownership of SELCO India was transferred from SELF to SELCO International. SELCO International has already started attracting international funds. Energy & Co., a US based International energy investment company has invested in SELCO India in exchange of some equity.

Table 5.3a *Following table summarises stages of development:*

Stage of development	Achievement
Catalytic phase	Grant money used as working capital Building confidence level in the service as well as the provider
Growth phase	Option of several financing schemes Establishment of well equipped and efficient branch offices
Sustainable market phase	Matching customer needs with different techno-commercial packages Investment by foreign agencies

5.3.3 Barriers and their Removal Exercise

In case of SPV, which has primarily emerged as a consumer oriented technology, end-use related barriers are identified as most crucial. Some of the constraints are associated with:

- ability to serve customer needs reliably,

- aesthetics and ruggedness of systems,
- supply and after sales service chain,
- economics of operation and maintenance particularly with respect to changing spares,
- ownership issues linked with high cost of the asset,
- willingness to pay for the services,
- extension of credit to individual customers, and
- marketing and campaigning, general awareness creation and specific user training.

Barrier removal exercises have therefore concentrated more on market oriented issues such as compulsory Annual Maintenance Contract with one year warranty on systems, customer friendly designs, need-based programmes, servicing remote and inaccessible communities etc.

Table 5.3b Following table highlights SELCO's approach in addressing such barriers.

Typical constraints faced by SPV technology	SELCO's approach to overcome them
Lack of end-use based applications	
Earlier SPV programmes were targeted at technology promotion and therefore systems which were developed and introduced through them were community based such as street lighting and power packs. These systems created interest among beneficiaries on the technology, they failed to induce any lasting impact as they did not provide individual benefits.	SELCO's systems are domestic systems and are owned by individual households, thereby bringing the technology closer to the end-user.
Historically poor performance	
Contrary to the general belief, SPV systems demand regular maintenance in the field. Due to large scale dissemination of these systems in remote areas where after sales services could not be provided effectively, system performance was often found to be sub-standard and below expectation.	SELCO's cluster approach, combined with its efficient service network consisting of well equipped branch offices have helped overcoming performance related constraints.
Marginal efforts at sensitizing consumer market	
Most of the awareness campaigns on SPV applications result in dutybound efforts at promoting a new concept. They do not raise fundamental issues such as health and hygiene linked with supply of clean drinking water or children's education through improved lighting.	SELCO's issue based campaigns supported by aggressive advertisements have sensitized the consumer base more effectively in adopting to SPV technology. SELCO has marketed the services rather than the technology, such as the noise free & reliable electricity for lighting and entertainment (TV / Radio).
Restricted growth in consumer market due to high capital cost	
Since SPV technology has a fundamental	With the involvement of Nationalized and

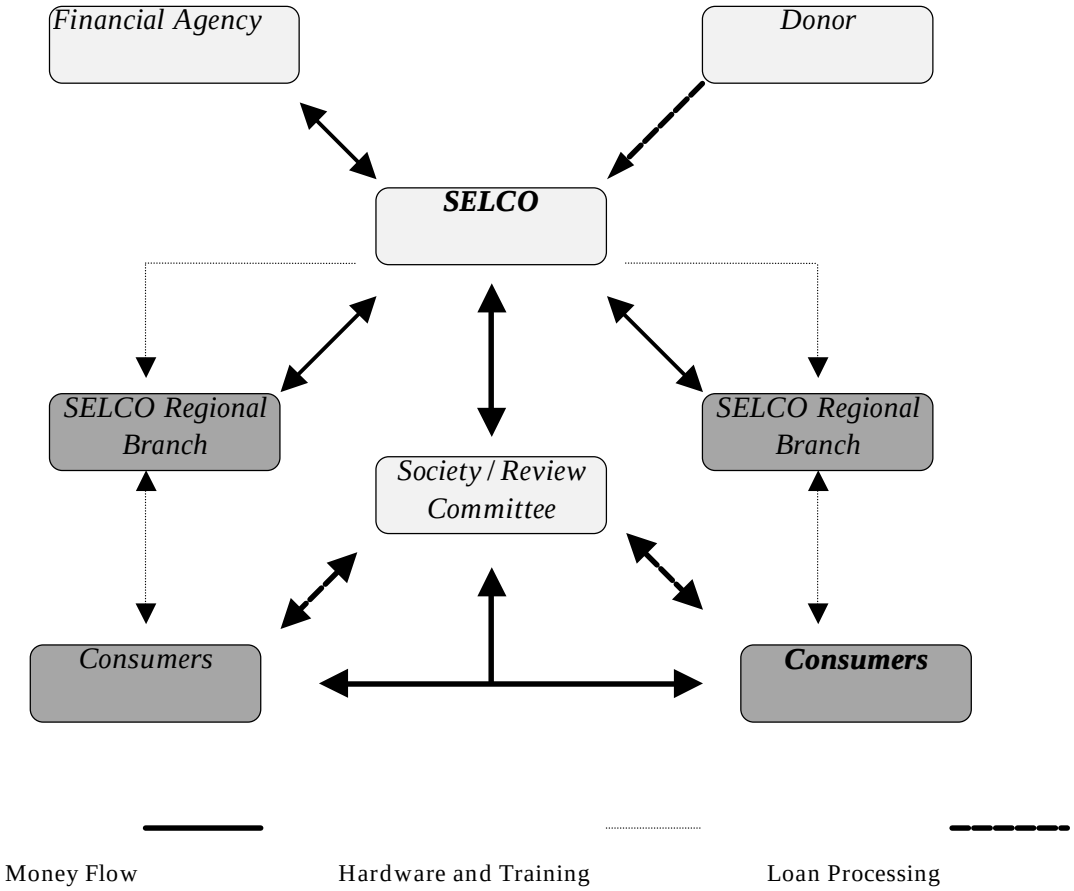
Typical constraints faced by SPV technology	SELCO's approach to overcome them
barrier of high technology cost, even with financial and fiscal incentives extended by the MNES and IREDA, its penetration in consumer segment has been limited.	Grameen banks, SELCO has been able to make the technology affordable to its customers.

5.3.4 ***Strengths & Opportunities***

The prime reason for SELCO's rapid business expansion is reliable, consistent and personalised service to its customers, in comparison to the local electricity boards and local dealers of DG sets and inverters.

With the involvement of banks, SELCO has provided one of the biggest opportunities for SPV systems to penetrate rural and semi-urban domestic sectors. This is the first case where credit facility is available from the banks for purchase and installation of SHS. Since the local community is already familiar with the procedures of availing loans from the bank and thus, it is convenient for them to get their SHS financed. Involvement of the bank also endorses the customer's confidence in the SPV systems. Further, it saves SELCO the risk of default in collection of payment from its customers. Presence of local branches close to the customers expedite their loan applications. The availability of instalment credit schemes at the doorstep of the beneficiary helps in speedy and wide spread diffusion of these systems.

Figure 5.3b SELCO Participatory Model



One of the important approaches, which SELCO adopted, was customer identification and matching of their needs with its techno-commercial offers. In other words, it is segregating customers on the basis of their ability to pay and willingness to pay for specific services. For example, its customers at the lowest level of socio-economic group, are those with an annual income of Rs. 12,000- 25,000 and use kerosene lanterns, candles and torches for lighting. This group opted for SPV to increase their working hours for household and productive uses.

The other end of the socio-economic group consists of households with an annual income of more than Rs. 56,000 and use appliances like kerosene lanterns, transistor, cassette player, torch, colour TV, DG sets, inverter etc. These customers perceive lighting as a basic necessity for the provision of comfort, convenience and social benefits. They preferred SHS for permanence and self-reliance as compared to cumbersome DG sets.

Credit of SELCO's success also goes to the income generating opportunity it provided to local youths by involving them in marketing, payment collection, and field services. Technicians and field staff working with SELCO have all been chosen and trained locally. Local involvement was also enhanced by

formation of local review committees and societies. The review committees control all loan disbursals at the micro level, and comprises the local postmaster, head of the school, and the SELCO branch manager.

SELCO has had a fair amount of success in demonstrating the efficacy of the institutional model it represents. However, the scale at which it has been operating, it is too small to predict its long term sustainability and wider replicability. Also, the operation has not been entirely commercial, as the seed money provided by international donors has been a hidden subsidy meeting some of the establishment costs. Nevertheless, many elements of SELCO's programme, such as decentralisation, strong institutional mechanisms (eg. Co-operative society, review committee), and participatory approach can be seen as factors common to successful low cost alternative energy interventions.

5.4 CONCLUSIONS

The case studies highlight the following:

- It is possible to involve local beneficiaries and consumers of energy as partners. This not only ensures commercial viability of any energy technology option, but also monetary and other benefits to the stakeholders.
- Problems of finance can be resolved by encouraging and involving local financiers as co-promoters of the technology.
- The credit arrangements between the local banks and consumers of energy from new technologies, encourages entrepreneurs to invest in technologies without incurring the risk of non-payment.
- Innovative institutional mechanisms encourage the control of consumers over source of energy, its pricing and reliable availability of energy.

The efforts of the Government of India in promoting RETs have not specifically focused on the urban poor and appropriate institutional mechanisms to ensure reliable supply of energy at the level of their willingness to pay.

6 POLICY RECOMMENDATIONS

The present Government policy, of providing basic amenities like energy only to people living in legal residential structures, needs to be appropriately changed. The poor have shown a willingness to pay, and energy options should be made available to them at affordable prices, regardless of where they reside.

Appropriate credit arrangements should be designed so that entrepreneurs are willing to invest in renewable energy technologies and loans are easily available for the poor to access these technologies.

Innovative institutional mechanisms should be encouraged to involve local people as partners in the process of providing cheap and reliable energy. Local stakeholders should not only share the benefits, but also some responsibilities.

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